Research article

From connections to conservation: Social networks in forest biodiversity management

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ABSTRACT

In response to the global biodiversity crisis, recent policies have increasingly focused on forest biodiversity and its role in broader conservation efforts. While existing research has often emphasised institutional design, policy coherence, or individual knowledge, there is comparatively little understanding of how biodiversity conservation is shaped through the social relationships of environmental street-level bureaucrats (SLBs). This study addresses this gab by examining the role of social networks among environmental SLBs, specifically state forest managers, in the implementation of biodiversity conservation policies.

Utilising a mixed-method egocentric network analysis, we explore the role networks play in facilitating biodiversity measures within German state-owned forests. Our findings reveal a range of perspectives on biodiversity, with an observed tendency for those with greater interest in biodiversity to engage with larger and more diverse networks. We identify three types of approaches towards biodiversity: engaged, routine, and contested. Additionally, the study explores the role of expert advice and the dynamics of advice-seeking within these networks, while also acknowledging the complexities of relationships that influence the implementation of environmental policy.

By integrating street-level bureaucracy with network theory, this research provides insights into the interactions of how implementation practices are relationally embedded. These findings underscore the critical role of interpersonal dynamics and social embeddedness in shaping policy delivery and suggest the need for context-sensitive research that accounts for social network structures in environmental and biodiversity governance.

1. Introduction

In response to the global biodiversity crisis, policy efforts at multiple levels have increasingly targeted forest ecosystems, which are estimated to harbour approximately one-third of the world's biodiversity and play a critical role in conservation strategies (Harrison et al., 2022). However, despite increasing policies and initiatives, the implementation of biodiversity conservation remains insufficient (Pörtner et al., 2021). The ongoing challenges in implementing these policies and initiatives point to a critical need for improved governance systems that can support more effective implementation practices (Xu et al., 2021). One approach to address this could involve emphasising collaborative efforts and relational approaches (e.g. Crona et al., 2011; Groce et al., 2019; Scott,

2015), especially at the local scale of implementation (Mischen and Jackson, 2008; Sodhi et al., 2011). In particular, understanding social dynamics like advice-seeking, trust-building, and learning may be central to explaining how biodiversity policies are interpreted and implemented.

The policy implementation process, often overlooked when new policies are introduced (Peckham et al., 2022), is critical for understanding the practical outcomes of biodiversity conservation policies and their social-ecological links (Angelstam et al., 2003). Whereas the implementation process is inherently complex, policymakers, local managers, and researchers alike need a deep understanding of the interactions between policies and their daily applications to effectively bridge the gap between policy design and practical outcomes (M. Hill,

2014; Hudson et al., 2019). Traditionally, research has focused on whether policies are implemented properly (Hjern, 1982; Sabatier and Mazmanian, 1979). More recently, implementation research within forest conservation has shifted towards bottom-up analysis on knowledge, perceptions, or beliefs of practitioners (e.g. Bieling, 2004; Maier and Winkel, 2017; Trusty and Cerveny, 2012).

One key theoretical approach in such bottom-up research on implementation, is street-level bureaucracy, established by Lipsky (1980). Street-level bureaucrats (SLBs) are civil servants who exercise discretion in their daily decisions while translating policy into practice. They operate in complex environments where rules offer broad guidance but leave room for flexibility. As such, they play a pivotal role in shaping how policies are implemented on the ground (Lipsky, 1980, 2010). Despite their importance, SLBs are often neglected in governance processes, especially within environmental governance (Holstead et al., 2021). While the concept was originally applied in relation to professions such as teachers, police officers, or doctors, it has more recently been extended to environmental actors, including foresters and land managers (e.g. Holstead et al., 2021; Sevä, 2016). Unlike traditional Lipskyan bureaucrats, environmental SLBs often operate at a greater distance from the public, with fewer face-to-face encounters and a more anonymous exercise of authority. This may shape how they interpret, prioritise, or even comply with policy demands (Sevä, 2016). At the same time, their embeddedness in specific ecological and administrative contexts gives them considerable discretion to adapt broad conservation goals to local realities (Bieling, 2004). These conditions make environmental SLBs particularly reliant on professional judgment, peer knowledge, and informal learning to navigate implementation.

German state forest managers exemplify environmental SLBs who are tasked with navigating multifunctional forest management. They have to balance the often conflicting demands of ecological conservation, societal needs, and economic productivity (Maier and Winkel, 2017). The German model of integrative forest management is internationally recognised for its efforts to combine timber production with conservation efforts (Borrass et al., 2017) and reflects this balancing act. Unlike models that separate land use by function, the German approach integrates diverse objectives within the same landscape. However, at the local level, this integration poses challenges, as forest managers have to align the diverse goals of global and national policies including those set concerning biodiversity with the immediate social and economic priorities of their regions (Pascual et al., 2021). Specifically, in German state forests, where multifunctional management is viewed as a role model (Winkel and Spellmann, 2019), forest managers play a pivotal role in negotiating these competing demands. They exercise discretion in implementing national policies while adapting to local conditions and addressing the needs of their higher authorities and other stakeholders (Kenntner, 2013; Maier and Winkel, 2017). To navigate the complexities of everyday decision-making, they rely on information exchange, problem-solving and advice seeking with others.

Although forest managers often describe themselves as independent individualists (Bethmann et al., 2018; Detten and Mikoleit, 2022; Luckert, 2006), they simultaneously emphasise their strong connections with local actors (Detten and Mikoleit, 2022). These connections are essential for the implementation process, seeking expert advice, integrating diverse sources of knowledge, and adapting to local conditions (Agneessens and Wittek, 2012). Such interpersonal ties facilitate peer learning and the mobilisation of knowledge. Still, these same networks can also cause friction. These challenges within professional networks are typically viewed as counterproductive; however, they can play a constructive role by shaping the direction and outcomes of collaborative governance efforts (Ulibarri, 2024). We define such challenging ties as "difficult ties", referring to relationships within a person's social network that are experienced as frustrating, demanding or problematic (Offer, 2020; Offer and Fischer, 2018).

Understanding these social ties, both supportive and challenging, is critical for examining how forest managers balance competing demands in the field. We assume that forest managers interact with a diverse range of people, balancing decisions on biodiversity conservation through interactions with locally operating actors, their experiences, and site-specific knowledge. To better understand the implementation of environmental SLBs, we combine the street-level bureaucracy framework with insights from relationalism and apply social (ego) network analysis, allowing us to explore not only the structure of forest managers' relationships but also their meaning and function in policy implementation. By focusing on a relational approach, including difficult ties, the research seeks to uncover how social networks of forest managers influence the implementation of biodiversity management practices. Specifically, we will (i) explore the social networks of state forest managers as environmental SLBs, focusing on how they rely on interpersonal relations to implement biodiversity conservation measures, (ii) analyse the function of advice seeking in decision-making for the implementation of biodiversity conservation measures and how these processes are embedded in the managers' network structures, and (iii) identify and interpret the role of work-related difficult ties that might hinder the implementation of biodiversity conservation measures.

2. Analytical framework: A relational approach towards street-level bureaucracy

Understanding biodiversity policy implementation requires attention not only to institutional structures and individual discretion, but also to the social relationships in which implementation is embedded. To this end, our analytical framework draws on three interrelated components: the street-level bureaucracy framework (Lipsky, 1980), relational sociology (Emirbayer, 1997), and ego network analysis (Perry et al., 2024). Together, these approaches allow us to conceptualise forest managers as environmental SLBs whose practices are shaped through situated interactions, and to empirically examine how these social ties influence implementation.

The concept of street-level bureaucracy provides a starting point for understanding how policy is enacted in practice. SLBs are public servants who translate abstract policy goals into context-specific action, often exercising discretion in doing so (Lipsky, 1980, 2010). This discretion becomes particularly relevant when policy objectives are vague, contested, or implemented under resource constraints. Environmental SLBs, such as forest managers, operate under such conditions and must balance formal rules with local needs and expectations (Sevä, 2016). However, SLB theory has traditionally focused more on individual-level discretion than on the relational contexts in which it is exercised. While Lipsky (1980, 2010) implicitly referred to informal networks within organisations, where SLBs rely on colleagues for advice or support, recent work has pointed to the need for greater attention to how formal and informal social networks influence discretion and implementation (Lotta and Marques, 2020; Sevä, 2016).

To address this, we draw on relational sociology, and in particular on Emirbayer's (1997) call for a relational mode of analysis. This perspective shifts attention away from individual attributes and towards the patterned relations in which actors are embedded. Actors "derive their meaning, significance, and identity from the (changing) functional roles" (Emirbayer, 1997, p. 287) they play within that relation, and these relations are shaped by symbolic, institutional, and material practices (Somers, 1994). Thereby, relational sociology helps us understand how discretion is not only a matter of individual judgement, but is also constructed through relationships of trust, obligation, dependence, or conflict. The goal is not applicability across settings; instead, we approach networks as a necessary means by which we analyse a specific setting (Erikson, 2013). This opens space to analyse how ties function not only as support structures, but also as potential sources of resistance, pressure, or constraint.

Relational approaches to the overall implementation are well established in bottom-up policy research (Hjern et al., 1978; Mischen and Jackson, 2008). Studies have found that the capacity for

implementation is strongly influenced by the existing network and its ability to distribute information and resources (Frank et al., 2015); going as far as noting that "the study of policy implementation is […] intimately tied to the study of networks" (Mischen and Jackson, 2008, p. 317). Nevertheless, most relational studies in implementation have been conducted in fields such as health (e.g., Braithwaite et al., 2018), education (e.g., Siciliano, 2017), and organisation (e.g., Nisar and Maroulis, 2017), with limited research in environmental or natural resource management. By bringing relational analysis to the context of forest biodiversity implementation, we contribute to extending these insights into an area that has received comparatively little attention.

To empirically investigate these dynamics, we apply ego network analysis, a method that focuses on the personal network surrounding a focal actor (the ego) and maps both the structure and content of their social ties (Herz et al., 2015; Perry et al., 2024). Ego network analysis enables a close examination of how relationships shape behaviour at the individual level while accounting for broader relational patterns. This method is well suited to exploring implementation in contexts where discretion is exercised in interaction with others, and where ties vary in strength, function, and emotional salience. We examine not only who forest managers interact with, but how these ties are used, for instance, for advice, problem-solving, or coordination, and what kind of ties are perceived as strong, weak, or difficult. Advice-seeking in particular plays a central role. It is common for an environmental SLB to be assigned a task without prescribed paths to achieve its goals. For a nonroutine and complex task, such as those often encountered in biodiversity management (Cook et al., 2012), there is rarely a single, correct answer (Nebus, 2006). To identify possible paths toward achieving their goal, forest managers interact with others and seek advice from certain networks that have formed around them. Nebus (2006) describes advice-seeking as a way to navigate such complexity by leveraging the experience and expertise of others. However, advice-seeking is not always deliberate; it is shaped by accessibility, prior relationships, and organisational norms. Although such networks provide support, they can also be restrictive by reinforcing familiar contacts and limiting exposure to diverse perspectives. In the context of SLBs, advice-seeking reflects not just a search for knowledge, but also a negotiation of legitimacy, responsibility, and peer expectations.

In environmental SLB contexts, where managers balance competing goals, such ties are often unavoidable. Exploring the role of difficult ties helps us capture the full range of relational dynamics that shape implementation practice. Research has shown that while difficult ties can reduce information exchange and increase counterproductive behaviours, they can also lead to positive outcomes when effectively managed (Brennecke, 2020). In situations where avoidance is not possible, individuals may attempt to alter or mitigate the impact of these ties (Kyeremeh and Schafer, 2024).

By integrating SLB theory, relational sociology, and ego network analysis, we build a relational framework for examining biodiversity policy implementation. This allows us to analyse how forest managers exercise discretion within a web of social relations, and how different ties shape their implementation strategies and access to knowledge.

3. Methods

3.1. Data collection and boundary specification

Our study utilised a mixed-method ego network analysis to examine the social networks of state forest managers in Germany. In Germany 29 % of the forest is owned by the state (BMEL, 2016). Even though the state forest is not the dominant forest ownership type (48 % is privately owned), state forest is assigned a role model function in multifunctional forest management, balancing ecological, social and economic aspects (Winkel and Spellmann, 2019).

We chose an in-depth case study approach, with boundary specification based on administrative boundaries. Three forest districts were

selected because they operate under a similar forest management regime and share comparable ecological and organizational conditions. While the specific locations remain anonymized to protect participant identities, the cases represent structurally similar contexts within the public forest administration. In each district, five (out of ten) managers were randomly selected leading to a total of 15 interviews. The random selection aimed to avoid selection bias and to ensure that the sample captured a range of managerial perspectives within each site. The use of equal-sized subsamples across districts supported comparability between cases. The first author conducted all interviews between October and November 2023, with durations ranging from just under an hour to over an hour and a half.

All participants were male, aged between 33 and 64 with a median of 53. The study design combined participatory network mapping and semi-structured interviews in a parallel mixed-method design (Kuckartz, 2017). The rationale for this design was to enable simultaneous collection of relational structure and contextual meaning, capturing both the configuration of social ties and the reasoning behind their formation and use. For this, we utilised concentric circles as a hierarchical network mapping tool to collect quantitative structured network data, while qualitative data was gathered through semi-structured interviews (van Waes and van Bossche, 2020) following an interview guideline (see Supplementary S.1). This participatory mapping technique has long been used in ego network research and is particularly suited to eliciting both structural and interpretive data within the same session. Recent work supports the effectiveness of this approach in producing multi-layered data (Jaspersen and Stein, 2019; van Waes and van Bossche, 2020).

We applied a free-choice name-generating technique allowing unlimited nominations. Forest managers were asked to identify relevant individuals or institutions involved in the implementation of forest biodiversity. The managers categorised their contacts into five pre-given categories: 'State Forest Company,' 'Experts,' 'Family & Friends,' 'Research,' and 'Others,' which were tested in pilot interviews. These categories were left undefined for the participants' interpretation. The interviewer further asked about non-human sources (e.g., digital platforms, magazines) used for implementing forest biodiversity. While these were not included in the network map, they were documented as contextual factors due to their role in knowledge acquisition.

Following the name-generating phase, the interviewer asked the participants to place the post-its on concentric circles. Alters highly relevant for the implementation of biodiversity management were placed in the innermost circle, with less relevant alters in outer circles. This spatial representation operationalised relevance as proximity to the ego and served as a cognitive tool to help participants reflect on who matters most in their work. The layout also helped structure the discussion and allowed systematic comparison across cases. During analysis, this mapping supported the interpretation of tie functions (e.g., advice, trust, conflict) in relation to perceived importance and structural position within the ego's network. The alters' position around the circle was chosen freely by participants and was not constrained by predefined rules.

In addition to relevance, the interviewer asked participants to identify three types of ties: Firstly, they identified direct exchanges of information which are crucial for making informed decisions in policy implementation (Borgatti and Cross, 2003; H. C. Hill, 2003). Secondly, the interviewer asked them to indicate with whom in their network they collaborate to find solutions, as problem-solving is practically relevant for SLB and their daily challenges (Agneessens and Wittek, 2012; Chang and Brewer, 2023). Thirdly, the participants were asked to identify strong ties explicitly defined during the interview as "very important and trusted individuals" who play a key role in their work. This phrasing was included in the interview prompt to ensure consistency (see Supplementary S.1). These strong ties constitute a foundation of trust that can reduce resistance. They provide comfort in the face of uncertainty and offer emotional and informational support (Krackhardt et al., 2003;

Krämer et al., 2014). In the last part of the interview, the interviewer discussed difficult ties, which were defined during the interview as frustrating, obstructive, or emotionally demanding relationships.

The visual nature of the participatory mapping served as a narrative stimulus, helping participants to articulate and reflect on their relationships in real time. This simultaneous visual and verbal process complemented the interview sequence and supported deeper insights into network relevance, function, and difficulty (Hollstein, 2024; Robins, 2015). By combining the spatial logic of the map with narrative elaboration, the method yielded both structural and interpretive data in a coherent way. Ego network studies require careful ethical consideration, especially since respondents often report on others who may not wish to participate. To address this challenge, pseudonymisation was used: names were replaced with pseudonyms or institutional roles post-data collection, ensuring only the researcher could link data to individuals. Given the potential for unique identification through a combinations of characteristics (Adams et al., 2019), we provided minimal information about the study location to enhance anonymity. Special attention was given to the data security of the ego. No further data beyond name, age, gender, or institution was collected about the ego. Additionally, we obtained truly informed consent (Borgatti and Molina, 2005) from all participants (see Supplementary S.2).

3.2. Data analysis

We employed Qualitative Structural Analysis (QSA) in line with Herz et al. (2015). This method combines standardised network data collection with qualitative inquiries to explore the network as perceived by the ego (Bakker, 2020). QSA aligns with core principles of qualitative social research, incorporating sensitising concepts, sequential procedures, coding, and memo writing. The analysis was supported by MAXQDA software (VERBI Software, 2024) with no use of its artificial intelligence features.

QSA involves the following four analytical and interlinked steps: (i) *Initial Analysis*: Each network was analysed case-by-case to develop descriptions based on sensitising concepts from social network analysis. These descriptions were documented through memos and summarised into analytical questions; (ii) *Close Reading and Coding*: The analytical questions guided the initial close reading and coding of interview transcripts. The resulting codes were revised and reapplied to ensure consistency; (iii) *Iterative Questioning and Analysis*: Analytical questions were addressed based on the interview reports. New questions from the interviews were applied to the network data, allowing for the iterative development of theoretical categories; (iv) *Cross-Case Analysis*: By integrating network data and interview categories, a cross-case analysis was conducted. This step led to the emergence of key relational categories, including advice-seeking strategies ("informing", "validation") and implementation perspectives on biodiversity ("engaged", "routine", "contested"). These typologies were derived inductively through systematic comparison and constant checking against coded transcripts, ensuring they were empirically grounded and analytically robust. The first author conducted the analysis and engaged in regular peer debriefings through group discussions focused on QSA. This collaborative step enhanced interpretive rigor and strengthened intercoder reliability, particularly important given the dual qualitative-quantitative design.

We used VennMaker 2.0.3 (Gamper et al., 2012) to visualise and pseudonymise the network maps while preserving the original placement of alters and ties. We used the R package 'igraph' (Csardi and Nepusz, 2006, version 2.March 0, 9047) to calculate network measures (for more information, see Borgatti et al., 2022). We focused on out-degree centrality which quantifies the number of outgoing connections from a given node in a directed network (Wasserman and Faust, 1994). Unlike in-degree centrality, which captures how often an actor is approached by others, out-degree provides a measure of proactive engagement in advice-seeking, aligning more closely with our analytical

interest. In our context, this measure captures how actively forest managers reach out to others for advice and information and serves as a proxy for their engagement in advice-seeking behaviour. In addition, we calculated constraint, as defined by Burt (1995), to assess the extent to which the forest managers' contacts are redundant or constrained by their connections, reflecting the ego's access to diverse information and opportunities. Higher constraint values indicate that a node's contacts are more redundant, limiting access to novel information and opportunities. Conversely, lower constraint values suggest a broader range of non-redundant connections, providing greater access to diverse information. This measure is particularly relevant in the context of biodiversity implementation, where access to diverse information can influence the flexibility and innovation of forest managers' decisions.

These structural indicators were not interpreted in isolation. Instead, they were triangulated with interview material to contextualise the quantitative network patterns. For example, high out-degree in advice-seeking was interpreted in light of narratives on trust, collaboration, or conflict. Similarly, constraint was explored not only as a structural condition, but also in terms of perceived dependence or autonomy, as described by participants. This analytic integration reflects what Kuckartz (2017) describes as data-based integration: connecting qualitative and quantitative dimensions to gain more comprehensive insight.

3.3. Methodological limitations

Our study faced several methodological challenges inherent to social network analysis. A key limitation is the subjective nature of network data, influenced by respondents' perceptions and narratives, which can lead to inaccuracies and missing data (Krause and Huisman, 2024). Although stimulators were used to minimise recall bias, they may introduce biases, as respondents could interpret predefined categories differently based on their personal experiences. To address this, we conducted pilot interviews and if necessary provided additional explanations to ensure consistent understanding of the categories. This approach aimed to enhance the reliability and validity of the data collected.

Additionally, capturing the dynamic nature of networks on a static map is challenging. This approach relies on respondents' accurate recall of past interactions (Heath et al., 2009) and provides only a snapshot of the network, missing its evolving nature. To mitigate this, we emphasised the importance of recalling recent and significant interactions during the interviews. Discussing difficult ties further posed limitations, as participants may have felt uncomfortable disclosing such sensitive relationships. To minimise this issue, we ensured confidentiality and tried to develop a sense of comfort with participants, leading to more open discussions. Despite these efforts, some difficult ties may still be underreported, leading to potentially incomplete representations.

4. Results

The results illustrate the individual ego networks of forest managers. We begin with a description of the networks, followed by a qualitative analysis of forest managers' networks All quotes presented are translated from German by the first author.

4.1. Social networks of forest managers

The state forest managers' egocentric networks are distinct, showing a variety of alters and categories, and differing in size (Fig. 1; for detailed views of each of the 15 networks at larger scale, see Supplementary S.3). Each diagram reflects the manager's own mapping of relevant contacts during the interview. Overall, the social networks included 81 distinct alters across various categories, with each forest manager's network comprising between 3 and 24 alters.

The predominantly male composition of the sample reflects the forest management workforce in the selected districts, where all 30 eligible
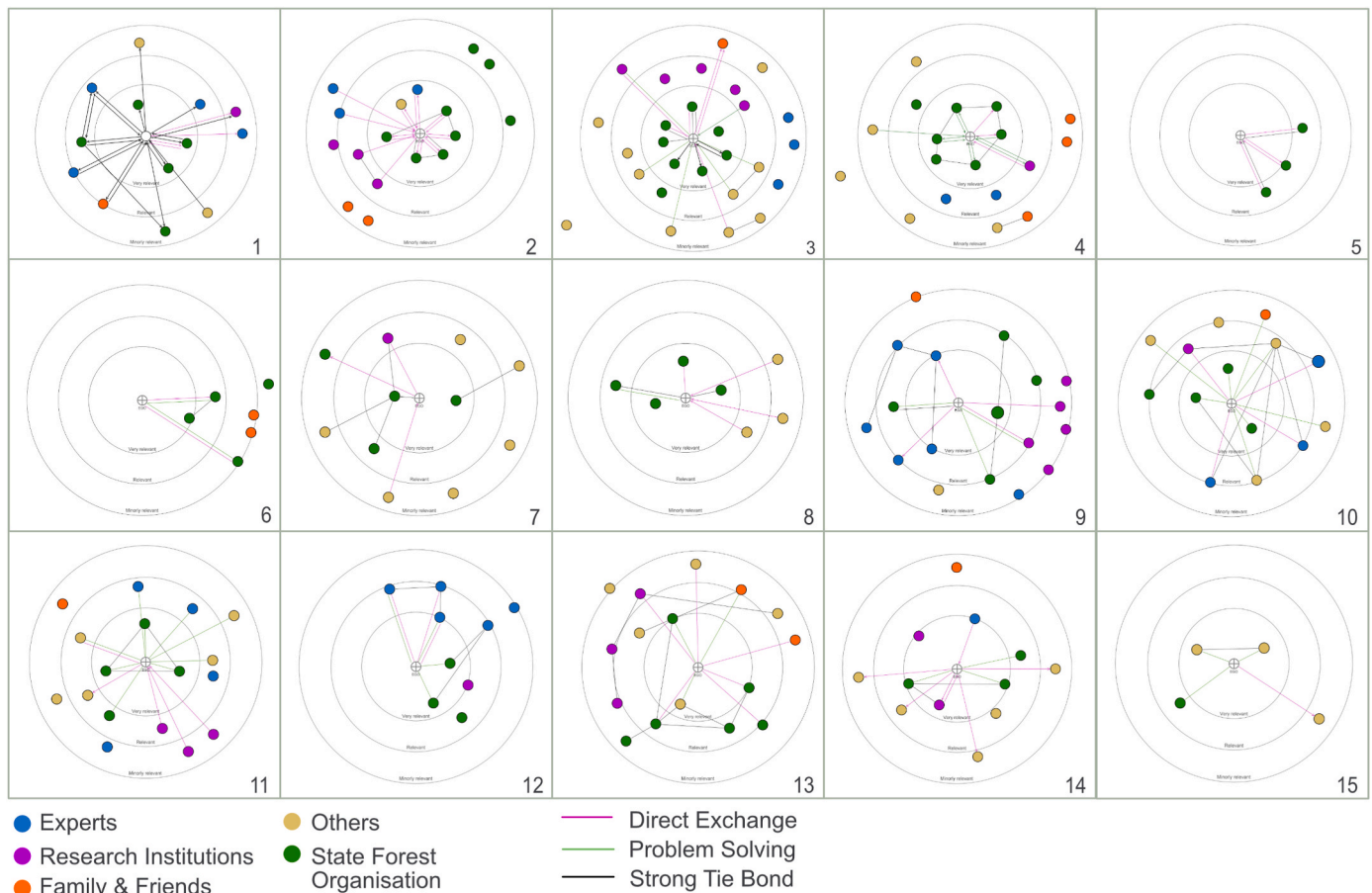
Fig. 1. Egocentric social networks of 15 state forest managers. Concentric circles indicate decreasing relevance; node placement reflects participant input. Node colours represent alter categories: dark green = State Forest Company, blue = Research Institutions, orange = Experts, grey = Others (e.g. civil society), yellow = Family and Friends. Ties reflect relationship types based on participant accounts. Tie colours indicate: black = general relationship, red = information exchange, green = problem solving, and purple = strong tie. For enlarged versions of each network, see Supplementary S.3.

managers at the time of the study were male. This gender pattern aligns with broader structural imbalances in the forestry sector in Germany and across Europe (Johansson et al., 2020). While it was not possible to include gender diversity in this sample, gender was recorded as part of the metadata, and we acknowledge this imbalance as part of the sectoral context in which forest management practices take place. Further, we found no apparent relationship between age and network size, structure, or tie composition. Age did not correlate with out-degree centrality or the types of ties reported, suggesting that individual networking behaviour is not age-dependent in this sample.

Of the 81 alters, 28 were categorised as "Others," 19 as "Experts," 10 as "Family and Friends," 8 as "Research Institutions," and 16 as "State Forest Company." Although "Others," primarily civil society actors, are numerically the largest category, they are not the most relevant and are placed in the outer concentric circle (less relevant). Family and friends are also predominant in the outer circle and, if named, were often mentioned for emotional support or assistance in decision-making while still being perceived competent, as they often worked in the forestry sector. Experts and research institutions mostly appear in the second circle and partly outer circle, indicating they are more important but not the most central figures. Experts were often related to specific topics (e. g., capercaillie, water management). Within the research institution category, all alters are related to the local forest research institutions and their departments, with the nearby university only rarely mentioned.

In terms of relevance, the state forest company dominates the social networks. This is reflected in expressions such as: "My contact person for all these questions is actually always my own company first and no-one

external" (Interview 5, Pos. 34). The core social network primarily consists of intraorganisational contacts within the state forest company. Within the state forest company, the forest district manager and environment division leader were the alters most frequently named, followed by forest manager colleagues, forest workers, and predecessors in the management area.

Interestingly, some managers viewed individuals directly involved in implementing biodiversity conservation measures, such as interns, apprentices, machine drivers, and forest workers, as highly relevant. One participant described the forest workers as the "ones who logically have to realise our ideas" (Interview 2, Pos. 100). In contrast, other managers did not mention these roles at all, highlighting differences in the perceived relevance of various roles within the work hierarchy.

This variability in how forest managers engage with others is reflected in their out-degree centrality, which measures the number of outgoing connections in their advice-seeking networks. Among the 15 forest managers, out-degree centrality ranged from 4 to 25, indicating significant variation in how actively forest managers sought advice. The median out-degree was 13, with several managers displaying particularly high levels of advice-seeking behaviour (see Table 1). These high out-degree values suggest that certain forest managers are more proactive in reaching out to a broader range of contacts for advice. In contrast, lower out-degree values suggest that some managers rely on fewer sources, potentially limiting their access to diverse information. The diversity of these advice-seeking patterns underscores the individualised nature of forest managers' networks and reveals significant variation in their interactions within the context of biodiversity implementation.

Table 1

Overview of Out-Degree Centrality, Constraint, and Tie Composition in Forest Managers' Social Networks for the implementation of biodiversity policies.

Interview	Out-Degree Centrality	Constraint	Number of Information Exchange Ties	Number of Problem Solving Ties	Number of Strong Ties
1	13	0,13	4	0	19
2	18	0,12	18	4	14
3	25	0,05	10	11	10
4	18	0,25	3	1	21
5	4	0,28	5	4	0
6	5	0,41	4	4	2
7	11	0,18	4	1	6
8	7	0,19	5	4	4
9	18	0,11	9	6	12
10	14	0,15	6	10	18
11	17	0,10	7	10	5
12	9	0,27	6	6	10
13	16	0,15	12	2	17
14	12	0,15	7	8	4
15	4	0,46	1	6	2

These differences suggest that both the quality and structure of network interactions are pivotal in shaping knowledge exchange and influencing conservation practices.

Regarding constraint, which measures the extent to which the forest managers' contacts are redundant or limited by their connections, the values vary considerably. For example, Interview 15 exhibits the highest constraint (0.46), indicating a more redundant network with limited access to novel information and fewer opportunities for accessing diverse information sources. In contrast, Interview 3 shows the lowest constraint (0.05), suggesting a broader range of connections, providing greater access to diverse information and opportunities through non-redundant contacts.

The data thereby reveal that forest managers with higher out-degree centrality values generally tend to have lower constraint values, as seen in the case of Interview 3 (high out-degree of 25, low constraint of 0.05). This suggests that managers who actively reach out to a larger number of contacts often benefit from more diverse and less redundant networks, increasing their access to novel information and opportunities. Conversely, managers with lower out-degree centrality, like Interview 15 (out-degree of 4, constraint of 0.46), often have higher constraint values, indicating that their networks are more closed and less diverse, with a higher degree of redundancy among contacts.

This pattern suggests that the more a forest manager engages in advice-seeking behaviours (as indicated by higher out-degree centrality), the more likely they are to develop a network with diverse and non-redundant contacts, which can provide broader access to information and novel insights. On the other hand, managers with lower out-degree centrality may rely on smaller, more tightly-knit networks that offer less exposure to new information, as reflected in their higher constraint values. These dynamics illustrate the individualised nature of forest managers' networks and the varying ways in which they access information and resources.

Further, the ego networks revealed a diverse composition of relational ties without a consistent pattern, with some networks dominated by specific types of ties (see Table 1). For example, Interview 5 has relatively few ties but engages in extensive information exchange with those alters. In contrast, Interview 7 has a larger number of alters but maintains only a few direct information or advice exchange ties. Interview 1, while lacking many explicit direct exchanges, has numerous strong connections, highlighting the strength and cohesion within their network. Overall, direct exchange and problem-solving relations are prevalent, with strong connections forming a significant portion of the ego networks. This underscores the importance of durable and robust relationships in facilitating the implementation network.

4.2. Social networks for implementation

Forest managers tailored their social networks to their local context and implementation needs, leading to a general satisfaction of their network. They regarded their networks as valuable components of their daily routines, positively contributing to their work experiences and the implementation of biodiversity conservation. By leveraging social networks, forest managers exercise discretion in selecting contacts, prioritising their time and efforts. In a first place, forest managers often perceived themselves as generalists, possessing broad knowledge about forests without specialising in specific areas such as bryology. When looking for specialised knowledge, typically, forest managers began with self-directed research using general web-based sources or internal organisational websites, then consulted colleagues within their company, and only turned to external experts as a last resort. While it was common and often necessary to consult within established working hierarchies, the networks' distinguishing factor was their reach to external contacts and experts, providing advice not readily available within the company.

The high variability in the social networks raised questions about the underlying reasoning behind how forest managers seek and use information. Through cross-case analysis, we identified categories, which reflect different relational functions within the managers' networks. These categories emerged inductively through pattern-based coding and constant comparison, following the principles of QSA.

4.2.1. Utilising advice and expertise

Understanding how state forest managers use their advice-seeking networks provides critical insights into how they strategically leverage social relationships to implement biodiversity conservation measures. We assessed the extent to which specialised knowledge was not only exchanged but also how problems were collectively solved within these networks. Managers used the information and knowledge acquired through their networks in two key ways: (i) to make better-informed decisions by acquiring specialised knowledge, and (ii) to gain acceptance and alleviate some of their responsibilities by relying on the expertise of others.

Beyond simply facilitating advice, these networks play a crucial role in shaping how forest managers approach decision-making and conservation efforts, and gain expertise. The exchange of specialised knowledge was pervasive across all alter categories, with the most dominant sources being experts and members of the forest research company. However, all categories contributed in some capacity. Advice-seeking behaviours could not be attributed to a single interview, as all managers incorporated both aspects to some degree, although certain interviews emphasised one function more heavily than the other (see Table 2).

Despite the clear benefits of engaging with experts, forest managers often expressed ambivalence toward their involvement. While experts contributed essential knowledge that informed decision-making and legitimised difficult actions, they were also sometimes perceived as disruptive or intrusive, especially when their recommendations conflicted with the managers' established practices. This ambivalence highlights a tension between internal expertise and external advice, as forest managers, acting as SLBs, must determine whose knowledge should ultimately guide the implementation of biodiversity measures. Despite institutional frameworks and regulations, the final decision remains in their hands.

These dynamics, particularly the tension between advice-seeking and maintaining control over decision-making, reveal the complexities inherent in utilising social networks for biodiversity management purposes. As a result, this can sometimes complicate the process of implementing conservation measures, especially when managers feel their autonomy is challenged by external expertise. Alongside these network complexities, individual approaches towards biodiversity further influence how forest managers engage with their networks, shaping their

Table 2
Two types of advice seeking identified across cases, informing and validation, based on how forest managers use advice in decision-making. Includes descriptions, illustrative quotes, and dominant interview examples.

Type	Description	Example Quote	Dominant in Interview
Informing	Managers use their networks to learn and make better-informed decisions by acquiring specialised knowledge from experts and peers.	"it was fascinating what they [mushroom experts] found up there, types of mushrooms that they thought had died out in Central Europe up there, they somehow found them in the forest, and you know I better with them" (Interview 2, Pos. 106) "It's always interesting to exchange ideas with your predecessor, so * retired colleagues who still know a lot about what happened, so that's always I think it's a good thing to be able to talk to them" (Interview 4, Pos. 110)	1, 2, 3, 4, 7, 8, 10, 11, 13, 14
Search for acceptance	Managers use their networks to gain acceptance or validation by relying on experts' knowledge and hierarchical structures within the state forest company.	"That was a recognised bog expert, so I'm on the safe side." (Interview 10, Pos. 70). "the bottom line is that I would do it via the forest district manager - it's often legal- it often goes into legal matters, which can be difficult and you are well advised to take precautions." (Interview 6, Pos. 216).	6, 9, 10, 12, 15

approach towards implementation.

4.2.2. Approaches towards biodiversity

We identified three general types of approaches towards biodiversity among the managers: engaged, routine, and contested biodiversity (see Table 3). Managers with more engaged perspectives on biodiversity tended to have larger and more diverse networks, while those with routine or contested views had smaller or more constrained networks. These categories, while not mutually exclusive, exist on a continuum, with individual forest managers holding unique and varied perspectives, yet all expressing some level of interest in biodiversity.

These approaches, as seen in Table 2, were closely associated with both forest managers' attitudes toward biodiversity and the structure of their social networks. Engaged biodiversity managers, for instance, exhibited larger, more diverse networks due to their proactive engagement with external experts and institutions. Routine biodiversity managers tended to rely more on internal networks and rarely sought external advice, resulting in more stable but less dynamic networks. Contested biodiversity managers, on the other hand, often had more constrained networks, with limited engagement outside their immediate professional circles, reflecting their scepticism towards species-specific biodiversity efforts.

This analysis highlights how forest managers' approaches towards

biodiversity are reflected in the composition and functionality of their social networks, affecting both the flow of information and the implementation of biodiversity conservation strategies.

However, network composition alone does not always guarantee smooth interactions. Even within well-established networks, tensions can arise due to conflicting management objectives or differing priorities among actors. In the following section, we further explore how these dynamics manifest in the form of difficult ties and their impact on network structure and effectiveness.

4.2.3. Tensions in networks

Difficult ties emerged as a recurring theme throughout the interviews, particularly when participants were implicitly encouraged to reflect on these experiences in the later stages of the discussions. While a few forest managers denied experiencing significant challenges within their networks, the majority acknowledged, either directly or indirectly, that they had encountered difficulties in their working relationships. Importantly, the focus was on difficult ties related to professional challenges and differences in opinion, rather than outright negative ties such as personal dislike or hostility.

Difficult ties primarily stemmed from conflicts of interest related to the prioritisation of biodiversity conservation within the broader context of multifunctional forest management. These tensions often

Table 3
Three perspectives on biodiversity implementation among forest managers, engaged, routine, and contested, based on their attitudes, decision-making approaches, and emotional connection to biodiversity. Includes characteristic descriptions, example quotes, and associated interviews.

Type	Description	Example Quotes	Dominant in Interview
Engaged biodiversity	Managers emphasised varied habitats and species, showing pride and emotional connection to biodiversity in their forest management area.	"Of course it is actually beautiful, so this variety is sometimes really beautifully overgrown with flowers and sometimes with orchids, I know that" (Interview 3, Pos. 506) "suddenly you have tree species that you've only known from books in your life. So this diversity in this area, regardless of whether it's tree species or plant species, that's why I feel extremely at ease here, because it's just so diverse" (Interview 2, Pos. 26)	1, 2, 3, 4, 7, 10, 11, 13
Routine biodiversity	Managers considered biodiversity measures as routine tasks integral to forest management, viewing formalisation – to some extend - as redundant. They felt these tasks did not warrant much additional attention or discussion.	"Most of it [biodiversity implementation] is simply so integrated into everyday life that you rarely really need additional information" (Interview 5, Pos. 314) "In everyday life I'm actually, yes, when you've been around for so long, you're more or less in the routine, diversity is simply in there" (Interview 15, Pos. 24)	5, 15
Contested biodiversity	Managers to some degree questioned some conservation measures, viewed biodiversity measures as an external burden (not adjusted to daily work practices), and felt it sometimes conflicted with practical decision-making. They expressed scepticism about the feasibility of focusing on specific species while managing multifunctional forests and rather emphasised a focus on the forest as a whole.	"at least for me, that's actually the biggest challenge, to manage the balancing act between all the demands that different creatures have on the forest yes. uh what's good for one is bad for the other and vice versa" (Interview 6, Pos. 118) "I always say: "I can't just look at one species, even if it's particularly endangered, I can't focus every measure on this species and do everything for it." (Interview 9, Pos. 24)	6, 9, 12, 14, 8

arose when managers faced decisions that required balancing conservation efforts with other forestry goals, such as timber production. Species-specific conservation measures, for example, were frequently seen as conflicting with the broader objectives of forest management. Misalignments between research and forestry practices further contributed to these challenges, particularly when differences in priorities, communication approaches, or expectations regarding the practicality of scientific findings were misaligned. Although difficult ties within the state forest company were noted, they were relatively rare and typically centred around differing management approaches.

The following table outlines the types of difficult ties identified within the networks. Unlike Tables 3 and 4, not all interviews are represented, and some interviews may appear in more than one category.

These tensions reveal the complexities of managing multifunctional forests, where the interplay between biodiversity conservation, societal demands, timber production, or other forest management goals can create conflicts. Species-specific conservation, for example, often placed pressure on managers to prioritise certain actions that might conflict with their broader management strategies. Similarly, misalignments between scientific research plans and practical forestry operations introduced further additional tensions to the forest managers.

Most managers did not actively choose these difficult ties but were required to engage with certain individuals due to existing structures. Despite these tensions, most managers expressed a pragmatic approach to navigating difficult ties, acknowledging that these conflicts were an inevitable part of their work. Rather than perceiving these ties as insurmountable obstacles, they often viewed them as challenges to be managed through compromise, and strategic decision-making. Nonetheless, the presence of difficult ties had the potential to complicate decision-making and occasionally hinder the smooth implementation of biodiversity conservation measures.

5. Discussion

In a broader policy implementation context, Frank et al. (2015) explored what constitutes a "good" network for an organisation to implement a new policy. They concluded that there is no single "good" network; the value of a network depends on its capacity to channel resources to support a particular practice. From a relational perspective, this reinforces the notion that networks are shaped by the dynamic interactions and relationships within them, as emphasised by Emirbayer and Goodwin (1994). The meaning and efficacy of these networks derive from the evolving roles and interactions among actors rather than any fixed structure. Specifying this within the context of environmental SLBs, we found that networks for implementation are adjusted to individual contexts, seek advice in individualised ways and are influenced by the individual's approach towards biodiversity, and tensions.

5.1. Local context & organisational cohesion in forest management

Implementation results from an everyday process, where environmental SLBs make decisions based on the local context and their experiential knowledge as well as the expertise held within their social network. Such a local focus aligns with Hedlund et al. (2021), who recommend recruiting and developing experienced and trusted "implementation brokers" to provide support tailored to local contexts, as well as ongoing assistance with problem-solving and capacity-building to develop sustainable implementation skills and knowledge. Environmental SLBs, such as forest managers, are physically located in and aware of local ecosystems. They have definite approaches and perceptions about resource decisions and possess additional knowledge about ecosystems, leading them to specific decisions within natural resource management (Aggestam et al., 2020). With the respective amount of discretion SLBs feel competent in shaping strategic responses to environmental pressure based on their unique knowledge (Putkowska-Smoter and Niedziałkowski, 2021). However, forest

Table 4
Types of difficult ties reported in the interviews, including species-related conflicts, research-practice misalignments, and diverging management priorities. Each type is illustrated with a short description and representative quote.

Type	Description	Example Quotes	Present in Interview
Species specific conservation	Difficult ties arose regarding species-specific conservation measures. Participants highlighted challenges in deciding on biodiversity actions, especially those involving the conservation of individual species.	"it's often the case with species experts that they have their species, the butterfly expert only the butterflies, the moss expert only the mosses and you can never please everyone, it always leads to problems" (Interview 7, Pos. 310) "Maybe it's right. I don't want to be to blame if the capercaillie dies out. On the other hand, I have my problem * how long do I ride a dead horse?" (Interview 8, Pos. 122)	4, 7, 8, 9, 12
Misalignments between research and forestry practice	Difficult ties emerged due to tensions between the scientific practices of researchers from the nearby forest research institute and university and the practical management approaches of forest managers. Participants expressed frustration over differing priorities, a lack of communication regarding biodiversity studies, and misunderstandings about expertise.	"You [researchers] do everything that God and the world had forbidden" (Interview 2, Pos. 724) "You feel stupid if you don't know something, and then some people are running around in a harvesting area without even using their brains" (Interview 12, Pos. 181).	2, 12, 14
Management decisions	Difficult ties emerged due to differences in the prioritisation of tasks within and outside the state forest company, e.g. silviculture focused measures versus biodiversity focused measures.	"That doesn't correspond at all with the way I envision it, there's a certain conceptual difference to a few colleagues" (Interview 2, Pos. 642) "The colleagues are all similar in principle, but there are still people who have different specialisms - it's not always easy" (Interview 4, Pos. 290)	1, 2, 3, 10

managers often describe themselves as generalists and frequently have to recognise the limits of their expertise in more specialised areas. To address this, they actively seek advice from their social networks, relying on these connections to access specific knowledge and expertise. This external support helps them manage their discretion and make more informed decisions in forestry management.

Our findings mirror patterns observed in other policy contexts,

reinforcing the relevance of network dynamics in implementation. For example, prior studies in education and local governance have highlighted the central role of intraorganisational networks in facilitating trust and aligning operational norms (Frank et al., 2015; Nisar and Maroulis, 2017). Similarly, Stoettner and Ní Dhubháin (2019) showed that in private forestry contexts, peer influence and relational learning often outweigh formal instruction. These parallels suggest that the relational mechanisms we observe among forest managers in Germany, such as advice-seeking, peer validation, and internal cohesion, are not only locally grounded but reflective of broader trends in environmental SLB behaviour across sectors and settings.

Implementation research in other fields, such as education, reveals that intraorganisational relationships act as vital channels for information and advice transfer, helping SLBs understand and implement necessary changes. These relationships are crucial within the context of high work demands, limited resources, and uncertain job environments (Nisar and Maroulis, 2017), supporting to cope with high-stress work environments by providing emotional support (Lipsky, 1980; Krackhardt et al., 2003). This concept applies well to forest managers who face growing uncertainty in decision-making due to climate change, increasingly diverse management demands, and the accelerating biodiversity loss, which increases the pressure to make informed decisions (Cosyns et al., 2020). The growing complexity of their roles heightens the need for informed, collaborative decision-making. Such a reliance on internal relationships was reflected in the high prominence of state forest company alters in nearly all ego networks. Within the state forest company, intraorganisational ties are critical in this process, facilitating direct information exchange and shared decision-making.

Further, forest managers tend to form relationships with peers who possess locally valued resource (Nisar and Maroulis, 2017), and these cohesive groups play a crucial role in coordinating actions and sharing advice (Frank et al., 2015). However, while these tight-knit networks foster solidarity and efficient decision-making, they may also influence SLBs' attitudes and perceptions of external actors (Nisar and Maroulis, 2017). In this context, public organisations like the state forest company can shape not only how SLBs implement policies but also how they categorise and engage with outgroups. Although forestry has evolved to meet changing societal expectations, the discipline remains grounded in a Western-centric approach that emphasises the management of forests primarily as resources for fulfilling human needs (Himes and Dues, 2024). In the case of the state forest company, this perspective is reinforced by a strong organisational culture that fosters a distinct 'forester identity' and a sense of belonging to the 'forest family' (Detten and Mikoleit, 2022; Mikoleit, 2020). This internal culture promotes solidarity and cohesion among members of the state forest company, which can help streamline decision-making but may also limit the openness to integrating diverse perspectives, particularly those from outside the organisation.

Nevertheless support for core policy values such as nature conservation can vary among individuals within the same organisation, resulting in diverse implementation practices (Bieling, 2004). Personal views and opinions significantly influence natural resource management and the behaviour of SLBs. Behavioural responses of forest managers often lead to different approaches to forest ecosystem services, ranging from token to full implementation (Aggestam et al., 2020). This aligns with prior findings that street-level factors, including policy understanding, knowledge, attitudes, and values, are key influences on SLB behaviour (Meyers and Vorsanger, 2011), whereas a positive perceptions of conservation impacts increase the likelihood of implementing these practices (Joa and Schraml, 2020).

Differences in network structure not only reflect individual variation but also relate to how forest managers use advice and perceive biodiversity. For instance, Interview 3's broad and diverse network supports an *engaged biodiversity* approach and active knowledge seeking. In contrast, Interview 5 demonstrates how even small, dense networks can be functional when biodiversity is viewed as routine and integrated.

Similarly, Interview 15's constrained network aligns with limited advice-seeking and a routinised implementation style. These examples illustrate that relational structure, advice use, and biodiversity orientation are closely linked, shaping how managers navigate implementation challenges.

Previous research highlights the critical role of social networks in fostering engagement in nature conservation. For instance, Stoettner and Ní Dhubháin (2019) demonstrated that social networks are crucial for private forest owners' engagement in conservation, with the influence of peers and reciprocal learning being more effective than external instruction (Bieling, 2004; Salomaa et al., 2016). Our findings align with this perspective, showing an association between forest managers' larger, more diverse social networks and their higher levels of engagement with biodiversity conservation. This relationship suggests that active participation in networks both reflects and enhances a manager's commitment to conservation. However, network size alone does not account for the full complexity of these relationships; the purpose behind advice-seeking plays a critical role. Many managers do not solely seek advice for knowledge acquisition but rather for validation and acceptance within their professional community.

This dynamic suggests that the quality of interactions within social networks can be as important as the quantity of connections. Forest managers with highly engaged peers may benefit from stronger knowledge exchange, which in turn can deepen their commitment to conservation practices. Beyond technical expertise, networks also promote acceptance, collaboration, and mutual support among members. Thus, networks become more than a collection of contacts; they represent an active and influential system that shapes behaviour and decision-making. Enhancing engagement through peer-learning and fostering stronger relationships within these networks may improve the implementation of biodiversity conservation measures.

Although age was not associated with variation in network structure, it is worth noting that many of the participating managers are approaching retirement. This reflects a broader generational shift currently underway in the German forestry sector. While not analytically significant in our sample, such demographic transitions may have long-term implications for how knowledge is shared and networks are reproduced across professional generations.

These relational patterns and typologies may also hold practical value. Understanding whether managers seek advice primarily for information or for validation, and how they relate to biodiversity implementation, can inform where different forms of support may be most appropriate. For example, managers with routine or validation-oriented patterns might benefit from structured exchanges that introduce alternative perspectives, while those engaged in diverse advice-seeking could function as internal knowledge brokers. These insights can guide the design of peer-learning formats or organisational initiatives that align better with the relational practices of different manager types.

5.2. Being an expert and seeking experts

Independent of network size or structure, forest managers often view themselves as autonomous and knowledgeable, functioning as generalists with oversight of their management areas. However from a relational sociology perspective, this sense of autonomy is not simply individual but is shaped by interactions with others. The dynamic relationships they maintain influence their sense of expertise, guiding their decisions and fostering confidence in areas where they lack full expertise. As a result, they perceive that no one else possesses their specific expertise, leading to confidence in independently deciding which measures to implement and how (Bieling, 2004; Primmer and Karppinen, 2010). This reinforces their desire for discretion, rooted in their tacit and local knowledge (Bieling, 2004). Indeed, management involves integrating prior experiential knowledge into new perspectives for practice (Folke et al., 2005), highlighting the importance of forest managers' own knowledge as a base.

However, even the most knowledgeable generalists will have to acknowledge the limitations of their expertise. The practical implementation of conservation measures often requires engaging with locally operating practitioners and mobilising their site-specific knowledge (Primmer and Karppinen, 2010). This need for specialised advice becomes particularly pronounced in multifunctional forest management, where balancing biodiversity conservation with other forestry goals necessitates external expertise (Borrass et al., 2017; Maier and Winkel, 2017). In such cases, forest managers actively draw on their social networks to access both technical expertise and peer support. These behaviours align with Nebus' (2006) theory of advice-seeking, which suggests that actors facing complex, non-routine problems consult their networks to reduce uncertainty, gain knowledge, and avoid costly mistakes.

Importantly, this advice-seeking is not limited to acquiring new information. It also serves a peer-learning function, allowing forest managers to reflect on their own practices in relation to those of their peers. This informal learning, shaped by direct experience and interpersonal trust, reflects a core insight from relational network theory: that knowledge is not only transmitted but co-constructed within relationships (Emirbayer, 1997). However, our findings suggest that peer-learning is not uniform; some managers appear to engage selectively, drawing primarily on familiar or like-minded sources (Levin and Cross, 2004). This selective uptake may reflect not indifference, but a perceived mismatch between the advice offered and their local operational realities or professional values (Raymond et al., 2010). In such cases, learning becomes a filtered process, where knowledge is integrated only when deemed contextually relevant or legitimate. This highlights that peer-learning in environmental governance is not only about access to information, but also about perceptions of trust, relevance, and identity, all factors that shape who learns from whom, and under what conditions (Prell et al., 2011). However, as our network data show, these opportunities are shaped by network structure. Managers with high out-degree centrality and low constraint had access to more diverse, non-redundant ties, which enabled greater exposure to expertise beyond their immediate organisational context. Others, constrained by tight-knit networks, were more likely to rely on habitual sources of advice, often within the state forest company. This reflects both the opportunity and limitation of embeddedness: while cohesive networks foster trust and solidarity, they may also constrain access to more diverse knowledge sources, potentially limiting innovation in biodiversity implementation.

Advice-seeking behaviours are shaped by perceptions of expertise, as individuals tend to seek help only when they believe the other party is knowledgeable in addressing their specific issues (Cross and Borgatti, 2004). Despite their independence, forest managers actively seek advice from peers and experts, particularly within their company, when facing complex problems. This practice aligns with research on environmental SLBs by Sevä (2016), who noted that even in structured decision-making environments, formal policies often lack sufficient operational guidance, forcing SLBs to rely on advice to effectively implement policies. The advice provided by these actors shapes bureaucrats' understanding of policy and informs their decisions (Sandström and Rova, 2010; Sevä, 2016), demonstrating the critical role of knowledge networks in effective policy implementation.

Moreover, research shows that SLBs who actively consult external resources in uncertain situations are more likely to implement policies effectively than those who do not seek advice (Sevä, 2016). The dynamics of advice-seeking play a crucial role in providing resources or general knowledge acquisition of environmental SLBs. Different attitudes toward seeking help can significantly influence knowledge exchange, as individuals may hesitate due to fears of appearing inadequate or risking rejection (Agneessens and Wittek, 2012). However, successful help-seeking can lead to improved problem-solving, organisational learning and positive outcomes for individuals (Cross et al., 2003; Flynn and Lake, 2008).

In complex situations, such as urgent biodiversity conservation, the need for informed decision-making increases, making advice-seeking behaviour even more crucial (Case, 2016). In these contexts, turning to experts not only provides critical knowledge but also might help to mitigate the risks associated with implementing complex conservation measures.

Ultimately, this section illustrates how relational discretion operates in practice. Forest managers selectively mobilise social ties not only to fill knowledge gaps, but to validate their decisions, secure institutional alignment, and navigate complex implementation environments. In doing so, they demonstrate how discretion is not a solitary act but a networked process, shaped by who they trust, consult, or strategically avoid.

5.3. Sensing tensions

Difficult relationships, often overlooked or seen as counterproductive in collaborative governance, play a crucial role in shaping outcomes (Ulibarri, 2024). These difficult ties can lead amongst others to diminished information exchange (Offer, 2021; Venkataramani et al., 2013). From a relational perspective, such ties act not merely as points of friction but as constraints that influence how managers perceive their role, exercise discretion, and respond to conflicting demands. Given the independent nature of their work, forest managers are often able to avoid difficult ties. However, certain hierarchies and expert relationships are unavoidable and may foster tensions that cannot be bypassed. This relational embeddedness means that even when managers feel empowered to make local decisions, the presence of difficult ties shapes how that discretion is negotiated, especially when biodiversity goals conflict with broader management objectives.

Forest managers often face tensions when new policy mechanisms, such as species-specific conservation, impose additional constraints on their operations. This pressure leads environmental SLBs to value their autonomy and discretion, viewing these as essential for managing the landscape of tensions they encounter (Putkowska-Smoter and Niedziałkowski, 2021). Our data show that such tensions frequently emerged when expert recommendations were perceived as impractical, narrow, or misaligned with multifunctional forest management. These conflicts reflect deeper issues of relational legitimacy, whose knowledge counts, who is considered credible, and which goals are prioritised in decision-making.

Notably, the low incidence of difficult ties within the state forest organisation suggests a cohesive internal environment, where shared goals and practices help mitigate conflict. However, this may also result from a tendency to avoid openly discussing conflicts, reflecting a culture in which such issues are downplayed. Thus, the appearance of cohesion may stem from the avoidance of conflict rather than its resolution. This internal alignment likely reflects the strong organisational culture and sense of professional solidarity that characterise forest management, as pointed out by Detten and Mikoleit (2020, 2022). However, the primary challenges faced by forest managers appear to stem from external actors. These tensions often arise from conflicting priorities, as conservation experts may focus narrowly on particular species, which can diverge from the broader, multifaceted goals of the state forest company. This dynamic underscores the complexity of forest management, where forest managers must constantly navigate and reconcile competing interests, balancing conservation efforts with other management objectives (Cosyns et al., 2020).

Understanding these relational dynamics, and how difficult ties influence forest managers' behaviour, is crucial for improving the implementation of biodiversity conservation measures. By addressing the relational contexts in which tensions arise, forest managers can reframe difficult relationships as potential opportunities for collaboration and enhanced problem-solving. While participants may have been prompted to identify challenges in the interviews, these relationships might already be viewed as opportunities. With adequate support and strategic

collaboration, forest managers may be able to further transform difficult relationships into opportunities for enhanced cooperation rather than obstacles to be avoided (Kyeremeh and Schafer, 2024). By reframing these tensions, managers might not only ease the strain on their operations but also foster more robust and adaptive forest management practices.

While this study provides insight into the relational dynamics of biodiversity implementation, several limitations remain. The focus on state forest managers within a single organisational context limits broader generalisability to other actor groups or governance settings. Additionally, the study captures how networks are used in implementation but does not measure implementation outcomes directly. As a case-based and anonymized analysis, findings should be interpreted as analytically transferable rather than broadly representative.

6. Conclusion

This study demonstrates that biodiversity policy implementation by forest managers, as environmental SLBs, is fundamentally a relational process. Rather than relying solely on formal rules or institutional mandates, forest managers mobilise their social networks to interpret policy, access knowledge, validate decisions, and navigate tensions. By combining street-level bureaucracy theory, relational sociology, and ego network analysis, this study offers a relational analytical framework for understanding how discretion is enacted and constrained within situated networks of professional practice.

Forest managers, who function as generalists with a deep understanding of local forest ecosystems, rely on their social networks not only for acquiring technical knowledge but also for validation and support. While larger and more diverse networks were associated with more proactive biodiversity engagement, network structure alone does not determine outcomes. Advice-seeking is not always driven purely by the need for knowledge but by the desire for professional approval, reflecting the dual nature of these interactions as both practical and relational. Following Nebus' (2006) advice-seeking helps forest managers navigate the complex, non-routine tasks of biodiversity conservation. Yet these interactions are shaped by existing ties, which can both enable and limit access to knowledge. Trusted relationships offer crucial support, but may also reinforce established routines and reduce exposure to more specialised or innovative perspectives.

Tensions are an inevitable part of collaborative governance, especially in complex domains like forest management. Conflicts related to species-specific conservation or research-practice misalignments reflect deeper tensions in biodiversity governance. These relational constraints must be acknowledged, not avoided. Supporting forest managers means equipping them not only with technical resources but also with the relational capacity to navigate conflict and ambiguity.

In conclusion, this study contributes to policy implementation research by advancing a relational perspective on environmental street-level bureaucracy. Policy implementation depends not only on the internal cohesion of organisations but also on the ability of SLBs to manage external relationships and navigate the complexities of diverse stakeholder interests. Future research should continue to explore how networks can be utilised, focusing on how to build and sustain relationships that provide both specialised knowledge and collaborative support necessary for successful biodiversity conservation and forest management within its specific ecological setting. The insights gained from addressing difficult ties are particularly valuable, as this area has received limited attention, highlighting a potential field for further exploration. As conservation challenges grow in complexity, fostering strong, diverse, and flexible social networks will be essential for effective policy delivery on the ground.

CRediT authorship contribution statement

Theresa Klara Loch: Writing – review & editing, Writing – original

draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Melanie Nagel:** Validation, Writing – review & editing, Methodology. **Daniela Kleinschmit:** Writing – review & editing, Conceptualization, Supervision.

Declaration of competing interest

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvman.2025.126701.

Data availability

The data that has been used is confidential.

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