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Shifting Borders, Disturbance, and Temporary Nature: Contested Wildlife in Opencast Lignite Mines in Germany

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Abstract
This paper explores the legal and socio-ecological dynamics of lignite mining landscapes, focusing on the borders and extraction frontiers that shape these environments. It conceptualizes disturbance as a socio-ecological process that generates ecotonal dynamics, where nutrient-poor, sparsely vegetated surfaces of opencast mines mirror the ecological features of other habitats, fostering specialized ecosystems. Drawing from border studies, more-than-human geographies, and ethnographic methods, the article examines the paradoxes of lignite mining by analyzing the co-constitutive relationships between human and nonhuman actors. It delves into how environmental disturbance reshapes the mining landscape, emphasizing the fluidity and complexity of borders and frontiers. The analysis transcends the traditional binary of destruction and preservation, revealing how disturbance affects the legal, temporal, spatial, and social dynamics of boundary formation. By engaging with these dynamics, the paper sheds light on the interconnected processes that shape post-mining landscapes and contributes to a deeper understanding of legal and socio-ecological interactions.

Keywords critical border studies, conservation, more-than-human geographies, more-than-human studies, postmining landscapes

1. Introduction

In the realm of environmental discourse, the notion of borders extends beyond geopolitical demarcations, encompassing the intricate interactions between human activities and the more-than-human world. Within this context, the landscapes shaped by opencast mining in eastern Germany stand as emblematic examples. Despite the significant biodiversity losses observed across Europe, these (post)mining terrains emerge as unexpected habitats for flora and fauna (e.g., Altmoos & Durka, 1998; Baumert, 2023; Pietsch, 1998; Thörner, 1998). Characterized by nutrient scarcity and structural diversity, these landscapes provide an important habitat for rare and specialized species, often on the brink of extinction.

Central to the inquiry of this paper is the exploration of the border of the lignite mining landscape as well as its extraction frontier moving through the open pit, where the interplay of environmental disturbance and unexpected biodiversity gives rise to a complex nar-

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rative. In this article, I conceptualize *disturbance* as a socioecological concept that creates ecotonal dynamics. Remarkably, the nutrient-poor, sparsely vegetated surfaces of the opencast mines mirror the ecological features of other habitats, such as river landscapes, heathlands, or nutrient-poor grasslands. This unique ecological position fosters the emergence of specialized ecosystems within the mining landscape, showcasing the co-constitutive character of human and nonhuman engagement. Drawing upon insights from border studies, more-than-human geographies, and ethnographic methods, this paper delves into the paradoxes inherent in lignite mining practices. Through the lens of border studies, which emphasize fluidity, complexity, and ethical engagement, I examine the moving frontier within the mining landscape as well as the surrounding border of the mining area. The border, as well as the moving frontier, transcend traditional dichotomies of destruction versus preservation, revealing the intricate relationships between human activities and ecological processes.

In the following sections, I provide a brief overview of critical border studies, focusing on the co-constitutive character of the more-than-human world and the role of disturbance in shaping socioecological relations. Subsequently, I engage in three ethnographic inquiries to unravel the more-than-human border-making practices and the spatial and temporal aspects of the boundary. This exploration demonstrates how disturbance influences the legal, temporal, spatial, and social dynamics of boundary formation and transformation.

In terms of contributions to the field of border studies, this paper conceptually expands borders beyond their traditional geopolitical context. By highlighting the significance of ecotones within the mining landscape and their implications for both human and nonhuman actors, this paper demonstrates the relevance of border studies concepts for understanding environmental issues. Additionally, it contributes to discussions within border studies about the ethical dimensions of bordering practices and the imperative to consider diverse perspectives in environmental decision-making. Overall, this paper offers insights into the complex relationships between human activities, ecological processes, and the boundaries that shape them, enriching the discourse on border studies and environmental governance.

2. Methods

This article draws on an ongoing ethnographic field research conducted in the Central German Mining District over the last three years. Utilizing a combination of qualitative methods, including expert interviews, participant observation, and go-along interviews, I engaged with a diverse array of stakeholders, encompassing natural scientists, mining company employees, activists, nature conservationists, planners, and residents. So far, I conducted 15 qualitative, semi-structured expert interviews, alongside numerous informal conversations. I employed participant observation to investigate the complexities of the lignite mining landscape and its ecological transformations. This involved actively engaging in inventory counts, planting and uprooting activities, and red-listed animal searches within the mining areas. I participated in workshops, bringing together land restoration experts, nature conservationists, and specialists such as ornithologists to facilitate discussions on ecosystem restoration strategies and biodiversity conservation. Through this participatory approach, I gathered insights into the dynamic interactions between human interventions and ecological responses within the mining landscape. Additionally, I employed go-along interviews, as outlined by Kusenbach (2003), accompanying individual informants on outings in (former) mining areas. Expanding from Kusenbach, I not only accompany people on their "'natural' outings" (Kusenbach 2003, p. 463), but I ask them to take a walk with me in the landscapes under study to see how they relate to, interact with, and move in that specific landscape. What comes to their minds? Where do they stop, take samples, pictures, remains and what do they say about them? Go-along interviews re-orient attention towards the collaborative and participatory processes involved when "walking the talking" (Duedahl & Stilling Blichfeldt, 2020, p. 438). This methodological approach allowed for a deeper exploration of how individuals relate to, interact with, and perceive the specific landscapes under study. Over the duration of the research period, approximately 30 go-along interviews have been conducted so far, some of which have involved multiple walks with the same informants, enabling the tracing of changes in landscape dynamics and changes in key interlocutors' perceptions.

3. Critical Border Studies and the Co-Constitutive Character of the More-than-Human World

The theoretical approach in this paper draws from two intersecting fields: critical border studies and more-than-human geographies. Critical border studies prompt a reconsideration of the complexities inherent in the formation and dissolution of borders and their conceptual understandings. While past critiques have highlighted the potential oversimplification of border conceptualizations (Sidaway, 2011; Vaughan-Williams, 2012), understanding borders requires broader contextualization within social and political theory, particularly in light of the constantly changing historical, political, and social landscapes (Brambilla et al., 2017). Although previous scholarship has recognized the dynamic relationship between borders and society (Rumford, 2006), there has been a historical oversight in considering the role of nonhuman actors in border constitution and negotiation. However, recent contributions indicate a shifting paradigm towards incorporating more-than-human perspectives into border studies, reflecting an emerging interest in understanding the nuanced interplay between human and nonhuman forces in shaping bordering practices (Fleischmann, 2020; Gutkowski, 2021; Khazaal & Almiron, 2021; Ozguc & Burridge, 2023). More-than-human geographies, meanwhile, push us to consider how nonhuman actors—whether animals, plants, or even geological processes—are co-constituents of these borders and frontiers, complicating human-centered narratives. Building on these perspectives, this paper aims to shed light on the complex legal, political, and socio-ecological processes shaping lignite mining landscapes in Germany.

In the context of mining, borders delineate the property governed by the German Federal Mining Act (Bundesberggesetz [BBergG]) from the surrounding environment. However, within the mining landscape, frontiers—dynamic zones where active extraction takes place—create a second layer of boundary-making processes. Critical border studies delve into the concepts of *border* and *frontier* to dissect the complexities of territoriality and spatial governance. While borders traditionally signify fixed boundaries that denote sovereignty and control, frontiers represent dynamic spaces of interaction and boundary-making processes (e.g., Lounela & Tammisto, 2021). Borders are often associated with containment and regulation, delineating divisions between inside and outside, whereas frontiers connote movement and exploration (Lounela & Tammisto, 2021). The relationship between borders and frontiers is marked by their mutual shaping and transformation, with frontiers serving as sites of border-making practices. By engaging with both concepts, critical border studies illuminate the intricate interplay between territorial boundaries and spatial dynamics, shedding light on their implications for mobility and power relations. Applying this understanding to the context of lignite mining areas reveals a nuanced interplay between borders and frontiers. Here, the border separates the mining property, governed by the BBergG, from its surrounding environment. This regulatory boundary underscores the containment and control associated with traditional border constructions. Concurrently, the frontier within the mining landscape delineates the boundary between active and inactive mining areas. This dynamic frontier, characterized by spatial and temporal movement, mirrors the fluidity and boundary-shaping processes attributed to frontiers. These frontiers, like borders, are not solely shaped by human action but also by the nonhuman forces at play.

More-than-human geographies expand our understanding of the mining landscapes by emphasizing the co-constitutive role of nonhuman actors in shaping space. Mining landscapes, often framed as disturbed or damaged in public discourse, are also sites of ecological reformation where species adapt to the changing conditions. From plants thriving in low-nutrient soils to animals navigating new open landscapes, nonhuman actors exert agency in shaping these spaces. This approach, which critiques anthropocentric binaries like nature/culture or human/animal (Panelli, 2010), enables us to understand the mining frontier as a fluid boundary that is shaped not just by human political and spatial practices but also by the ecological dynamics of species like birds, wildcats, and toads. More broadly, more-than-human geographies engage with the co-constitutive relationship of humans and nonhuman actors (e.g., Steiner et al., 2022). The nonhuman actors can be animals (e.g., Buller, 2014; Phillips, 2020), plants (Atchison & Phillips, 2020; Head & Atchison, 2009), mushrooms (A. L. Tsing, 2015), viruses (e.g., Fleischmann, forthcoming; Kirksey, 2020), the microbiome (Lorimer, 2020) or soil (Salazar et al., 2020). Generally speaking, more-than-human geographies criticize anthropocentric perspectives by considering living beings and materials equally in their investigation (e.g., Srinivasan & Kasturirangan, 2016).

Even though more-than-human studies are regularly set in "flat ontologies" (Ash, 2020, p. 345), I am particularly interested in how power, practices, and the legal framework assist in creating the shiftiness as well as steadiness of the open-cast boundaries, as nonhumans play a pivotal role in political practices (e.g., Fleischmann & Everts, 2024). To understand "ecological relations" (Youatt, 2020, p. 1), one must recognize that humans and nonhumans are so interconnected that it is impossible to consider one without the other. The boundaries within a mining area are not solely influenced by human political and legal factors, treating nonhuman entities merely as "objects of debate" (Youatt, 2020, p. 1). Instead, there are complex dynamics at play where the interactions between humans and nonhumans contribute to shaping these borders, rather than nonhumans being passive subjects of human discourse or actions. Accordingly, this article examines the engagement with and the production of borders through nonhumans in order to reach a better understanding of ecologies, particularly of those in "post-industrial ruin" (Bubandt & Tsing, 2018, p. 1), by focusing on their co-constitutive interdependences. This article also seeks to explore how disruptions, far from being solely detrimental, actively contribute to the creation of new ecological boundaries and transitional zones within post-mining landscapes. Disturbance, ecologically understood as a temporary alteration to an ecosystem, thus becomes an important concept in understanding the transformations of mining landscapes and accordingly will be explained in the following section before diving into the ethnographic vignettes.

4. Disturbance and Ecotones

Open-cast lignite mining was drastically intensified in Germany in the wake of industrialization and has to date altered almost 180 thousand hectares of land (Sandau et al., 2021, p. 79), which is about twice the size of Berlin. Correspondingly, lignite mining can be considered an anthropogenic disturbance that covers a wide temporal and spatial scale. According to Turner and Gardner (2015), disturbances serve as pivotal catalysts for spatial and temporal heterogeneity, fundamentally altering the state and dynamics of ecosystems. This temporal heterogeneity can, in some cases, foster heightened biodiversity, leading certain ecologists to posit the positive effects of disturbance (e.g., Yuan et al., 2016). Yet, within ecological literature, interpretations of events as human-induced or natural disturbances differ, prompting critical examination. Crucially, the factors of temporal and spatial scale emerge as paramount considerations. While anthropogenic disturbances often precipitate habitat loss and biodiversity decline (e.g., Barnosky et al., 2012), documented cases also reveal instances of increased biodiversity contingent upon scale (e.g., Yuan et al., 2016).

From the perspective of human geography, one might scrutinize the concept of disturbance as applied in ecological discourse, where it tends to be framed solely in terms of its ecological consequences, potentially overlooking broader social and cultural impacts. The reliance on spatial and temporal scales to determine the perceived effects of disturbance may overlook the intricate socio-political dynamics at play. Furthermore, the dichotomy between human-induced and natural disturbances may oversimplify the complex interactions between human activities and ecological systems. More-than-human geography compels us to move beyond anthropocentric frameworks, recognizing that agency is not solely a human trait but is distributed across various actors that coalesce to shape ecological outcomes. Such an understanding turns nonhuman entities into active participants with the capacity to influence their surroundings, thus reframing the dynamics of ecological interactions. This approach advocates for a recognition of situated and multiple knowledges, which highlights that different beings understand and engage with the world in diverse ways (Lorimer & Hodgetts, 2024).

Accordingly, by emphasizing the co-constitutive character of landscape transformation, disturbance thus could underscore that ecological, social, and political factors interact and shape each other in complex ways. Consequently, I would like to propose a concept of *disturbance* that considers the interconnectedness of ecological, social, and political dimensions in the co-constitutive character of landscape (trans)formation. Disturbances are not only physical alterations to the environment but also carry social and political implications, such as changes in land use, resource distribution, and power dynamics. This approach to understanding disturbance moves beyond ecological frameworks and opens up new avenues for interdisciplinary research and action that consider the broader implications of landscape change on human societies and ecosystems alike. Thus, disturbance becomes a socio-ecological concept, which is not simply a nega-

tive force; instead, it generates new opportunities for biodiversity to flourish and underscores the need to consider human and nonhuman actors as co-creators of space in the interplay between ecological, social, and political dimensions.

Though the extraction of lignite from the ground leaves deep "scars" in the landscape (see Storm, 2014, p. 1), these scars also provide a home for pioneering species that can only thrive in such disturbed landscapes. The edited volume *Arts of Living on a Damaged Planet* (Tsing et al., 2017) has impactfully demonstrated how life in ruins can unfold and thrive. Focusing on urban nature, geographer Matthew Gandy explores the complex interplay between urban environments and ecological processes, particularly in relation to abandoned landscapes and waste areas. In his book *Natura Urbana* (2022), Gandy examines how post-industrial sites, such as abandoned factories and derelict land, can become unexpected spaces of ecological vitality and biodiversity. He argues that these landscapes, often perceived as degraded or undesirable, can serve as vital habitats for diverse species and foster unique ecological interactions. By embracing the inherent complexity of such areas, Gandy calls for a shift in perspective that recognizes the ecological potential of waste landscapes, encouraging sustainable practices that enhance biodiversity and promote ecological resilience in urban settings. His work invites a rethinking of how we engage with and manage post-industrial spaces, emphasizing the importance of recognizing their value as sites of ecological regeneration. Arguing in a similar vein, Sandra Jasper writes about the revaluation of abandoned urban spaces, particularly railway yards (2021), as sites of ecological and social significance rather than mere vacant land awaiting development. She thereby challenges the notion of "vacant space" by highlighting how these areas can be reanimated (Jasper, 2021, p. 54).

This perspective aligns with viewing post-mining terrains as dynamic spaces where unexpected biodiversity emerges in response to human-induced changes. By examining these landscapes through the lens of human-nonhuman co-production, we can better understand how they function as ecotones—transitional zones characterized by unique biodiversity patterns and ecological processes. Lignite mining activities create these ecotones, where species from adjacent habitats mix and interact, leading to areas of ecological flux (Holland, 2012). Understanding the dynamics of these zones is crucial for grasping the socio-ecological implications of mining from a (more-than-)human geography perspective. Ecotones serve as interfaces for diverse human-environment interactions, including land-use conflicts, conservation efforts, and cultural practices, revealing the complex ways in which mining landscapes shape human livelihoods, identities, and power relations. Additionally, the resilience of ecotonal ecosystems highlights the adaptive capacity of both humans and nonhumans in navigating environmental change. Integrating the concepts of disturbance and ecotones into human geography research offers a deeper understanding of the socio-ecological complexities inherent in resource extraction processes.

The (post)mining landscape provides an opportunity for those species that have specialized in a way that enables them to thrive in post-industrial landscapes, such as plants that live in low-nutrition soil, animals that need open landscapes with little vegetation, and migrating birds that find shelter in the surrounding parts of the pit, which are uninhabited by humans and resemble steppes and semi-deserts. In the following three vignettes, a migrating bird, a wildcat, and a toad will demonstrate how the frontier within and the border of mining landscapes are made, contested, mitigated, and moved through space and time.

5. The Pipit in the Pit

"Mining companies have trouble with too much nature in opencast mining," stated an employee of the Nature Conservation Association (Naturschutzbund [NABU]) of Saxony-Anhalt in his presentation on stage. The NABU was one of the organizers at a conference in October 2021 on bird protection in (post)mining landscapes in the Central German Mining District. Other organizers were the respective mining company as well as the Saxony-Anhalt Ornithologists Association. The conference was dedicated to the tension in conflicts over the use of land with a special focus on the possibilities and limitations of bird protection. More than 90 participants came to the community center in Hohenmölsen to attend the conference. The speakers included representatives of the mining company, lawyers, administrators, ornithologists, nature conservationists, and biologists. They represented the various fields of action and actors from spatial planning to approval procedures, active mining, and land restoration.

Active mining creates dynamic habitats of nutrient-poor and vegetation-poor areas. The tawny pipit *(Anthus campestris)* is a migrating bird, which is specialized in this environment. The mining landscape resembles dune sites of dynamic river systems that used to leave behind gravel and sand areas (e.g., Donat, 2018; Thörner, 1998). Today, such sites rarely exist in Germany due to the canalization and diking of rivers. Ultimately, the tawny pipit could only live in cultural habitats, for instance on sandy fallow land, on sand fields, and heathland. Yet, also such habitats were overexploited in the 19th century, and with the disappearance of these areas, the tawny pipit, too, largely disappeared from Germany (Gedeon et al., 2022). However, today we find tawny pipits in Germany's mining landscapes and in decommissioned military training areas. As a consequence, the distribution area of the tawny pipit virtually marks the inner-German border, as it nearly exclusively exists in eastern Germany, the former GDR. In most parts of western Germany, landscape structures such as unrestored mining landscapes and decommissioned military areas rarely exist. About a third of the total tawny pipit population in Germany is found in opencast mines (Gedeon et al., 2022). During the above-mentioned conference on bird protection in (post) mining landscapes, a nature conservationist explains:

> If we consider how small the opencast mining areas are compared to the rest of Germany, we have a huge responsibility. To leave the areas to its dynamic succession would mean that the pipit would simply disappear again, but we cannot be responsible for that. Process protection is nature conservation for the lazy, if you don't know how to keep a landscape open. We all know, or at least those who have studied biology, that in Central Europe everything will eventually become forest, and that's the question: Do we want this forest there, or do we want to keep an open or a semi-open landscape? (Nature conservationist 1, October 2021)

Process protection is based on the idea of non-interference (by humans) in the natural processes of ecosystems. Succession overwrites the open landscape by the spread of shrubs and trees (e.g., Pietsch, 1998). Depending on the climate, such shrub encroachment is the precursor to forest, as young trees can often develop well protected by thorny bushes from browsing herbivores. By some nature conservationists, a high intrinsic value is adjudged to an unhindered course of natural succession, mainly because of its rarity (Altmoos & Durka, 1998). Succession and process are thereby connected to changes in the composition and structure of species and landscapes, though these are intended in this respect and are therefore accepted as value-neutral (Altmoos & Durka, 1998). However, breeding bird species that are particularly relevant to nature conservation currently focus on the inhabitants of sparsely vegetated banks, sparsely vegetated open, and semi-open land. And these are exclusively groups of species, whose importance will decrease as succession progresses, such as the tawny pipit.

Calling process protection "nature conservation for the lazy," as in the quote above, highlights the dissonance even within one field of expertise—in this case, nature conservation. Although some nature conservationists are convinced that the progressive development of the areas and their natural succession is not associated with any devaluation in the nature conservation sense, conflicting interests within nature conservation remain. This applies above all to the expected loss of early succession stages, which are the habitat for particularly endangered species and thus largely determine the current value of the landscape to nature conservation. Difference appears not just in what species is the object of the individual conservation interest but also in different notions of temporality, as in what emerges versus what is maintained in the landscape. Both can include a high demand for human efforts or exclude human practices from the vision. The approach of an unguided (from a human perspective) natural succession that some nature conservationists highly recommend, is by a nature conservationist interested in birds such as the tawny pipit, degraded as being "lazy." Upon closer examination, the term "lazy" may not accurately capture the nuanced dynamics at play within the field of nature conservation. Rather, the quote sheds light on the divergence of perspectives among conservationists, particularly regarding approaches to habitat management and restoration. While some advocate for unguided natural succession, emphasizing minimal human intervention, others prioritize more proactive conservation strategies that involve deliberate human efforts to maintain and enhance habitat conditions. This discrepancy reflects differing conceptualizations of conservation goals, temporal scales, and the role of human agency in ecological stewardship. Thus, the quote underscores the complexity of conservation discourse and the diverse array of perspectives within the field.

The protection of a specific habitat for a specific species is contrary to the temporalities of succession and therefore requires myriad human interventions to try to halt back succession. Disturbance here is framed as both an ecological and ethical concern, where human responsibility for maintaining specific habitats—such as open landscapes for species like the pipit—requires ongoing interference with natural processes. The speaker implies that this requires expertise when he says, "if you don't know how to keep a landscape open." By invoking the role of biology and landscape management, the speaker suggests that deliberate disturbances—such as grazing, mowing, or habitat creation—are necessary to prevent ecological homogenization and maintain biodiversity. In this way, disturbance as a socio-ecological concept highlights the interplay between human decisions, ecological dynamics, and species survival. It reveals the ongoing negotiations involved in land management, where human interventions aim to preserve certain ecological states while challenging the notion that non-intervention is inherently more natural or ethical. This perspective reinforces the idea that disturbance is not simply destructive but can be an active strategy for maintaining ecological diversity in post-industrial or anthropogenically altered landscapes. Interestingly, active mining and with it the unintentional moving of the extraction frontier, takes over the practice of disturbance by creating an open landscape with specific habitats for these specialized species. Consequently, the restoration of the landscape and subsequent removal of the mining border pose a danger for these specialized species, such as the tawny pipit, which is now threatened with extinction due to changed habitat conditions.

Similarly to the tawny pipit, the wheatear *(Oenanthe oenanthe)*, the sand martin *(Riparia riparia)* and the bee-eater *(Merops apiaster)* are all migrating birds that highly benefit from mining areas. These birds fill niche biotopes, which are formed again and again not just through the shifting extraction frontier but also through erosion:

> Erosion are things that the stability expert in the [mining] company does not like to see, but of course, they are not a problem in the mining process. They can often simply be left lying around for years and therefore offer nesting sites for years to come. (Ornithologist, October 2021)

The mitigation of erosion and landslides during the mining process is closely associated with the boundaries defined by German mining law, which distinguish the mining area from its surrounding environment. Typically, within active mining sites designated as private property, access is restricted, and authorized personnel undergo training and insurance coverage for safety measures, minimizing the consequences of erosion compared to areas beyond the mining borders. Upon restoration public safety concerns become paramount, and erosion needs to be prevented and dealt with when it happens.

Once an opencast mining landscape is restored and released from mining law, the landscape must not pose a potential danger to the public. This legal issue, which is only eminent with the removal of the private property border and the release of the landscape from German mining law, was addressed during the same conference by another person, who is in charge of planning the restoration of former mining areas. In her slideshow, she showed a picture of an angled restored cliff that she described as a potential bird-nesting spot for the sand martin. A person in the audience started laughing, and as people turned their heads to him, he said: "No sand martin will ever nest there, it is not steep enough." She asked: "How many degrees should the steep face have?" "Vertical," he replied. The restoration planner looked defeated and answered: "You know, my problem is, the landscape needs to be safe. I cannot create steep faces. It is impossible to please everybody."

Under the BBergG, specifically § 55, the requirements for the final mine closure plan (*Abschlussbetriebsplan*) are outlined. This section mandates that after mining operations have ceased, the operator must submit a closure plan to the relevant authority. The plan must include measures to ensure that, once the mining area is no longer under mining law, there are no risks to human life, health, or public safety. These requirements are further specified through various regulations and guidelines, such as the General Federal Mining Ordinance (*Allgemeine Bundesbergverordnung*) for open-cast mines. The precise process of releasing a landscape from mining law involves rigorous assessments by the mining authority to verify that all safety and stability standards, such as slope stability and the prevention of subsidence or water ingress, have been met. This legal framework ensures that former mining areas are safe and stable before they can be fully released from the obligations and regulations

of mining law. This legal transition underscores the challenges of balancing safety and ecological considerations in post-mining landscapes. Despite efforts to restore these landscapes safely, conflicts often arise due to competing interests, including nature conservation, agriculture, forestry, and tourism, complicating the restoration process and posing challenges for conservation efforts.

The ethnographic example illuminates the intricate interplay between ecological dynamics, human interventions, and conservation practices within mining landscapes. Through the lens of disturbance ecology, the example underscores the transformative power of mining activities in creating dynamic habitats that support specialized species such as the tawny pipit. The concept of disturbance, viewed through a socio-ecological lens, highlights the multifaceted nature of landscape transformation, encompassing both ecological and human dimensions. In this context, mining-induced disturbances serve as catalysts for ecological flux, shaping the formation of transitional zones or ecotones where species from adjacent habitats mix and interact. However, this type of disturbed landscape, with its vertical steep cliff faces, is only permitted when humans are not allowed to enter the area.

Accordingly, the example illuminates the complex bordering practices inherent in mining landscapes, where regulatory boundaries delineate active mining areas from their surrounding environment. These borders, governed by BBergG, symbolize containment and control, reflecting traditional notions of territoriality. Concurrently, the concept of the frontier within mining landscapes signifies spatial and temporal movement, mirroring the fluidity and boundary-shaping processes attributed to frontiers. The advancing extraction frontier, marked by shifting boundaries between active and inactive mining areas, embodies the dynamic nature of spatial governance and territorialization within mining landscapes.

Moreover, the example highlights the unintended consequences of mining activities on avian biodiversity, particularly the role of erosion and landslides in creating nesting sites for migrating birds, which are only legal to leave unattended because of the private property border. This phenomenon challenges conventional notions of disturbance as solely negative ecological impacts, emphasizing the co-constitutive relationship between human activities and ecological processes. In addition, the legal transition from active mining to landscape restoration further complicates border-making practices, revealing the challenges of balancing safety concerns with ecological considerations. This tension underscores the need for interdisciplinary approaches to conservation and land management that account for the diverse array of perspectives and temporalities at play (Adam, 2000; Phillips, 2020) within mining landscapes, recognizing the pivotal role of multiple temporalities in shaping socio-environmental events and processes within specific landscapes and their extraction boundaries.

6. Of Wildcats and Lions

When we stepped out of the bus in the opencast mine Profen, we saw a bushy semi-open landscape, sandy soils, and implemented land-structures made of chipped wood and piled stones. The guide, who works for the mining company and is responsible for the coordination of land restoration and compensation areas, showed us various projects for subsequent use as well as active nature conservation. In this particular site, he addressed challenges as well:

> We found that a wildcat made itself a home here. We do not really know why, as these animals normally prefer dense forest and not such semi-open landscapes, which we created here. If they come too close we have to stop the extraction, therefore we employ methods of deterrence. (Mining Landscape Tour Guide, October 2021)

Legally, the mining company is obliged to stop its extraction when there is a red-listed animal that might be harmed. The wildcat (*Felis silvestris*) is nowadays rare and one of the "specially protected" species (Götz, 2015, p. 17). It is listed as "vulnerable" on the Red List of Vertebrates (Meinig et al. 2020, p. 27). It is also subject to European protection regulations, for instance in the Flora-Fauna-Habitat (FFH) Directive (Habitat Directive). The FFH is a European Union law aimed at protecting certain wild animal and plant species and their habitats, with its implementation carried out at the national level. In the German FFH-Guideline the wildcat appears in Appendix IV, which lists animal and plant species of common interest to be "strictly protected" and prohibits killing individuals of these species or damaging their breeding and resting places (Bundesamt für Naturschutz [Federal Agency for Nature Conservation], 2024, p. 3).

Though the mining company is not allowed to kill or catch the respective species, it is legally authorized to employ preventive measures (*Vermeidungsmaßnahme*). One of the preventive measures is deterrence (*Vergrämung*), which aims at discouraging animals from dwelling in a particular place. For instance, in order to avoid protected birds from nesting within the active mining zone defined by the moving extraction frontier, as this, too, would require the company to stop the extraction, noise is often employed as a measure of deterrence. Deterrence through mobile acoustic signaling devices covers about one hectare per device. The sounds include fireworks and other shot sounds, but also sounds taken from nature, for example, from natural enemies.

When I asked about what particular measure they were going to use to deter the wildcat, the guide answered that they would cut some of the plants to remove suitable hiding spots, so that it "voluntarily" moved outside the mining site.

Normally, the European wildcat lives hidden and secluded in natural deciduous and mixed forests, reluctant to leave its protective cover. Although it looks confusingly similar to grey-brown tabby domestic cats, it roamed Europe's woodlands long before the Romans brought the first domestic cats over the Alps (*Bund für Umwelt und Naturschutz Deutschland* [BUND, German Federation for the Environment and Nature Conservation], n.d.). Originally native to all of Germany, an estimated 6,000 to 8,000 animals live in Germany today, mostly in central and southern Germany (BUND, n.d.). Wildcats are representative of many other forest dwellers, as they are a highly demanding species and therefore signpost habitats of other endangered and equally demanding species.

After the field excursion, I spent more time talking to biologists and nature conservationists about the wildcat and its territories. As the habitats are scattered around Germany in an island-like pattern, it is enormously difficult for young cats to find new territories and to migrate from one to the other. As a consequence, there is a higher risk of inbreeding, leading to smaller variety in the genetic pool. The border of the mining company's private property is not fenced, which allows for wildlife movement. This openness creates what appears to be an attractive new habitat in the absence of other options:

> We collected wildcat hair samples in areas adjunct to the private property of the mining company, as we cannot monitor on their territory. The decommissioned but not yet fully restored and [for humans] inaccessible mining landscapes seem to provide a sanctuary for the wildcat. (Nature Conservationist 2, Interview October 2022)

Yet, once detected by the mining company, its staff employs measures of deterrence to make the wildcat leave its property, as it could potentially put the extraction on hold if it comes too close to the moving frontier of extraction. Although the guide on the tour through the mining landscape told us only about cutting plants as a deterrent, another nature conservationist told me about an inquiry from the company about another measure of deterrence:

> How they initially wanted to deter the cat was with the use of lion feces. They wanted to scare the cat through olfactory means, thinking that it will be afraid of a much bigger cat living in their territory and therefore they asked the zoo if they could get some lion feces from them. But the zoo refused, saying that they are animal lovers and therefore will not hand out their lion feces for such a purpose. (Nature Conservationist 3, Interview October 2022)

However, the deterrence measures that the mining company employs all aim at the targeted animal leaving their private property. Therefore, the border of that property needs to be traversable for the specific species in order to be able to leave voluntarily. The accessibility of mining property borders for wildlife trafficking underscores the porousness of these borders and their implications for species movement and habitat connectivity.

The presence of wildcats in semi-open landscapes created by mining activities challenges conventional understandings of habitat preferences for these animals, highlighting the dynamic relationship between human interventions and wildlife behaviors. Legally, mining companies are obligated to halt extraction in the presence of red-listed species, such as the wildcat, underscoring the legal dimensions of border-making practices and the intersection between environmental protection regulations and industrial activities.
The employment of deterrence measures by mining companies, such as cutting plants or deploying acous-

tic signalling devices to discourage wildlife presence further exemplifies the complex negotiation of borders within mining landscapes. The measures of deterrence also underscore the socio-political dimensions of disturbance, as legal obligations compel mining companies to navigate the presence of protected species within their operational landscapes. The company's use of deterrence measures like plant cutting and its potential inquiry into more unconventional methods (such as using lion feces) to prevent wildcats from halting extraction operations exemplify the negotiation of frontiers where industrial imperatives meet conservation laws. This negotiation extends to the ethical considerations surrounding wildlife management, where the refusal of the zoo to participate in deterrence reflects broader societal values and conflicts within environmental governance. Thus, the example demonstrates the co-constitutive relationship between human activities, legal frameworks, and ecological processes in shaping mining landscapes and their borders.

In this context, the wildcat's presence and the company's response to it exemplify how disturbance reshapes both the physical landscape and the socio-legal frameworks governing it. The wildcat becomes a marker of the shifting ecological frontiers, where the boundaries of human and nonhuman territories are actively constructed, contested, and reimagined. Thus, the vignette not only illustrates the complexity of these interactions but also enriches the conceptual understanding of disturbance as an emergent, socio-ecological phenomenon.

7. Toad Territory & Temporary Nature

Lignite has been mined in the mining field Schwerzau, which is part of the open-pit Profen, since 2006. This particular mining field covers 888 hectares of landscape, in which 30,000 tons of coal are transported to the surrounding power plants every day.

> In this active mining field, about 1,000 natterjack toads live in over 80 temporary water bodies in the inner dump of the open pit, as well as 100 green toads—and this is only a small part of the territory of the open pit. (Wildlife Advisor of the Mining Company, October 2021)

The landscapes immediately following opencast lignite mining before restoration offer important secondary habitats for pioneer species that are specialized in highly dynamic environments. In central Germany, the natterjack toad *(Epidalea calamita)* is one of those species that is particularly dependent on opencast mining. With the coal phase-out and ongoing succession, these habitats are increasingly being lost, and the natterjack toad population has declined sharply in recent decades. Outside the borders of the pits, nature conservationists struggle to find suitable habitats for the endangered toads:

> Natterjack toads are so dependent on active mining and love these lunar landscapes. We sometimes have people come in saying that they have land they would like to offer to nature conservation, but when I show them how the habitat for natterjack toads would look like, they are all immediately like "not this kind of landscape, please." It is for most people not aesthetically pleasing. (BUND employee, Interview October 2022)

In a figurative sense, the description of certain areas within mining landscapes as "lunar landscapes" evokes imagery of barren terrain devoid of vegetation, comprised mainly of stones, dust, and rubble. Yet these rugged landscapes, akin to extraterrestrial environments, foster the creation of temporary bodies of water and offer suitable habitats for species like the natterjack toad, which possesses unique adaptability to both aquatic and terrestrial phases of life. This characterization demonstrates the profound transformation of these landscapes, transcending traditional notions of terrestrial ecosystems and prompting contemplation on the boundaries between the familiar and the unknown.

Moreover, the rejection of these lunar-like landscapes by people offering their land to the BUND due to their perceived lack of aesthetic appeal invites critical reflection on the human-centered notions of beauty and landscape aesthetics. From a more-than-human geography perspective, this rejection underscores the anthropocentric bias ingrained in conventional perceptions of landscape aesthetics, which prioritize human preferences and ideals while overlooking the diverse values and experiences of nonhuman beings. By deconstructing the human-centric gaze that perceives these landscapes as unattractive or undesirable, we can begin to appreciate the intrinsic value of these spaces from a multi-species perspective. These barren terrains represent thriving ecosystems teem-

ing with life and ecological complexity, challenging us to broaden our aesthetic sensibilities and cultivate a deeper appreciation for the diverse forms of beauty found in the more-than-human world.

Especially for habitats perceived as aesthetically unappealing, the legal concept of *Natur auf Zeit*, literally *temporary nature* holds potential. This approach allows nature to thrive temporarily within mining landscapes during periods of industrial interruption, providing niches for biodiversity while acknowledging the impermanence of these habitats, as a lawyer explained to me in an interview: "Temporary nature gives nature the freedom to move and thrive within a temporal limitation." (Lawyer, Interview October 2021)

The legal framework for temporary nature in Germany is not governed by a single law but by several interconnected legal provisions, primarily within the Federal Nature Conservation Act (*Bundesnaturschutzgesetz* [BNatSchG]). The concept is supported by amendments made in 2021, which emphasize the role of dynamic conservation. Paragraph 1(7) of the BNatSchG highlights the importance of cooperation between public authorities and private actors in achieving conservation goals, allowing for temporary conservation efforts without permanent land-use restrictions. Paragraphs 54(10a) and (10b) BNatSchG provide the Federal Ministry for the Environment with the authority to issue regulations for implementing temporary nature, focusing on areas such as mineral extraction and industrial or traffic land use. This enables temporary ecological regeneration on unused land, with the possibility of future land-use changes. Additionally, Paragraph 45(7) of the BNatSchG allows for early agreements between businesses and authorities, offering legal certainty regarding future land-use decisions while engaging in temporary conservation.

In sum, the temporary nature concept introduces an approach to habitat creation within mining landscapes, entailing the deliberate cultivation of temporary habitats during periods of industrial interruption, followed by their subsequent destruction to facilitate extraction. Considered to be "integrative" nature conservation, temporary nature allows nature to thrive temporarily before resuming industrial activity (Becker et al., 2019). It generally refers to the temporary development of nature on unused areas, such as industrial wasteland or mining sites.
This approach transforms temporality into both a method of protection and destruction, as it provides niches for biodiversity while allowing for their destruction when industrial or mining activities resume. The shifting frontier within the landscape, characterized by dynamic flux between active and inactive mining zones, offers transient habitats for endangered species amidst human-induced ecological change. The notion of temporary nature underscores the processual character of landscape transformation, providing nature with the freedom to adapt and thrive, but only within a temporal framework defined by the temporality of extraction or other industrial activities. As restoration progresses, special biotopes in active mining landscapes shrink, leading to the loss of high-quality structures and niches. While temporary nature aims to provide such niches, it also permits their destruction when necessary for industrial operations to proceed.

Exploring the concept of temporary nature and its implications reveals several critical dimensions. When a temporary reserve is relocated, ethical responsibilities demand cautious displacement to minimize ecological harm, which involves assessing the site's ecological significance and ensuring the survival of displaced species. The temporariness of these ecosystems can foster resilience, allowing for adaptation to changing conditions and serving as experimental grounds for conservation practices. Politically, the management of temporary nature reflects power dynamics, revealing how decisions about reserves often align with broader economic interests such as mining or urban development.

8. Conclusion

In critical border studies, there is a paradigm shift towards incorporating more-than-human perspectives, reflecting an emerging interest in understanding the nuanced interplay between human and nonhuman forces in shaping bordering practices (Fleischmann, 2020; Gutkowski, 2021; Khazaal & Almiron, 2021; Ozguc & Burridge, 2023). Additionally, more-than-human geographies challenge anthropocentric perspectives by emphasizing the entanglements of human and nonhuman actors in socio-material processes (Steiner et al., 2022; Lorimer & Hodgetts, 2024), contributing to an understanding of ecological relations (Youatt, 2020). This article examined how nonhuman entities contribute to shaping borders, emphasizing their co-constitutive interdependences in

"post-industrial ruin[s]" (Bubandt & Tsing, 2018, p. 1). By integrating more-than-human perspectives, the article explored nonhuman entities in border constitution and negotiation, challenging anthropocentric views and emphasizing the co-constitutive relationship between humans and their environments. The exploration of mining landscapes through the lens of temporary nature conservation unveils a nuanced understanding of the border-making processes inherent in these dynamic environments.

The example of the migrating birds demonstrates how a species, which holds the advantage of being capable of easily crossing land borders through its ability to fly, benefits from the borders of the mining landscape as a private property. As a private property, the surrounding areas of the pit are rarely confronted with human traffic, and therefore especially nesting seems to be suitable in a somewhat undisturbed environment of a disturbed landscape. Additionally, with the human interventions that converted these landscapes into habitats that resemble steppes and semi-deserts, the distribution of such birds was fostered, and they find new homes in the post-industrial ruins. The possibility of erosion and landslides within the mining process is closely tied to the border of the mining area, delineated by BBergG, contrasting with its surrounding environment. This distinction significantly impacts the management of erosion, particularly in active mining sites where public access is restricted and safety measures are enforced for authorized personnel, reducing the risk compared to areas outside the mining borders. Such landslides provide suitable nesting spots.

Similarly, the natterjack toad benefits significantly from the disturbed landscape resulting from human activities. The excavator, as it eats its way through the landscape, serves as a moving frontier of active and inactive mining, creating the lunar-like landscapes preferred by the natterjack toad for its unique habitat requirements. With a lack of predators and the toads' ability to quickly warm up in sunlight, unshaded temporary pioneer waters provide ideal conditions for their larval development, surpassing the speed at which any other native amphibian species can progress. The legal concept of temporary nature offers potential for providing temporary habitats for the natterjack toad. However, while mining companies may express willingness to accommodate temporary nature, concerns over species protection may impede their ability to resume extraction activities after areas have been set aside for conservation. Nonetheless, the legal framework allows for prior exceptions to be made, ensuring that companies could proceed with their operations regardless of developments during the temporary nature period. By examining these dimensions through a legal lens, particularly the concept of temporary nature, this analysis contributes to more-than-human geography by highlighting the interplay between legal frameworks, ecological processes, and ethical considerations, ultimately shedding light on how human actions shape ecological landscapes and the responsibilities that accompany them.

The specific legal concept of temporary nature highlights the temporal aspects of the border and border-making within private property. It is a concept that shall do both: allow nature to thrive within such unique landscapes while also allowing the mining or construction company to destroy that nature after "the time is up" to proceed with their work. The example of the wildcat, on the contrary, demonstrates how the reinforcement of a border is dealt with through practices of deterrence. In this case, the fear of the cat coming too close to the extraction frontier, which would require the mining company to stop excavating, led the humans in charge of the wildlife areas to investigate measures that will make the wildcat move. This paper demonstrated how more-than-human entanglements are engaged in the making and unmaking of the boundaries of the mining landscape. By examining how mining disturbances alter habitat structures and resource availability for nonhuman species, more-than-human geography highlights the interconnectedness between human actions and ecological dynamics.

In conclusion, this paper has employed a theoretical framework rooted in critical border studies and more-than-human geographies to examine the complexities of borders and frontiers in the context of lignite mining. Drawing on critical border studies, I aim to contribute to the conceptualization of borders beyond mere territorial demarcations to dynamic sites of interaction and boundary-making processes. Additionally, by incorporating more-than-human perspectives, I have emphasized the ethical dimensions of resource extraction and land management practices, calling attention to the intrinsic value of nonhuman entities and their contributions to ecosystem functioning. By highlighting the dynamic and co-constitutive nature of borders and frontiers in the context

of lignite mining, the framework emphasized their role as sites of interaction and boundary-making processes. This interdisciplinary approach opens up new avenues for research that consider the broader implications of landscape change on human societies and ecosystems, contributing to a deeper understanding of borders and their socio-ecological contexts.

Incorporating disturbance as a socio-ecological concept is vital for understanding the dynamics at play in mining landscapes. Disturbance, whether through mining activities or natural processes, reshapes habitats and influences species distributions, creating new ecological niches while also posing challenges to existing ecosystems. These disturbances are not merely negative; they can foster resilience and adaptability in certain species, illustrating the interplay between human-induced changes and ecological responses. By examining disturbance through a socio-ecological lens, this paper highlights how human actions and ecological systems co-evolve, creating both opportunities and challenges for biodiversity and ecosystem functioning. This perspective enriches the discussion of borders and frontiers by underscoring that they are not static boundaries but dynamic zones where ecological and social processes intersect, continually reshaping both (post)mining landscapes and the species that inhabit them.

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