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Forest biodiversity conservation between classification and emotional engagement

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ABSTRACT

Biodiversity conservation in European forests operates at the intersection of evidence-based guidelines, bureaucratic governance, and practical fieldwork, shaping how non-human life is valued and managed. This study examines the creation and implementation of the Forest Target Species Guidelines (WZAK) and its associated digital Forest Nature Conservation Information System (WNSinfo) in Baden-Württemberg, Germany, by drawing from political ecology, science and technology studies, and more-than-human geography. The research highlights how conservation is co-produced through scientific classification, institutionalized bureaucracy, and affective engagements with non-human life. Findings from semi-structured interviews and participant observation illustrate that forest conservation governance is shaped as much by institutional and bureaucratic dynamics as by ecological considerations. A fragmented institutional landscape, characterized by sectoral divisions and legal constraints, generates tensions in data accessibility and conservation implementation. While the WZAK conceptually promotes a conservation approach based on forest structures, in practice, conservation primarily targets the selection of certain species. That allows for easier navigation of political and financial constraints, underscoring the persistent friction between systemic conservation strategies and emotional commitments to individual species protection. The WNSinfo, intended to integrate biodiversity data into decision-making, remains marginalized due to institutional ambiguity and bureaucratic inertia, exemplifying the challenges of digital conservation governance. By critically examining the intersections of classification, bureaucracy, and conservation practice, this study contributes to broader discussions in political ecology, demonstrating how conservation unfolds as a political process of negotiation, experimentation, and human-non-human entanglement. It calls for flexible, adaptive governance frameworks that account for the relational and contested nature of forest conservation in political landscapes.

INTRODUCTION

The car rolled to a stop on a narrow gravel road, deep inside the state-owned forest. As I stepped out, the crisp air was punctuated by the sharp barking of two dogs - one belonging to the trainee of the state forest agency, the other to the local forest manager - challenging each other before their owners called them to order. The two scientists, who had helped develop the Forest Target Species Guidelines (WZAK), were already scanning the roadside vegetation. This site had been flagged through the WNSinfo digital conservation platform as a potential area for targeted conservation. Together, we walked along the forest road, inspecting the vegetation and discussing whether the routine roadside clearing - necessary to keep the path accessible - could be adjusted to support butterfly species that rely on open forest structures. The discussion moved fluidly between species requirements, technical feasibility, and administrative realities, revealing how conservation had to be negotiated within existing forestry operations. Later, driving to another site in two separate cars, I sat with the two scientists as they continued their discussion. As I listened, different underlying questions became apparent to me: „What does the butterfly need here?", „How can the forest manager be convinced to implement conservation measures?", „How can a management plan fit within existing funding schemes?", and „How does it comply with legal mandates?"

This vignette, based on my participant observation, offers a situated entry point into the everyday reality of forest biodiversity conservation in Baden-Württemberg, Germany. Rather than a purely ecological or technical task, conservation unfolds as a negotiated process shaped by digital classification tools, bureaucratic procedures, and affective relations with non-human life. The vignette gives exemplary insights into my field work, but it also serves as a conceptual anchor for exploring how conservation knowledge and governance interact in practice.

Forests provide essential ecological and social functions, from carbon storage to habitat preservation and supporting human well-being. In response to ongoing deforestation and forest degradation, the international community has emphasized the need for more effective conservation policies. The 2024 *State of the World's Forests* report calls for innovations in digital tools, financing, and governance models to meet biodiversity and sustainability goals (FAO 2024). However, forest governance remains a complex policy arena, where various goals and actors intersect in uneven and sometimes conflicting ways. In Europe, efforts to integrate

ecosystem service-related objectives have often resulted in fragmented policy, partly due to institutional misalignments and diverging policy rationales (Lindahl et al. 2023).

Political ecology (PE) offers a critical perspective on these dynamics, viewing forests not only as ecological spaces but as landscapes structured through legal decisions, administrative routines, and embedded systems of knowledge (Forsyth 2003, Peluso and Vandergeest 2001, 2015; Turnhout, 2018). Classification becomes a central practice in conservation, determining which species and habitats receive attention (Braverman 2017). Yet these classification systems are not impartial - they carry the imprint of institutional agendas, funding mechanisms, and regulatory constraints (Bowker and Star 1999, Braverman 2014).

As conservation and classification practices become increasingly data-driven, critical questions arise around who defines biodiversity knowledge, how access to ecological information is managed, and what this means for institutional accountability (Rantala et al. 2020). Researchers have examined the politics of environmental data (Brockhaus et al. 2024) and the emergence of digital monitoring tools (Nost and Goldstein 2022).

While considerable progress has been made in understanding global forest governance in general, less is known about how classificatory instruments and conservation technologies function within specific administrative and ecological contexts - particularly in Europe's temperate forests. This study responds to those gaps by investigating the political, epistemic, and practical frictions that emerge when conservation is operationalized through digital infrastructures and evidence-based species frameworks. It focuses on the *Forest Target Species Guidelines* („Waldzielartenkonzept", WZAK) and the associated *Forest Nature Conservation Information System* (WNSinfo), developed in Baden-Württemberg, Germany. These tools aim to operationalize biodiversity targets in forest management by translating ecological data into actionable conservation priorities. Against this backdrop, the study asks:

How do classificatory instruments shape forest biodiversity conservation priorities and decision-making?

Addressing this question, the study offers an empirically grounded contribution to debates on forest governance, knowledge infrastructures, and more-than-human conservation. It engages with recent research that foregrounds the political and infrastructural dimensions of forest and environmental data (Brockhaus et al. 2024, Nost and Goldstein 2022) to provide a situated, reflexive, and practice-aware analysis of the ways in which data and digital tools shape governance. The findings are intended to inform scholars in PE, science and technology studies

(STS), and forest policy and governance, offering insights into the challenges of aligning digital infrastructures, and ecological classifications with on-the-ground conservation work.

THEORETICAL FRAMEWORK

This section outlines the theoretical concepts that guide the analysis. The next subsection engages with literature on PE perspectives, serving as the overall frame for answering the main research question - *how classificatory instruments shape forest biodiversity conservation priorities and decision-making*.

In order to investigate the WZAK case, I developed case-specific sub-questions, which explicitly explore three fields of activities around the development and implementation of the WZAK. These sub-questions structure the empirical investigation (analysis and coding, see section on *data collection and analysis* in the *Case description and methodology paragraph*) and the findings in this paper (paragraph on *Findings*):

1. How are species selected, categorized, and prioritized within the WZAK framework, and how does scientific knowledge inform these classificatory decisions?
2. How do legal, institutional, and administrative structures enable or constrain the integration of the WZAK into forest governance in Baden-Württemberg?
3. How do conservation practitioners interpret and implement the WZAK in decision-making on the ground?

The theory subsection (refer to *Practices of classification and standardization*) deals with classification and knowledge infrastructures, mainly informing the coding and analysis for the first two sub-questions. Subsection on *Affects and non-human charisma* looks at relational and affective approaches to (digital) conservation practices, which help to capture the dynamics on the ground called for in sub-question three.

Political forests and naturecultures: expanding the scope of political ecology

PE has been a crucial arena for exploring human-environment interactions. Originally focusing on the socio-political dimensions of environmental change, PE has examined how power, governance, and material realities shape landscapes (Bauriedl 2016, Forsyth 2003, Mattissek and Wiertz 2014). Within this broader field, the *political forest* (PF) framework (Peluso and

Vandergeest 2001, 2015) has provided a forest-specific articulation of PE's core concerns, showing how forests are not merely ecological entities but governance constructs. While initially focused on dynamics in the Global South, there is an increasing interest in the Global North (Ott 2025). PF do not simply exist; they are actively produced through the interplay of scientific and political processes making conservation and land-use decisions contingent upon both the (seemingly) more technical tasks of classification and zoning as well as on the mediation of state actors, regulatory frameworks, and power asymmetries (Brockhaus and Angelsen 2012, Peluso and Vandergeest 2011). This raises questions such as *what is recognized as a forest, who has authority over it, and how conservation should be practiced* (Brockhaus et al. 2024).

While PE and PF have made substantial contributions to understanding environmental and forest governance, the *naturecultures* perspective introduces an expansion by shifting the focus towards relationality and more-than-human agency. In contrast to a dichotomous separation of nature and culture as a persistent theme in Western thought (Lloyd 2007, Manicas 1992), this perspective emphasizes the mutual entanglement of nature and culture (Braun 2004, Castree 2005, Castree and Braun 2001, Haraway 1997, Latour 1993). Latour's concept of *naturecultures* argues that neither nature nor culture exists as separate, universal categories, but rather as in space and time situated, interwoven entities (Latour 1993). Similarly, Haraway (2003) coined *naturecultures* to highlight the inseparability of the two, framing human-non-human interactions as inherently political and contested processes. Highlighting the limitations of territorial governance models that treat nature as a static entity „out there" to be preserved (Hinchliffe 2007, Whatmore 2002), it expands beyond rigid classifications of species, landscapes, and conservation spaces, calling for a *more-than-human political ecology* (Gesing et al. 2019, Hinchliffe 2008, Lorimer 2015, Myung-Ae 2016). As such, a *naturecultures* perspective moves beyond solely anthropocentric governance models to consider how conservation unfolds as a dynamic, affective, and multispecies process, making it a useful lens for analyzing contemporary conservation efforts (Lorimer 2015, Simberloff 2018).

By locating itself at the intersection of PE with naturecultures, this study highlights not only the institutional and human dimensions of conservation but also the more-than-human negotiations that shape how species, data, and habitats are classified, protected, or overlooked.

Practices of classification and standardization

The classification of nature is a fundamental practice in environmental sciences, conservation, and biodiversity governance. Scholars from STS and PE have critically examined the ways in which classification practices shape human-non-human relations, influence policy decisions, and contribute to knowledge production. These studies highlight that classification is never neutral; it is embedded in epistemic traditions, institutional infrastructures, and sociopolitical contexts (Bowker and Star 1999, Waterton 2003).

The establishment of classification systems often involves standardization, which aims to create consistency across conservation efforts. However, standardization can also obscure the underlying contingencies and negotiations involved in defining conservation categories. Bowker and Star (1999) argue that classification systems tend to become „invisible infrastructures", shaping environmental governance in ways that are often taken for granted. They highlight that classifications are most visible when they break down - for instance, when conservationists encounter species that do not fit neatly into pre-existing categories.

Classification practices establish categorical distinctions within the living world, determining which species, habitats, and ecosystems are prioritized for protection. According to Gesing et al. (2019), classification is a deeply social, symbolic, and material practice, shaping both scientific knowledge and everyday conservation work, and by that highlighting the performative nature of classification - it does not merely reflect an objective reality but actively constructs it. Braverman (2014, 2017) has examined the *biopolitical dimensions* of species classification, particularly in the context of conservation laws such as the Endangered Species Act. She argues that listing a species as „endangered" or „threatened" is both an administrative and a political act, as it determines access to funding, regulatory protections, and conservation efforts. However, the classification process is selective, privileging certain species over others based on their perceived ecological, economic, or cultural value (see also Biermann and Mansfield 2014). This results in what Braverman (2014) calls „listless" species - those that, despite being at risk, do not receive the same level of attention because they lack political or public appeal. Waterton (2003) similarly emphasizes that classification is not a fixed or neutral act but rather a performative and dynamic process. She examines how biodiversity databases, monitoring systems, and conservation protocols embed particular assumptions about nature, often reinforcing dominant paradigms while marginalizing alternative ecological understandings. Bowker, as one of the first, explores in his book „Biodiversity Datadiversity" (2000) how data management in biodiversity science embeds values that shape both knowledge

and policy. He argues that as databases grow, they reflect the political, social, and organizational biases of their creators, often privileging economically and scientifically valued species. Bowker highlights challenges like inconsistent classifications and ethical issues in international data sharing. Moving beyond rigid classification systems, scholars such as Haraway (2008) and Whatmore (2002) advocate for more flexible, open-ended approaches that recognize the emergent and dynamic nature of ecological processes.

Affects and non-human charisma

Classifying nature and ecosystems is not simply a bureaucratic or conceptual exercise; it is a material and embodied practice requiring expertise, sensory engagement, and fieldwork experience as more-than-human geography shows (Lorimer 2008). While some things evoke the impulse to care, others are neglected. According to the so-called *affective turn* (Clough and Halley 2007, Singh 2018, Zariņa et al. 2024) affects play a major role in this dynamic. Affects are understood as potentially physical reactions that often take place „automatically" and subconsciously, but at the same time are not completely „pre-social". Affects are thus located in an intermediate space between a material, instinctive level and a mental, conscious, and social level. Therefore, one key to shape and understand multi-species encounters in a meaningful way is „learning to be affected" (Despret 2004, Haraway 2008).

One way to conceptualize how different species evoke different affectious reactions in humans is by looking at *non-human charisma.* According to Lorimer (2008, 2015) it includes three aspects: *ecological*, *aesthetic*, and *physical* charisma. Ecological charisma refers to an organism's traits (size, behavior, habitat) that influence primarily discoverability and observability, especially in field encounters. Aesthetic charisma is linked to visual appeal, evoking emotional responses like affection or fear, often influenced by anthropomorphic features. Especially for aesthetic charisma, the affects do not only take place on a purely personal level, but rather reflect social preferences or trends (e.g., think of insect-like alien depictions in popular movies). Animals with strong aesthetic charisma can become *flagship species* and, as such, yield significant financial and political power (think of a panda or a polar bear). Physical charisma involves emotional connections in close and regular encounters, shaped by context such as farming, hunting, doing research, etc. For example, the first sighting of a species or the completion of a list is often described as deeply satisfying or exciting situations (Lorimer 2015). All these forms of charisma shape conservation practices,

public perceptions, and political support for species protection and have been taken up to explain (selective) conservation efforts (e.g., Jarić et al. 2020, Molhuizen et al. 2025).

In line with a *digital turn* (Ash et al. 2018) there is a growing body of literature on the role of digital data and technology in shaping emotional and affectious human and non-human interactions and environmental governance in recent literature (Nost and Goldstein 2022). More specific the paradox role of disconnection (Soga and Gaston 2016) and reconnection to nature and wildlife through digital tools like smartphones, social media and augmented reality has been investigated (Adams 2020, Peltola and Ratamäki 2023): they can both bring people closer to nature by facilitating learning and deeper engagement, and distance them by mediating and potentially disrupting the direct experience of nature. Von Essen et al. (2023) highlight in a similar way the paradox of *digital intimacy*, where animals become more accessible yet distant, often commodified through digital surveillance technologies. They may deepen public connections to wildlife, but also risk prioritizing surveillance over authentic engagement, raising ethical concerns about animal agency and privacy. Charvolin (2024) explores amateur naturalists' participation in a citizen's science biodiversity database, emphasizing their deep attachment to nature and ethical responsibility in biodiversity monitoring. Rather than being driven by self-interest or social stratification, contributors engage out of passion and a sense of indebtedness to nature.

Synthesis and application of concepts

The integration of PF with naturecultures offers a productive expansion of PE that has been underexplored. While PF provides the institutional and governance-based foundation for understanding conservation as a structured process embedded in power relations (reflected in findings, sections on *Classifying nature for conservation* and *Cumbersome institutions*), naturecultures extend this analysis by emphasizing relationality and non-human agency.

Scientific classifications, such as those embedded in conservation databases and policy frameworks, can be seen as governance tools that define what to conserve and whose knowledge is legitimized in decision-making. This is evident in the creation of species lists, digital conservation infrastructures, and bureaucratic zoning, which mediate the ways forests and forest species are understood, protected, and managed. These insights shaped my coding categories related to bureaucratic classification, ecological expertise, and tensions in species prioritization for answering the first two sub-questions (findings on *Classifying nature for conservation* and *Cumbersome institutions*).

The perspectives of naturecultures, including the non-human charisma concept, helped me to trace how affective responses shape conservation decisions, particularly around certain species, who dominantly appeared in the interviews (like the capercaillie or butterflies; see findings, section on *Cluttered field realities*).

CASE DESCRIPTION AND METHODS

WZAK guideline and WNSinfo information platform

Baden-Württemberg, located in southwestern Germany, features extensive forest landscapes, species-rich grasslands, and a variety of habitats shaped by centuries of mixed land use (Konold et al. 2020, LUBW 2024). Its position at the intersection of Central European and Alpine biogeographic zones contributes to high ecological diversity, including many endangered and protected species (MLR 2020). To address this ecological responsibility, Baden-Württemberg launched strong political initiatives for biodiversity conservation, including a *special program to strengthen biodiversity* (MLR 2018) and the forest-specific *Forest Nature Conservation Strategy* ("Gesamtkonzeption Waldnaturschutz") (ForstBW 2015).

The *Forest Target Species Guidelines* („Waldzielartenkonzept", WZAK) (Braunisch et al. 2020) emerged from these efforts to integrate biodiversity conservation more systematically into forest management. To achieve this goal, 122 so-called „target species" were systematically selected through a combination of algorithmic and expert-based approaches, ensuring representation across diverse species groups (e.g., mammals, vascular plants, birds). These species and their habitat requirements served as key indicators of essential forest structures at various spatial scales within the forest communities of Baden-Württemberg (Braunisch et al. 2020, p. 53).

Beyond the species list, an online platform, the *Forest Nature Conservation Information System* („Waldnaturschutz-Informationssystem", WNSinfo), was developed to support implementation. The platform provides detailed species-specific information and conservation recommendations for forest planning, particularly for endangered species. In addition to the WZAK target species, the WNSinfo platform also includes other endangered and „listed" species, primarily those designated under Natura 2000, with some species appearing on both lists.

The WNSinfo platform serves multiple functions (see Figure 1), including:

- Integration of existing biodiversity data,
- Data exchange with external databases,
- Interfaces and tools for data input, quality assurance, and management,
- Information provision for different target groups, and
- Data preparation and accessibility for forest management.

Figure 1. The functions of the „Waldnaturschutz-Informationssystem" (WNSinfo information system) according to the official webpage (FVAa); text was translated by the author from German to English.

Institutional context of the WZAK

The WZAK guideline is embedded within a complex institutional framework. It is an integral component of the *Forest Nature Conservation Strategy* (ForstBW 2015), developed under the umbrella of the Biodiversity Strategy of Baden-Württemberg, Germany (BMUV 2024). This strategy aligns with the EU's Natura 2000 network under the *Birds* and *Habitats Directives* (EEA 2024), nature conservation frameworks requiring member states to achieve biodiversity goals while granting them flexibility in designing national legislation to implement these objectives (EU 2025).

At the state level, the Forest Nature Conservation Strategy operationalizes these EU directives, with a particular focus on forest ecosystems and their ecological significance. The administrative structure in Baden-Württemberg follows a sectoral approach, with a division of responsibilities between open land and forest ecosystems. This results in the jurisdiction of two separate ministries:

- The *Ministry for the Environment* (UM) oversees open land conservation, biodiversity, and environmental policies.
- The *Ministry for Rural Areas and Consumer Protection* (MLR) governs forests and forestry-related policies.

Within these ministries, different institutions are responsible for scientific guidance and policy implementation:

- The *State Institute for Environment Baden-Württemberg* (LUBW) operates under the UM, handling biodiversity and species conservation across all ecosystems.
- The *Forest Research Institute Baden-Württemberg* (FVA) functions under the MLR, focusing specifically on forest research and conservation.

Furthermore, a significant institutional restructuring took place in Baden-Württemberg's forest sector in recent years, primarily aimed at ensuring fair market competition among different forest ownership types. This restructuring led to the separation of:

- The *Forest State Administration* (LFV) – which now serves as the regulatory and policy authority overseeing the management of all ownership categories.
- The *State Forest Agency* (ForstBW) – which functions as the economic and management body responsible exclusively for state-owned forests.

The FVA remains part of the LFV and thus conducts research and provides support across all ownership types. However, in practice, the Forest Nature Conservation Strategy, being a state-level implementation of the EU directives, is only legally binding for state-owned forests, which fall under ForstBW's management.

Data collection and analysis

For this study, I employed a qualitative, actor-oriented research approach to examine the interplay of digital conservation tools, bureaucratic structures, and more-than-human conservation practices. To explore the perspectives of key stakeholders involved in the implementation of the forest target species concept (WZAK) and its associated digital information platform (WNSinfo), I conducted 11 semi-structured interviews from August until December 2024. I purposefully selected interviewees to ensure a diverse representation across different actor groups including an institutional gradient, including state forest administrators

(interviewees I5, I7), regional forest conservation practitioners (I8, I9, I10, I11) and scientific experts involved in the development (I1, I4) and implementation (I2, I3, I6) of the WZAK. The criteria for selection were professional working experience with the WZAK and WNSinfo, either in the development process or application context. With this selection, I aimed to capture the range of expertise, institutional perspectives, and practical experiences in order to address the three research sub-questions adequately.

Theoretical concepts such as classification politics, institutional governance, and non-human charisma informed the development of the interview guide. I designed the interview structure in order to elicit both episodic and semantic knowledge (Flick 1995). Episodic elements focused on concrete experiences with the WZAK and WNSinfo, including decision-making processes, encountered challenges, and affective engagements with conservation efforts. Semantic components addressed broader themes such as governance frameworks, conservation philosophies, and institutional interactions. Interviews lasted between 45 and 90 minutes and were conducted in person or via online conferencing tools (*Zoom, MS Teams,* and *Webex*). I recorded, transcribed, and anonymized all interviews for analysis, following ethical and methodological standards for qualitative research (Kaiser 2024). All quotes used in this article are translated from German to English, while aiming to preserve their original meaning. I used verbatim quotes selectively - primarily where they illuminated interpretive or practice-oriented insights not easily captured otherwise. I excluded redundant filler words (marked by „[…]") to ensure clarity, while maintaining the integrity and meaning of the original speech (Kaiser 2024).

In addition to interviews, I conducted a participant observation (PO) on November 14, 2024, to gain insights into the day-to-day realities of nature conservation work (Guest et al. 2013). Over one day, I accompanied conservation practitioners and forestry officials during field visits and internal meetings where conservation measures were discussed and implemented. I maintained detailed field notes to document these engagements, focusing on interactions, negotiations, and emergent problem-solving strategies. Those notes build the foundation for the vignette at the beginning of this article (cf. Schöneich 2021) as well as parts of the finding sections.

I analyzed the data using a combination of deductive and inductive coding techniques within the software *MAXQDA24* (Mayring and Fenzl 2019). Based on the theoretical framework and the sub-research questions, I developed an initial set of codes: *classification (norms and values, expertise), bureaucracy (data, institutional structures), field-level implementation (non-*

human-charisma, affects). After several coding rounds with continuous comparison between interview data, observational insights and the theoretical framework I adapted and supplemented the initial codes leading to the final set (three levels): *classification (creation process, expertise, norms and values), bureaucracy (data [collection, management, access], institutional structures, law, economy, barriers), field-level implementation (affects [care, fear], non-human-charisma, experimentation), conservation and change (species and structure)*. I structured the findings according to this final code system. Each finding section represents mainly one first level code in order to answer the research sub-questions (*refer to chapter on Theoretical framework.*): *classification* for the analysis of the development of the WZAK (section on *Classifying nature for conservation*), *bureaucracy* for the entanglement of conservation efforts within institutional and political landscapes (*refer to section on Cumbersome institutions*), and *field-level implementation* for the situated implementation of conservation practices (*section on Cluttered field realities*). Some codes (e.g. *conservation and change, data, affects*) run also across the sections.

During the writing process of this article, I used *OpenAI* - language model *GPT-4o* - in order to enhance the readability of the text. In line with the COPE guidelines for AI use (COPE 2023), I reviewed and edited the content carefully after using this tool/service and take full responsibility for the content of this publication.

FINDINGS

This section presents the empirical findings. It demonstrates how forest biodiversity conservation is conceptualized and confronted by human and non-human actors and factors through the classificatory WZAK guideline and its WNSinfo information platform. In line with the overall aim of the study and in particular the three research sub-questions (refer to chapter on *Theoretical framework*), it touches the following main aspects:

Firstly, the subsection on *Classifying nature for conservation* sheds light on the scientific creation of the guideline and which values and normative considerations underlie the involved concepts. Secondly, the subsection on Cumbersome institutions shows how the guidelines and the information platform are entangled in a bureaucratic system, with its own rules and dynamics. Thirdly, the subsection on *Cluttered field realities* focuses on the actual „doing conservation," that is, implementing concrete action (in the field).

Classifying nature for conservation

How are species selected, categorized, and prioritized within the WZAK framework, and how does scientific knowledge inform these classificatory decisions? Understanding the creation process behind the forest target species concept (WZAK) requires examining not only the scientific methodology but also the underlying values and normative considerations that shaped it (refer to the section on *Practices of classification and standardization*). The following subsections reconstruct the development of the WZAK, based on the interviews, participant observation, and official documents, and explore how scientific classification interrelates with non-human life in both theory and practice.

Scientific methodology and expertise

The WZAK was designed as a practical tool to facilitate species conservation within forest management. However, its primary objective is not solely the protection of individual species but rather the conservation of forest ecosystems as a whole. By focusing on key species that serve as ecological indicators, the approach aims to preserve essential habitat structures that support broader biodiversity. Developing such a scientifically grounded species list was a complex and multi-stage process (Braunisch et al. 2020). According to the developers (I1, I4), the first challenge was defining clear inclusion criteria, specifically determining whether a species should be classified as a forest target species. Because the WZAK emphasizes habitat structures, this decision was inherently tied to the classification of forest types (Braunisch et al. 2020). The key criterion for selection was the specificity of a species to a particular forest type - in other words, species that appear exclusively and consistently in a distinct forest structure were considered representative of that habitat.

Translating this conceptual approach into a concrete species list was not straightforward (I1, I2, I4). It required an iterative selection process that combined algorithmic approaches with expert assessments. Algorithmic selection analyzed species distribution and habitat preferences using quantitative data, while expert assessments relied on ecologists and conservationists evaluating species based on practical field knowledge and ecological significance (Braunisch et al. 2020). Despite the rigor of this dual approach, interviewees (I1, I3, I4) highlighted that further adjustments were necessary. Some species, while theoretically ideal umbrella species, posed practical challenges. Certain species were poorly documented or virtually unknown, making identification difficult, while others required highly specialized expertise to recognize, meaning that their conservation and monitoring would be impractical. As a result, the final

selection underwent additional refinement, incorporating ecological feasibility alongside scientific rigor (I1, I4).

Norms and values

While conservation efforts often emphasize saving specific species, the WZAK's architects primarily saw themselves as advocates for ecosystems rather than individual life forms (I1, I2, I3, I4, I6). One interviewee (I2) explained that certain species might not survive climate change, but conservation efforts should still focus on ensuring that the habitat itself remains intact. Despite concentrating on singular species, conservation within the WZAK framework is ultimately understood as protecting the complex interplay of living beings within an ecosystem. While this aligns with the WZAK's conceptual foundation, it also creates tensions in practical implementation, which will be further explored in the section on *Cluttered field realities*. The shift from species-specific conservation to structural conservation means that while the WZAK provides a framework for protecting biodiversity, its measures do not always translate into direct protection of individual species, a point that can be contentious in conservation debates.

When interviewees were asked why specific forest ecosystems should be prioritized for conservation, two primary justifications emerged. During the participant observation, two interviewees emphasized an intrinsic value perspective, where forests and their biodiversity are preserved for their own sake, independent of human benefit. Others argued from a utilitarian and anthropocentric perspective, where conservation is motivated by cultural, historical, or practical considerations (I1, I2, I3, I6). One interviewee illustrated this perspective with a metaphor, comparing conservation to the maintenance of medieval cathedrals in European cities. Just as significant resources are dedicated to preserving historic buildings shaped by past human practices, according to the interviewee, certain forest types, formed under now-declining management regimes such as cattle grazing, should be maintained due to their aesthetic, cultural, and ecological value for future generations. Beyond this historical and aesthetic argument, another, more relational logic of care emerged. Two interviewees expressed a commitment to protecting life, independent of whether future generations will experience certain species or habitats directly. It was not about whether their children would ever see a specific animal or type of forest, but rather that its continued existence was intrinsically valuable. However, this commitment to preservation was often tempered by realism. Many interviewees acknowledged the limits of conservation in the face of climate change and societal transformations (I1, I2, I3, I5, I6). A common sentiment was that not all

species or ecosystems can be saved, and that conservation must focus on systemic resilience rather than absolute preservation.

Cumbersome institutions

How do legal, institutional, and administrative structures enable or constrain the integration of the WZAK into forest governance in Baden-Württemberg? As outlined in the sections on *WZAK guideline and WNSinfo information platform*, and *Institutional context of the WZAK*, the WZAK and WNSinfo are part of a broader forest nature conservation strategy. Their development and implementation are embedded within multiple layers of governance, spanning from EU regulations to regional policies, creating a bureaucratic landscape with its own internal logic. This landscape reflects the interplay between structure and tool, tensions between various governing bodies and their domains of influence, as well as questions of authority, access, legitimacy to data and advocacy over the non-human world.

The mutual influence of tools and structures

During my interviews, it became evident that the WZAK serves political purposes beyond ecological measures. On the one hand the tool is used by forest conservation administrators and practitioners to support their political standing and agendas (e.g., for application for funds, or to justify competence and actions) and on the other hand the tool itself is shaped by the institutional landscape as it has to fulfill certain legal and technical requirements.

Starting at a high political level, the mere existence of an evidence-based guideline is seen as a powerful political tool:

„Of course, there is EU law. There are certain obligations that you have to fulfill at the EU level, and it is always good if you deliver guidelines that help meet these obligations; they are very popular." (interview 4, pos. 83)

Further down the institutional hierarchy, Baden-Württemberg maintains an administrative distinction between open land and forest ecosystems (refer to the section on *Institutional context of the WZAK*). This division is reflected at both the ministerial level (MLR for forests and UM for open land) and the scientific-advisory level (FVA for forestry research and LUBW for nature conservation). While LUBW officially leads species and nature conservation across all ecosystems, the FVA, as the state's forest research institute, plays a key role in forest-related questions, particularly from a landscape and structural perspective. Despite this theoretical division, institutional boundaries are not as rigid in practice. The WZAK itself exemplifies this

overlap - it integrates species conservation while remaining within the FVA's mandate by focusing on forest structures and habitats rather than (individual) species.

Interviewees described willing and constructive cooperation between institutions in most cases (I8, I9, I11). However, tensions persist, particularly regarding how forest nature conservation should be effectively integrated into forest management. In this context, the WZAK is perceived as a tool that advances forest-related institutions (e.g., LFV) politically:

„We occupy a thematic field and want to develop it professionally, work on it extensively and satisfactorily. As far as nature conservation administration [LUBW] is concerned, we are very convincing with such guidelines, and approaches like this are incredibly helpful." (interview 7, pos. 43)

The interviewee continues to explain that there was also hope of securing budgetary resources with the help of the WZAK. However, leveraging such guidelines as political tools is not without challenges. They must align with legal and political expectations, while remaining adaptable to shifting political priorities:

„There are topics that are readily implemented, accepted, and promoted. […] And then, on the other hand, there are certain things that are just not so 'sexy': […] At the moment, we have an absolute moratorium, a stop to process conservation areas. I sometimes feel that what is currently in vogue and what is needed can be very short-lived." (interview 4, pos. 83)

In the case of the WZAK, integration into existing administrative structures and political frameworks has been only partially successful. Again, this can be linked to institutional logics. While the WZAK and WNSinfo were designed to be applicable across different forest ownership categories, their implementation in state-owned forests carries unique legal pressures, whereas their adoption in private and communal forests remains an open question.

This distinction matters because state forests in Baden-Württemberg are the most centrally regulated - or, at the very least, the most centrally controllable. As a result, new tools must be integrated into pre-existing, standardized systems. In the case of the WNSinfo as an online information platform, this remains an ongoing challenge that has yet to be fully resolved. Interviewees (I3, I5, I7, I8, I11) raised concerns regarding the WNSinfo's role and place within existing workflows, particularly in relation to older, but well-established digital systems named Fokus 2000/InfoGIS, which are already embedded in ForstBW and LFV operations:

„I would say it is the FVA's playground. Which has advantages and disadvantages. The advantage is that you are relatively free - you can try things out, add elements, and see how

they work. The disadvantage is that it remains in this 'FVA island existence,' so to speak. And it doesn't achieve a real, let's say, official status" (interview 5, pos. 60).

Beyond administrative integration, legal considerations also influence the WNSinfo's credibility as an official platform. The source of information used in legal procedures is crucial, as highlighted by one interviewee:

„In legal matters, we are usually asked a question, which is then backed up by an administrative act. An administrative act also contains legal remedies. [...] And if an appeal is lodged, the files are requested, and everything must be properly documented." (interview 8, pos. 20)

This interviewee further explained that, in legal assessments, the preference is to avoid citing WNSinfo as a reference, opting instead for Fokus 2000, which is already embedded in standard legal procedures within the LFV. However, it was acknowledged that the WNSinfo does offer advantages for rather informal communication, particularly within internal planning processes, where legal considerations are secondary and WNSinfo's technical features allow for more efficient data handling compared to Fokus 2000. Ultimately, the future positioning of the WNSinfo and WZAK within institutional frameworks is seen as a political decision: „That has to come from the top. Simply put - what status do we want to give it?" (interview 5, pos. 60).

The (bio-)politics of data economy and management

The presence or absence of a species on an official conservation list carries ecological, political, and bureaucratic consequences (Braverman 2014, 2017). However, beyond classification itself, the availability and accessibility of data play a crucial role in conservation efforts. As one interviewee succinctly put it, „only what is known can be protected" (interview 7, pos. 16). Section on *Classifying nature for conservation* examined how data collection influenced which species were initially included in the WZAK. However, issues with collecting, integrating, and accessing relevant biodiversity data continue to affect how the guideline is used in practice today.

One of the primary obstacles is the integration of pre-existing biodiversity data into the WNSinfo. According to an interviewee (I7), incorporating data from the LUBW database, one of the WNSinfo's intended external data sources, presents significant challenges. The permissions management system of the LUBW database restricts access, particularly when data ownership does not lie with the environmental administration itself. Some of the information originates from commercial third-party projects or external partnerships, often accompanied

by non-disclosure agreements that legally prevent redistribution. Furthermore, in some cases, data is considered too sensitive to be shared openly, even within governmental conservation efforts.

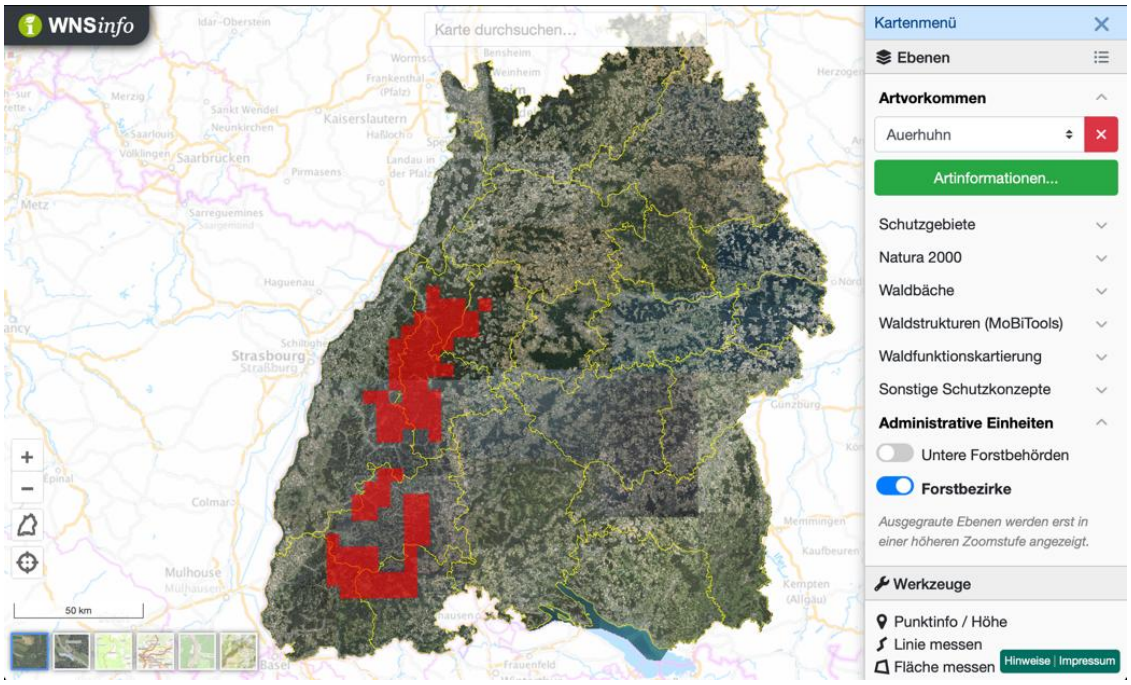

Figure 2. Example for displaying the location of capercaillie (tetrao urogallus) for public access at the WNSinfo information platform. The resolution is very low by purpose in order to protect the species against potentially disturbing visits (FVAb).

Financial interests and contractual restrictions are not the only barriers to data access. Confidentiality concerns, especially regarding species that are understood as particularly vulnerable to human disturbance, also play a crucial role. Certain species are classified as highly endangered, and their exact locations are deliberately withheld from public access to prevent excessive human interference (e.g. see fig. 2). Several interviewees (I1, I3, I9) reported concern that detailed species location data - if openly accessible - could attract photographers, amateur naturalists, and wildlife enthusiasts to fragile habitats, ultimately causing unintended harm through habitat disturbance:

„People are simply afraid that the data will fall into the wrong hands, to photographers, ornithologists, who will then disturb an area. […] There simply isn't the confidence to give out such data" (interview 9, pos. 30).

This principle extends to the WNSinfo system itself, which operates on a tiered access model. While public users can view highly generalized species distribution maps, registered users -

such as forestry professionals and conservation practitioners - can obtain more precise location data and access additional functionalities:

„The reason is that we have received data from various associations, organizations, etc., but often under the agreement that we are not allowed to simply give it out, but that we only provide it to certain people“ (interview 3, pos. 59).

However, even among registered users, access is further differentiated by species sensitivity. Some species, such as the *Vipera aspis (L. 1758)*, are considered particularly rare and at risk, and their precise locations remain restricted even to authorized users (I3).

This restricted data-sharing policy also affects collaboration between conservation professionals of different institutions. An example mentioned in interviews was the Euroasian eagle owl, a species known to occur in specific regions but not officially listed in WNSinfo records, making access to its location data complicated even for conservation officials:

„There is evidence of the eagle owl in our forest district. It's not official, but we know it occurs there. I can't see that in the system [WNSinfo], but the information has worked its way through to us via oral knowledge transfer. [...] We asked for the data, but especially with the eagle owl, it was like, 'No, that's such sensitive data, they would keep it with them'" (Interview 9, pos. 28).

While access restrictions limit the retrieval of data, the contribution of new data into the WNSinfo is also a challenge. Similar to (full-sized) citizen science initiatives, where amateur naturalists can submit biodiversity records, the WNSinfo relies on verification processes. Only data that has been scientifically validated is integrated into the system, ensuring high accuracy but also slowing the process of data incorporation (I3). Field professionals and semi-professional observers are not automatically able to contribute species records, as each submission must undergo expert review. This is especially relevant for rare or difficult-to-identify species, where misidentifications could lead to misguided conservation efforts. The FVA's scientific team is ultimately responsible for validating new records, but due to limited human resources, this process remains a significant bottleneck. One interviewee noted that capacity constraints within the FVA mean that data verification is not always prioritized, adding to the broader challenge of integrating WNSinfo into existing conservation workflows. Here again, the institutional positioning of the WNSinfo within Baden-Württemberg's conservation bureaucracy further complicates its role. As discussed in the section on *The mutual influence of tools and structures*, the WNSinfo lacks an official status within the legal-

administrative framework of ForstBW and the LFV. This creates a disconnect between the technical potential of the platform and its practical acceptance in decision-making processes.

Cluttered field realities

How do conservation practitioners interpret and implement the WZAK in decision-making on the ground? The findings show that its application involves navigating tensions between structural habitat goals and emotional connections to individual species. Practitioners translate abstract guidelines into concrete actions by balancing ecological aims with institutional constraints and personal motivations. The following sections illustrate how these dynamics unfold in practice.

Between individuals and structure – a relational spectrum

Concrete conservation actions in forest management are often framed in terms of forest structure, such as creating edge habitats or restoring moorlands. However, my interviews show that their implementation frequently depends on practitioners' personal engagement and emotional investment in specific species. As one interviewee explained, species-based conservation provides a tangible reference point, making interventions more practical and relatable compared to purely structural arguments:

„[a species] is something very specific compared to a forest structure […] and it is also something that I can count: […] If someone needs advice, you can say, 'You have a relict population of this species here, or this forest target species occurs here, and if you want to do something about it, then I have specific information about the species. Ideally, I also have the spatial coordinates.' Whereas, if I come from the structural side, it often remains rather vague" (interview 5, Pos. 82-84).

One example frequently cited as a best-practice case in my interviews involved the scarce heath butterfly (*Coenonympha hero, L. 1761*) in the eastern Swabian Alb. Initially, only two individuals of this highly endangered species were sighted. With support from FVA scientists, targeted conservation measures were implemented, redesigning the forest landscape to meet the butterfly's habitat needs. Over the following years, the population multiplied, and not only did the scarce heath recover, but many other butterfly species also thrived.

This case was repeatedly emphasized by some interviewees (I5, I6, I9, I10) as a clear success story, reinforcing the validity of the WZAK guideline. However, it also highlights the necessity of integrating single-species perspectives into broader conservation strategies. Practitioners explained how, in order to effectively implement conservation measures, they had to mentally

step into the perspective of the butterfly, asking: „How does a butterfly perceive the forest? How does it need its living room to be furnished?“ This act of perspective-taking illustrates how conservation work is not just an ecological or bureaucratic task but also a relational and interpretive practice, requiring practitioners to attune to and translate non-human needs into actionable management strategies (Lorimer 2015).

While species protection is partly integrated into standard forest management plans, the extent of species-specific conservation efforts often depends on the personal interest and passion of individual forestry managers. As one interviewee (I7) explained, while general nature conservation measures are routinely included in forest inventory planning, some managers go beyond these requirements by actively advocating for specific species that they personally care about. He uses the following example: while species such as the Bechstein's bat (*Myotis bechsteinii, Kuhl 1818*) or the red kite (*Milvus milvus, L. 1758*) are already covered under broader management frameworks, some forestry professionals choose to dedicate additional efforts to particular species, such as the purple hairstreak butterfly (*Favonius quercus, L. 1758*), out of personal commitment. This affective dimension of conservation further demonstrates how emotional connections to non-human beings can influence conservation priorities, leading to a more engaged and proactive approach to species protection beyond standardized planning procedures.

While affective encounters with individual non-human beings anchor conservation practices in the tangible reality of living entities, the political and emotional resonance of certain species shapes which species receive attention and resources. The WZAK, with 122 target species, offers a broad ecological framework, but many species remain difficult to identify or emotionally connect with. As a result, only a handful of particularly charismatic species tend to dominate conservation discourse. Interviewees (I1, I2, I4) noted that animals generally receive more attention than plants, and within the animal kingdom, mammals, birds, and a few more visually appealing insects (e.g., some butterflies) stand out as the most politically and emotionally powerful groups. This was summed up in one interviewee's comment:

„Of course, it's not comparable. The green stubble lichen [Calicium viride, Pers. 1794] will never be as sexy as the capercaillie [Tetrao urogallus, L. 1758]" (interview 1, pos. 95).

Figure 3. Images of scarce heath, Coenonympha hero (L. 1761) (left), and capercaille, Tetrao urogallus (right) as depicted in the WNSinfo information platform (FVAc; FVAd).

The capercaillie is a well-known example of this dynamic in Baden-Württemberg. It is a large, „charismatic" grouse species, depending on open forest structures for survival. However, its conservation seems to have been at the center of political controversy for decades, which was often cited in my interviews as an example of how conservation issues can become emotionally and politically charged:

„There are 30 or 40 years of extremely hard political work behind it to protect the capercaillie. […] But climate change actually speaks against the future of the capercaillie in the Black Forest. 'Why am I so stupid as to pour millions of euros into the protection and preservation of the capercaillie every year?' That's something that, when viewed from the outside, seems completely nonsensical. If I don't provide the information and say that the capercaillie is only one part of what we want to protect, but rather that it's about preserving certain structures in the forest. And not only the capercaillie benefits from this, but also, I don't know, 20 or 30 other species that are worth protecting" (interview 5, Pos. 72-74).

This case illustrates how strong identification with a single species can both mobilize and polarize conservation efforts. While the emotional and political prominence of the capercaillie has generated significant funding and attention, it has also sparked heated debates about whether conservation priorities should be dictated by species charisma or broader ecological needs. In contrast to the affective engagement with individual species and the politically charged discourse around charismatic species, the WZAK's structural approach seeks to provide a more systematic and utilitarian rationale for conservation. The capercaillie debate itself serves as an example of how a structural perspective can help reframe conservation goals. Instead of emphasizing the species itself, conservationists can shift the focus to the preservation of open forest structures, benefiting not just the capercaillie but a whole suite of species.

However, despite the benefits of this systemic argument, interviewees (I5, I6, I11) noted that broad structural conservation goals often fail to generate the same level of emotional or political support. When structural perspectives alone fail to convince stakeholders, legal frameworks such as EU directives become crucial tools for ensuring conservation action:

„It is good to have EU legislation such as the 'Birds Directive' in the background because that ends the discussion relatively quickly" (interview 4, Pos. 65).

Therefore, conservation efforts often operate between emotional engagement and bureaucratic enforcement. While affective encounters with non-human entities drive individual motivation, and charismatic species shape political discourse, legal structures also provide a necessary backbone to ensure long-term ecological protection.

Bridging science, policy and fieldwork

The participant observation described at the beginning of this paper offered a first-hand insight into the multifaceted expertise required for conservation work in managed forests. While the site had been identified through the WNSinfo digital platform for its potential to support butterfly species, the field discussions quickly moved beyond biodiversity concerns. The group weighed technical constraints, funding availability, and regulatory requirements, recognizing that successful conservation hinged on aligning ecological objectives with forestry logistics. The scientists, though coming from a research background, demonstrated an acute awareness of the practical realities of forest management, from machinery use to institutional hierarchies. Rather than simply advocating for ecological measures, they worked to frame conservation in terms that made sense to forestry practitioners, emphasizing feasibility and regulatory fit rather than abstract ecological ideals. This process of balancing, translating, and adapting became even clearer as we traveled between sites. In the car, the two scientists continued strategizing, not only about how to implement conservation measures but also how to ensure their acceptance within the existing administrative and financial landscape. Their expertise extended beyond species ecology into the politics of conservation, revealing that biodiversity protection in managed forests is as much about navigating governance systems as it is about ecological knowledge.

Later, I accompanied the two scientists to another site where conservation measures had already been implemented. One scientist emphasized the importance of ongoing monitoring - regularly revisiting sites, assessing progress, and engaging in dialogue with forest managers to

refine conservation strategies. The scientist described a common disconnect between conceptual conservation planning and on-the-ground implementation, explaining:

„There's this idea that if we provide good guidelines, good species profiles, a good information system, the measures will be implemented, and we can simply evaluate whether they worked [ecologically]. But I've realized over the last few years that if we don't actively accompany them in the field, very little actually happens" (interview 6, Pos. 51).

One interviewee (I9) explained me a particularly revealing and exemplary case that involved a forest refuge, an area designated for non-intervention where natural processes are meant to unfold without human interference. However, the Forest Research Institute (FVA) discovered that the area harbored a population of chalk burnet butterflies (*Zygaena Fausta, L. 1767*), a species that depends on open forest conditions. Their habitat requirements clashed with the non-intervention policy, which allowed forest succession to progress unchecked, leading to increasing canopy closure.

This presented a conservation dilemma: Should the strict non-intervention policy be upheld, or should selective management actions be taken to maintain the butterfly's habitat? To resolve this, the forestry team consulted with the nature conservation administration, which ultimately granted an exception to the non-intervention rule. The team was allowed to thin the forest canopy, removing certain trees and shrubs along the forest edge while ensuring that the felled material remained within the ecosystem. This intervention was considered a successful compromise between the goals of species conservation and forest refuge protection represented by the different institutions, as it created the necessary habitat conditions for the butterfly without fundamentally violating the principles of the forest refuge. Notably, this was the first time the team had applied the legal instrument of an exception permit in practice, even though they were familiar with it theoretically.

DISCUSSION

The development of the WZAK target species list, as shown in the section on *Classifying nature for conservation*, exemplifies how classification is both scientific and political. The iterative blending of algorithmic selection with expert judgment reflects the dual imperative to maintain ecological credibility and practical feasibility. Scholars have long shown that classification systems are never neutral: they embed institutional priorities, social values, and assumptions about what counts as nature (Bowker and Star 1999, Waterton 2003). In this case, the balancing of structured habitat representation with species recognizability demonstrates how classificatory acts reflect broader biopolitical negotiations (Braverman 2014, 2017). Species were not simply selected for their ecological roles, but also filtered through what Gesing et al. (2019) describe as performative knowledge practices - where classification constructs, rather than merely describes, conservation realities.

Thereby, classification work cannot be seen and understood in isolation from institutional dynamics. As the section on *Cumbersome institutions* illustrated, the WZAK's dual role - as both ecological tool and strategic institutional asset - demonstrates how guidelines can serve to assert authority, attract funding, and align with legal (in this case, EU biodiversity) mandates. This strategic use is connected to persistent sectoral fragmentation between forestry and conservation agencies in Baden-Württemberg, reflecting broader patterns identified in forest governance literature (Lindahl et al. 2023). On the other hand, this institutional ambiguity around WNSinfo, in particular, reveals how digital infrastructures struggle to gain traction when they lack formal status or legal embedding (Nost and Goldstein 2022). Furthermore, the management of biodiversity information becomes a form of biopolitical control (Bowker 2000, Rantala et al. 2020). Restrictions on data sharing - driven by legal constraints, ownership issues, and fears of disturbance - create barriers not only for collaboration but for trust among conservation actors. In practice, such data politics reinforce existing hierarchies, positioning certain institutions as gatekeepers while limiting adaptability.

At the field level, conservation becomes an emotional and ethical endeavor (Haraway 2008, Jarić et al. 2020). As the section on *Cluttered field realities* showed, practitioners interpret guidelines in ways that are often shaped by affective engagement with specific species. Rather than strictly applying habitat-oriented measures, many adopt a more relational approach – "thinking like a butterfly," as one put it - to design interventions that resonate with both ecological goals and emotional attachments. This aligns with work by Lorimer (2007, 2015)

and Despret (2004), who show how non-human charisma and affect shape conservation practices. Practitioners' motivations are not derived from abstract structural principles alone, but also from embodied encounters and ethical commitments to species survival, even in the face of ecological uncertainty.

Furthermore, practitioners must also navigate bureaucratic procedures, technical constraints, and legal norms. The example of butterfly conservation within a designated non-intervention zone underscores this complexity. Even well-intentioned action requires legal exceptions and institutional negotiation, reflecting the argument that environmental interventions are always mediated by socio-technical arrangements (Hinchliffe et al. 2005, Latour 2004). This aligns very well with a debate in STS literature on (scientific) experimentation (Allamel-Raffin et al. 2024, Papadopoulos 2018, Radder 2009), which critiques the conventional view of experimentation as a controlled, replicable process (Latour and Woolgar 1986, Rheinberger 1997) and instead frames it as an open-ended, relational, and situated practice embedded in complex socio-ecological assemblages of knowledge, tools, and actors - including non-human ones (Hinchliffe et al. 2005, Latour 2004, Ojani 2023).

CONCLUSIONS

In response to the overarching research question - *how do classificatory instruments shape forest biodiversity conservation priorities and decision-making* - this study demonstrates that tools like the WZAK and WNSinfo influence conservation outcomes not merely by organizing ecological data. These instruments do not act as neutral frameworks; rather, they embed specific ways of seeing forests, reflecting institutional logics, political interests, and affective attachments. In doing so, classificatory systems are both being shaped by the socio-ecological contexts in which they operate, but also actively reshaping these contexts through their application. This process is dynamic and contingent, varying across institutional environments, actor constellations, and practical field conditions. Consequently, the study underscores that forest biodiversity conservation is not a straightforward matter of scientific classification and its bureaucratic implementation. It is a relational, political, and evolving practice where guidelines, regulations, and emotional engagements with non-human beings intersect in complex ways. Understanding conservation as this situated and evolving practice points to the

need for governance approaches that are more adaptive, reflexive, and responsive to the complexity of forest landscapes.

To move forward, future research should further examine how classificatory and digital tools reinforce institutional hierarchies or, alternatively, enable experimental governance. Exploring the PE of digital infrastructures (Nost and Goldstein 2022) in more depth could offer insights into how knowledge systems shape ecological interventions. More attention should be paid to the role of affect and species charisma in shaping conservation outcomes. Understanding these relational dynamics through a more-than-human lens opens pathways for more ethical and responsive conservation strategies that are attuned to situated ecological complexity. Additionally, research and policy should center the role of conservation practitioners as key intermediaries (Cvitanovic et al. 2025). Their work involves translating abstract frameworks into context-sensitive action, requiring both institutional support and epistemic flexibility. Therefore, policies should address:

- Increased funding and resources for field-based conservation, rather than relying solely on conceptual guidelines.
- Training programs to equip practitioners with skills to navigate bureaucratic structures while maintaining ecological flexibility.
- Institutional flexibility to allow conservation measures to be adapted to field conditions rather than constrained by rigid administrative categories.
- Participatory governance mechanisms that actively involve practitioners and local stakeholders in shaping conservation policies.

CONFLICTS OF INTEREST

The authors confirm there are no conflicts of interest.

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REFERENCES CITED

Adams B. 2020. Digital animals. The Philosopher 108(1). Available from: https://www.thephilosopher1923.org/post/digital-animals.

Allamel-Raffin C, Gangloff J-L, Gingras Y. 2024. The characteristics and diversity of experimentation in the sciences. In: Allamel-Raffin C, Gangloff J-L, Gingras Y, editors. Experimentation in the sciences: comparative and long-term historical research on experimental practice. Springer Nature Switzerland. p. 1-8. https://doi.org/10.1007/978-3-031-58505-0_1

Ash J, Kitchin R, Leszczynski A. 2018. Digital turn, digital geographies? Prog Hum Geogr. 42(1):25-43. https://doi.org/10.1177/0309132516664800

Bauriedl S. 2016. Politische Ökologie: nicht-deterministische, globale und materielle Dimensionen von Natur/Gesellschaft-Verhältnissen. Geogr Helv. 71(4):341-351. https://doi.org/10.5194/gh-71-341-2016

Biermann C, Mansfield B. 2014. Biodiversity, purity, and death: conservation biology as biopolitics. Environ Plan D: Soc Space. 32(2):257-273. https://doi.org/10.1068/d13047p

BMUV. 2024. Nationale Strategie zur biologischen Vielfalt. Retrieved 08.04.2025 from https://www.bmuv.de/themen/naturschutz/allgemeines-und-strategien/nationale-strategie.

Bowker, G. C. 2000. Biodiversity datadiversity. Social Studies of Science, 30(5): 643-683. https://doi.org/10.1177/030631200030005001

Bowker GC, Star SL 1999. Sorting things out: Classification and its consequences. The MIT Press. https://doi.org/10.7551/mitpress/6352.001.0001

Braun B 2004. Nature and culture: on the career of a false problem. In A Companion to Cultural Geography (pp. 151-179). https://doi.org/10.1002/9780470996515.ch11

Braunisch V, Hauck F, Dalüge N, Hoschek M, Ballenthien E, Winter M-B, Michels H-G 2020. Waldzielartenkonzept und Waldnaturschutz-Informationssystem: Instrumente zur Artenförderung im Staatswald von Baden-Württemberg. Standort.wald 51:53-76.

Braverman I 2014. En-listing life: red is the color of the threatened species list. In Collard R, Kathryn G, eds. Critical animal geographies. Routledge/Earthscan 2015 SUNY Buffalo Legal Studies Research Paper No. 2015-001:184-202. https://doi.org/10.4324/9781315762760-11

Braverman I 2017. Anticipating endangerment. BioSocieties 12(1):132-157. https://doi.org/10.1057/s41292-016-0025-0

Brockhaus M, Angelsen A 2012. Seeing REDD+ through 4Is: A political economy framework. Analysing REDD+: Challenges and choices:15-30.

Brockhaus M, De Sy V, Di Gregorio M, Herold M, Wong G Y, Ochieng R, Angelsen A 2024. Data and information in a political forest: The case of REDD+. Forest Policy and Economics, 165, 103251. https://doi.org/10.1016/j.forpol.2024.103251

Castree N. 2005. Nature. Routledge. https://doi.org/10.4324/9780203448410

Castree N, Braun B. 2001. Social nature: theory, practice and politics. Wiley-Blackwell.

Charvolin F. 2024. Faune France: amateur naturalists' attachment and indebtedness in a citizen science biodiversity database. Sci Cult 33(3):321-341. https://doi.org/10.1080/09505431.2022.2025775

Clough PT, Halley J. 2007. The affective turn. Duke University Press. https://doi.org/10.1515/9780822389606

COPE. 2023. COPE position - authorship and AI - English. Accessed 2025 Apr 15. https://doi.org/10.24318/cCVRZBms

Cvitanovic C, Karcher DB, Breen J, Badullovich N, Cairney P, Dalla Pozza R, Duggan J, Hoffmann S, Kelly R, Meadow AM, Posner S. 2025. Knowledge brokers at the interface of environmental science and policy: a review of knowledge and research needs. Environ Sci Policy 163:103973. https://doi.org/10.1016/j.envsci.2024.103973

Despret V. 2004. The body we care for: figures of anthropo-zoo-genesis. Body Soc 10(2-3):111-134. https://doi.org/10.1177/1357034X04042938

EEA. 2024. The Natura 2000 protected areas network. Accessed 2025 Apr 8. Available from: https://www.eea.europa.eu/themes/biodiversity/natura-2000/the-natura-2000-protected-areas-network

EU. 2025. Types of legislation. Accessed 2025 Feb 3. Available from: https://european-union.europa.eu/institutions-law-budget/law/types-legislation_en

FAO. 2024. State of the world's forests 2024: forest sector innovations towards a more sustainable future. Available from: https://knowledge4policy.ec.europa.eu/publication/state-world's-forests-2024-forest-sector-innovations-towards-more-sustainable-future-0_en

Flick U. 1995. Qualitative Forschung: Theorie, Methoden, Anwendung in Psychologie und Sozialwissenschaften. Rowohlt.

ForstBW. 2015. Die Gesamtkonzeption Waldnaturschutz mit den Waldnaturschutzzielen 2020. https://www.forstbw.de/fileadmin/user_upload/ForstBW_Gesamtkonzeption_Waldnaturschutz.pdf

Forsyth T. 2003. Critical political ecology: the politics of environmental science. Routledge; London and New York. 336 p. https://doi.org/10.4324/9780203017562

FVAa. Waldnaturschutz-Informationssystem Retrieved 13.11.2024 from https://wnsinfo.fva-bw.de/waldnaturschutz-informationssystem/

FVAb. Waldnaturschutz-Informationssystem - Auerhuhn Karte. Retrieved 20.01.2025 from https://wnsinfo.fva-bw.de/karte/

FVAc. Waldnaturschutz-Informationssystem - Waldwiesenvögelchen Steckbrief. Retrieved 20.01.2025 from https://wnsinfo.fva-bw.de/arten/wald-wiesenvoegelchen/

FVAd. Waldnaturschutz-Informationssystem - Auerhuhn Steckbrief. Retrieved 20.01.2025 from https://wnsinfo.fva-bw.de/arten/auerhuhn/

Gesing F, Amelang K, Flitner M, Knecht M. 2019. NaturenKulturen-Forschung: eine Einleitung. In: Gesing F, Knecht M, Flitner M, Amelang K, editors. NaturenKulturen. p. 7-50. transcript Verlag. https://doi.org/10.1515/9783839440070-001

Guest G, Namey EE, Mitchell ML. 2013. Participant observation. In: Collecting qualitative data: a field manual for applied research. SAGE Publications, Ltd. https://doi.org/10.4135/9781506374680

Haraway D. 2008. When species meet. University of Minnesota Press.

Haraway DJ. 1997. Modest_Witness@Second_Millennium.FemaleMan_Meets_OncoMouse: feminism and technoscience. Vol. 30. Routledge.

Haraway DJ. 2003. The companion species manifesto: dogs, people, and significant otherness. Prickly Paradigm; University Presses Marketing; Chicago, Ill., Bristol. https://search.library.wisc.edu/catalog/999944308902121

Hinchliffe S. 2007. Geographies of nature: societies, environments, ecologies. SAGE Publications Ltd. https://doi.org/10.4135/9781446212516

Hinchliffe S. 2008. Reconstituting nature conservation: towards a careful political ecology. Geoforum 39(1):88-97. https://doi.org/10.1016/j.geoforum.2006.09.007

Hinchliffe S, Kearnes MB, Degen M, Whatmore S. 2005. Urban wild things: a cosmopolitical experiment. Environ Plann D Soc Space 23(5):643-658. https://doi.org/10.1068/d351t

Jarić I, Courchamp F, Correia RA, Crowley SL, Essl F, Fischer A, González-Moreno P, Kalinkat G, Lambin X, Lenzner B, Meinard Y, Mill A, Musseau C, Novoa A, Pergl J, Pyšek P, Pyšková K, Robertson P, von Schmalensee M, Jeschke JM. 2020. The role of species charisma in biological invasions. Front Ecol Environ 18(6):345-353. https://doi.org/10.1002/fee.2195

Kaiser R. 2024. Research interviews: a practical guide to qualitative data. Springer Spektrum. https://doi.org/10.1007/978-3-658-45333-6

Konold W, Bauhus J, Hein S, Klein A-M, Lenz R, Pekrun C, Steidle J, Wallner K. 2020. Sonderprogramm zur Stärkung der biologischen Vielfalt der Landesregierung Baden-Württemberg. Abschlussbericht 2018/2019 - Evaluation durch das wissenschaftliche Fachgremium.

Latour B. 1993. We have never been modern. Porter C, trans. Harvard University Press.

Latour B. 2004. Politics of nature: how to bring the sciences into democracy. Harvard University Press.

Latour B, Woolgar S. 1986. Laboratory life: the construction of scientific facts. Princeton University Press. https://doi.org/10.1515/9781400820412

Lindahl KB, Söderberg C, Lukina N, Tebenkova D, Pecurul M, Pülzl H, Sotirov M, Widmark C. 2023. Clash or concert in European forests? Integration and coherence of forest ecosystem service-related national policies. Land Use Policy 129:106617. https://doi.org/10.1016/j.landusepol.2023.106617

Lloyd G. 2007. Nature versus culture reassessed. In: Cognitive variations: reflections on the unity and diversity of the human mind. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199214617.003.0008

Lorimer J. 2007. Nonhuman charisma. Environ Plann D Soc Space 25(5):911-932. https://doi.org/10.1068/d71j

Lorimer J. 2008. Counting corncrakes: the affective science of the UK corncrake census. Soc Stud Sci 38(3):377-405. https://doi.org/10.1177/0306312707084396

Lorimer J. 2015. Wildlife in the Anthropocene: conservation after nature. University of Minnesota Press. https://doi.org/10.5749/minnesota/9780816681075.001.0001

LUBW. 2024. Natur und landschaft in Baden-Württemberg. Retrieved 08.04.2025 from https://umweltportal.baden-wuerttemberg.de/umweltdaten-bericht-2024/natur-und-landschaft

Manicas PT. 1992. Nature and culture. Proc Am Philos Assoc 66(3):59-76. https://doi.org/10.2307/3130661

Mattissek A, Wiertz T. 2014. Materialität und Macht im Spiegel der Assemblage-Theorie: Erkundungen am Beispiel der Waldpolitik in Thailand. Geogr Helv 69(3):157-169. https://doi.org/10.5194/gh-69-157-2014

Mayring P, Fenzl T. 2019. Qualitative Inhaltsanalyse. In: Baur N, Blasius J, eds. Handbuch Methoden der empirischen Sozialforschung. Springer Fachmedien Wiesbaden. p. 633-648. https://doi.org/10.1007/978-3-658-21308-4_42

MLR. 2018. Das Sonderprogramm zur Stärkung der biologischen Vielfalt. Stuttgart: Ministerium für Ländlichen Raum und Verbraucherschutz Baden-Württemberg. Retrieved from https://um.baden-

wuerttemberg.de/fileadmin/redaktion/m-um/intern/Dateien/Dokumente/2_Presse_und_Service/Publikationen/Umwelt/Naturschutz/Sonderprogramm-zur-Staerkung-der-biologischen-Vielfalt.pdf

MLR. 2020. Bericht zur Lage der Natur in Baden-Württemberg 2020. Stuttgart: Ministerium für Ländlichen Raum und Verbraucherschutz Baden-Württemberg.

Molhuizen T, Beumer K, Dorresteijn I. 2025. Who to revive? Explaining charismatic species bias in the selection of de-extinction candidate species. Environ Plan E Nature Space 0(0):25148486241310698. https://doi.org/10.1177/25148486241310698

Myung-Ae C. 2016. More-than-human geographies of nature [새로운 정치생태학을 위한 비인간지리학의 인간-자연 연구]. J Korean Geogr Soc 51(5):613-632.
http://www.dbpia.co.kr/journal/articleDetail?nodeId=NODE07064402

Nost E, Goldstein JE. 2022. A political ecology of data. Environ Plan E Nature Space 5(1):3-17. https://doi.org/10.1177/25148486211043503

Ojani C. 2023. Experimenting with fog: Environmental infrastructures, infrastructuring environments, and the infrastructure of infrastructure. Environ Plan E Nature Space 6(1):24-41. https://doi.org/10.1177/25148486221101458

Ott A. 2025. Ontological conflict over forests in Inari/Aanaar: Sámi's fight for preservation and renewal. Environ Sci Policy 163:103957. https://doi.org/10.1016/j.envsci.2024.103957

Papadopoulos D. 2018. Experimental practice: Technoscience, alterontologies, and more-than-social movements. Duke University Press. https://doi.org/10.1215/9781478002321

Peltola T, Ratamäki O. 2023. Sharing epistemic power: digitally mediated wolf monitoring in Finland. Sci Cult 1-24. https://doi.org/10.1080/09505431.2023.2214148

Peluso NL, Vandergeest P. 2001. Genealogies of the political forest and customary rights in Indonesia, Malaysia, and Thailand. J Asian Stud 60(3):761-812. https://doi.org/10.2307/2700109

Peluso NL, Vandergeest P. 2011. Political ecologies of war and forests: Counterinsurgencies and the making of national natures. Ann Assoc Am Geogr 101(3):587-608. https://doi.org/10.1080/00045608.2011.560064

Peluso NL, Vandergeest P. 2015. The International Handbook of Political Ecology. In: Bryant RL, editor. Chapter 12 Political forests. Edward Elgar Publishing. https://doi.org/10.4337/9780857936172

Radder H. 2009. The philosophy of scientific experimentation: a review. Autom Exp 1(1):2. https://doi.org/10.1186/1759-4499-1-2

Rantala S, Swallow B, Paloniemi R, Raitanen E. 2020. Governance of forests and governance of forest information: Interlinkages in the age of open and digital data. For Pol Econ 113:102123. https://doi.org/10.1016/j.forpol.2020.102123

Rheinberger HJ. 1997. Toward a history of epistemic things: Synthesizing proteins in the test tube. Stanford University Press.

Schöneich S. 2021. 'On a hot day in the field...': The art of writing ethnographic vignettes. Ethnoscripts 23(1). https://journals.sub.uni-hamburg.de/ethnoscripts/article/view/1666

Simberloff D. 2018. Nature, culture, and natureculture: The role of nonnative species in biocultures. In: Rozzi R, May RH Jr, Chapin III FS, Massardo F, Gavin MC, Klaver IJ, Pauchard A, Nuñez MA, Simberloff D, editors. From biocultural homogenization to biocultural conservation. Springer International Publishing. https://doi.org/10.1007/978-3-319-99513-7_12

Singh NM. 2018. Introduction: Affective ecologies and conservation. Conserv Soc 16(1):1-7. https://doi.org/10.4103/cs.cs_18_33

Soga M, Gaston KJ. 2016. Extinction of experience: The loss of human-nature interactions. Front Ecol Environ 14(2):94-101. https://doi.org/10.1002/fee.1225

Turnhout E. 2018. The politics of environmental knowledge. Conserv Soc 16(3):363-371. https://doi.org/10.4103/cs.cs_17_35

Von Essen E, Turnbull J, Searle A, Jørgensen FA, Hofmeester TR, Van Der Wal R. 2023. Wildlife in the digital Anthropocene: Examining human-animal relations through surveillance technologies. Environ Plan E Nature Space 6(1):679-699. https://doi.org/10.1177/25148486211061704

Waterton C. 2003. Performing the classification of nature. Sociol Rev 51(2_suppl):111-129. https://doi.org/10.1111/j.1467-954X.2004.00454.x

Whatmore S. 2002. Hybrid geographies: Natures cultures spaces. SAGE Publications Ltd. https://doi.org/10.4135/9781446219713

Zariņa A, Vinogradovs I, Svece A. 2024. Wildlife as an affective multiplicity: Approaching Deleuzo-Guattarian pack-animals. Environ Plan E Nature Space 8(1). https://doi.org/10.1177/25148486241301992