ANIMAL INFRASTRUCTURES:

A MORE-THAN-HUMAN GEOGRAPHY OF ANIMALS AND/IN/AS NATURE-BASED SOLUTIONS



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To Colleen, who always believed I could do it

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Abstract:

From the reintroduction of beavers for natural flood management to the managed grazing of cattle for biodiversity gain, the inclusion—or use—of nonhuman animals in/as environmental interventions is gaining traction in Britain, often associated with the policy turn towards 'Nature-based Solutions' (NbS) to climate change and biodiversity loss. NbS are defined by the IUCN as actions that protect, manage, or restore ecosystems while addressing societal challenges (Cohen-Shacham et al., 2016), often involving humans 'working with nature' (Seddon et al., 2021). In this thesis, I build upon my past work on NbS (Welden, 2023; Welden et al., 2021), forming a critique of the NbS concept with animals at the centre and demonstrating how this concept necessarily enrols, enmeshes, and enfleshes certain animals as infrastructure.

While infrastructure is 'conceptually unruly' (Larkin, 2013), I define it as material relation with (environmental) objects in the (re)production of an organised practice. Drawing from a year of fieldwork with beaver restorationists, regenerative farmers, organisation directors, and the beavers and cattle themselves, I explore the different ways in which beavers and cattle are made to be the infrastructure of Nature-based Solutions. Weaving together animal geographies, more-than-human geography, political ecology, and biopolitics, I develop a typology of the process of making animal infrastructure: Enrolment, Enmeshment, and Enfleshment, the latter two expanding upon language from Barua (2021)'s ontology of nonhuman infrastructure.

Enrolment traces how beavers and cattle are discursively framed as infrastructure, evoking diverging 'natures,' framed in relation to humans and technologies, and enroled as the infrastructure of 'solutions,' obscuring differences between animals and species. Enmeshment explores the ways in which animals are choreographed in their material relations with technologies that both hold them in place and make them move, enmeshing their bodies in relation to produce 'solutions.' Enfleshment shows how the cyclical labours (for life) of 'ecosystem engineers' enfleshes their bodies as infrastructure, producing both themselves and the 'solution.' The thesis then concludes with reflections on the real futures that are opened up or closed down for animals enroled, enmeshed, and enfleshed as infrastructure of NbS, and lays out a speculative future in NbS policy that acknowledges animal infrastructuralisation in NbS interventions.

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List of Abbreviations:

NbS: Nature-based Solutions to climate change and biodiversity loss

IUCN: International Union for the Conservation of Nature

UNFCCC: United Nations Framework Convention on Climate Change

COP: Conference of the Parties

REDD+: Reducing Emissions from Deforestation and Forest Degradation in Developing Countries

EC: European Commission

UN: United Nations

GHG: Greenhouse Gas

UNEP: United Nations Environment Programme

RQ: Research Question

SNH: Scottish National Heritage

DEFRA: UK Department for Environment, Food, and Rural Affairs

NRW: Natural Resources Wales

PFLA: Pasture Fed Livestock Association

ELMS: Environmental Land Management Scheme

SFI: Sustainable Farming Incentive

MTH: more-than-human

WWF: World Wildlife Fund

IIED: International Institute for Environment and Development

OPEN: Oxford Policy Engagement Network

BDA: Beaver Dam Analogue

Chapter 1: Introduction

1. The Rise of Nature-based Solutions to Climate Change and Biodiversity Loss

From the reintroduction of beavers to the rise of 'regenerative' farming practices, Nature-based Solutions (NbS) to climate change and biodiversity loss are gaining traction in Britain, marking a shift towards this novel paradigm of environmental governance. Defined by the International Union for the Conservation of Nature (IUCN) as 'actions to protect, sustainably manage and restore natural or modified ecosystems, which address societal challenges effectively and adaptively, while simultaneously providing human wellbeing and biodiversity benefits' (Cohen-Shacham et al., 2016, p. xii), NbS involve people 'working' with nature (Seddon et al., 2021) (Figure 1), acknowledging connections and dependencies between people and 'nature' (Welden, Chausson et al., 2021). Still, their neoliberal tendencies—making 'nature' *work*, for free (Welden, 2023) and discursively aligning with ecosystem services (Kotsila, 2021; Osaka et al., 2021)—have material effects on the more-than-human elements involved and have thus brought the trend under scrutiny. Regardless, the concept continues to grow in popularity, with an increasing number of projects termed Nature-based Solutions rolled out across Britain: all of which include more-than-human others, many of whom are nonhuman animals acting as the ecosystem engineers or 'keystone' species managing life (Lorimer, 2020), or mediating life's organisation (Berlant, 2016), as infrastructure. Through Nature-based Solutions, animals' stories are retold in a new context (Chapter 4), their bodies are both made to move and held in place (Chapter 5), they labour metabolically, probiotically, and reproductively to produce themselves as NbS (Chapter 6), and ultimately their possible futures become defined by this concept (Chapter 7). Thus, this expansion of NbS is deeply significant to the lived experiences of the current and future animals within these projects and requires critical exploration and

understanding at a time where NbS are being 'scaled up' across Britain (Cohen-Shacham et al., 2019; Smith and Seddon, 2023).

1.a. Conceptual History of Nature-based Solutions

The term Nature-based Solutions was first coined by the World Bank in their 2008 report on biodiversity for climate change adaptation (World Bank, 2008), and since then, its usage and definition have expanded past those spaces to include carbon mitigation within 'Net Zero' strategies and commitments (Seddon, 2022). The term was then taken up by the IUCN, appearing in one of the organisation's position papers to the UNFCCC COP15 (IUCN, 2009), after which point the IUCN named it as one of its three programmatic areas for 2013-2016, looking to expand ecosystem-based approaches and REDD+. Out of this time came the seminal IUCN (Cohen-Shacham et al., 2016) report defining Nature-based Solutions (Table 1) and Cohen-Shacham et al.'s (2019) follow-up paper with guidelines and criteria for impactful NbS. As defined in Table 1, the European Commission and the United Nations also formalised definitions for NbS in 2015 and 2022, respectively. However, the IUCN's definition is the most cited and widely adopted on an international scale, and it is the definition from which this thesis primarily draws.

Organisation	Nature-based Solutions definitions
IUCN	Actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits (Cohen-Shacham et al., 2016).
European Commission (EC)	Solutions that are inspired and supported by nature, which are cost effective, simultaneously provide environmental, social, and economic benefits, and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient, and systematic interventions (EC, 2015).
UN	Actions to protect, conserve, restore, sustainably use, and manage natural or modified terrestrial, freshwater, coastal, and marine ecosystems, which address social, economic, and environmental challenges effectively and adaptively, while simultaneously providing human well-being and biodiversity benefits (UNEA-5.2, 2022).

Table 1: Varying definitions of Nature-based Solutions across three primary defining agencies.

Following the IUCN's development of NbS, they also published the IUCN Global Standard for Nature-based Solutions, laying out criteria for what constitutes a given NbS (IUCN, 2020). This came in response to critiques (outlined below) that the concept was being appropriated by bad climate actors, used for greenwashing [e.g. Shell's Nature-based Solutions marketing campaign (Shell Global, n.d.)], and thus provides a standard off which particular interventions are considered NbS or not. The eight criteria for inclusion are outlined in Table 2.

Criterion 1	NbS effectively address societal challenges
Criterion 2	Design of NbS is informed by scale
Criterion 3	NbS result in a net gain to biodiversity and ecosystem integrity
Criterion 4	NbS are economically viable
Criterion 5	NbS are based on inclusive, transparent, and empowering governance processes
Criterion 6	NbS equitably balance trade-offs between achievement of their primary goal(s) and the continued provision of multiple benefits
Criterion 7	NbS are managed adaptively, based on evidence.
Criterion 8	NbS are sustainable and mainstreamed within an appropriate jurisdictional context

Table 2: The 8 Criteria that make up the IUCN's (2020) Global Standard for Nature-based Solutions

Under the IUCN's definition and criteria, then, fall multiple environmental interventions, which involve—according to Seddon et al. (2021)—people 'working with nature.' The authors classify NbS interventions into four categories: protection, restoration, management, and creation (Figure 1). These could include specific interventions like the protection of an area to prevent deforestation in a biodiversity-rich place, the restoration of a 'degraded' ecosystem or wetland by reintroducing beavers, the (holistic) management of agricultural land through 'regenerative' farming, the creation of locally-managed marine protected areas, and more. In the IUCN definition's explicit acknowledgement of the connections between humans and more-than-human others, NbS are considered unique modes of modern land management (Welden, Chausson et al., 2021). This thesis takes the aforementioned examples of beaver reintroduction and regenerative farming as the foundational case studies through which I explore the concept of NbS. While NbS is wide-reaching in scope, all these interventions listed by Seddon et al. (2021) share a foundation in the IUCN definition and criteria.

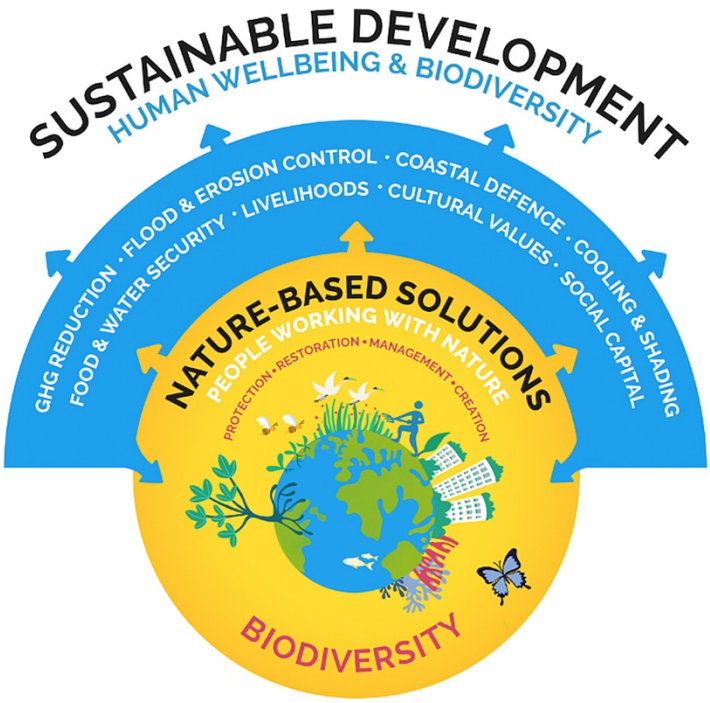


Figure 1: A figure produced by Seddon et al. (2021) in their paper 'Getting the message right on Nature-based Solutions,' depicting four broad categories that NbS fall under and examples of various NbS interventions. Copyright CC BY.

1.b. Scientific History of Nature-based Solutions

Because Nature-based Solutions is a term to encompass multiple, individual interventions, the 'science' behind Nature-based Solutions is likewise variegated. However, there are a few studies that demonstrate the impact of Nature-based Solutions as a whole, based on global measurements and modelling. For example, Girardin et al. (2021) model how Nature-based Solutions may reduce global temperatures, demonstrating that Nature-based Solutions—under conditions of ambitious, rapid uptake—can assist in long-term global temperature reduction and can provide short-term mitigation benefits. They do posit, though, that the temperature reduction potential of Nature-based Solutions is contingent upon immediate decarbonisation measures and is ultimately only one piece of addressing climate change. Likewise, in a review of the science behind Nature-based Solutions, Seddon (2022) cites the 30 (at the time of writing) articles written on the global measures of Nature-based Solutions impacts on climate mitigation, noting the variance in the articles' models and findings. She concludes, writing,

'Nature-based Solutions can make an important contribution to reaching net-zero[1] carbon emissions this century, but only if combined with other climate solutions, including substantial cuts in GHG [greenhouse gas] emissions across all sectors of the economy' (p. 1415).

2. The 'Trouble' with Nature-based Solutions

2.a. Critiques of Nature-based Solutions

However, the concept of Nature-based Solutions is not without its critics. In a joint report I co-authored for the think-tank Unearthodox (Chausson et al., forthcoming), we find the proponents and critics of the concept split, existing along discursive poles of NbS as an intervention which harnesses 'nature's' inherent power and NbS as a 'dangerous distraction,' borrowing from Melanidis and Hagerman (2022). While we found proponents hold the perspective that NbS delivers multiple co-benefits and fosters social-ecological resilience—with some strong proponents claiming universal scalability and cost-effectiveness—critics believe that NbS is a false solution with potential to harm nature and people, delaying (or distracting from) decarbonisation efforts. Many of these critiques build off Indigenous ontologies of human-nature relationality and the historical dispossession of Indigenous peoples from the land—calling to reframe Nature-based Solutions on the basis of human-nonhuman relationality rather than capitalist resource extraction, against potential injustices and violence that NbS may enable (Reed et al., 2022; Townsend et al., 2020). The worry amongst many Indigenous scholars and advocates is that NbS may be a reincarnation of past policy buzzwords, which have led to harm (Reed et al., 2022).

[1] Net-zero is a policy concept often related to, or referenced alongside, NbS. It refers to a 'net-zero' measure of greenhouse gas emissions (from human activity) by carbon drawdown interventions (e.g. Nature-based Solutions) (UNEP, 2023).

In addition to the distraction or greenwashing critique, critiques of NbS extend to an overall neoliberal appropriation of—or inherent link with—the concept (Chausson et al., forthcoming). In previous work, my co-authors and I have written on the link between the concept of Ecosystem Services and Nature-based Solutions, arguing that such a link with monetary value and nonhuman resources inhibits the transformative, societal potential of NbS (Welden, Chausson et al., 2021). These neoliberal tendencies of the concept—making 'nature' *work*, for free (Welden, 2023) and discursively aligning with ecosystem services (Bekessey et al., 2018; Kotsila, 2021; Osaka et al., 2021)—also have material effects on the more-than-human elements involved in a given Nature-based Solution. Beyond tendencies, scholars like Kronenberg et al. (2017) claim that NbS are inherently neoliberal, insofar as 'the existence of anything needs to be justified by its ability to solve some problem' (p. 303), and Kotsila et al. (2019) argue that NbS position neoliberal governance as 'nature-friendly' with the risk of the term being used to support the further exploitation of humans and nature. These critiques and further development of Nature-based Solutions as a concept are emerging from the critical social sciences, as 'working with nature' from Seddon et al. (2021) bounds Nature-based Solutions in the context of multispecies work/labour (Welden, 2023) and sets up particular knowledge and power hierarchies (Woroniecki, 2019), which critical social scientists are particularly poised to explore. This is reviewed in the section below and expanded by this thesis.

2.b. (Critical) Social Science of Nature-based Solutions

In a review paper on Nature-based Solutions, Nesshöver et al. (2017) outline the interdisciplinary 'nature' of Nature-based Solutions. However, despite claims that NbS address both humans and biodiversity (Welden, Chausson et al., 2021), and 'can help to reassert the connection between humans and nature' (Woroniecki, 2019 p. 16), the critical social science on Nature-based Solutions remains limited (Hanson et al., 2020). It is, however, growing and,

like much of the critical social science space, it is split amongst the subdisciplines of political ecology (e.g. Kotsila, et al., 2019; Woroniecki et al., 2020), biopolitics (e.g. Christiansen, 2021; Wakefield, 2019), and more-than-human geography (e.g. Maller, 2021; Welden, 2023). While the former two disciplines offer interesting insights into the institution of Nature-based Solutions and the various modes of power it exerts—and are thus are woven into this thesis in places—I take particular interest in the latter. I argue that a more-than-human perspective on Nature-based Solutions offers a nuanced, 'scaled down' view of the bodies and lives impacted in the everyday process of making and remaking—being the infrastructure of—a Nature-based Solution.

3. An Infrastructural Approach

This focus on scaling-down is pertinent given that much of the discourse surrounding Nature-based Solutions is focused on 'scaling up' these projects which - given their IUCN definition - are primarily localised, adaptable, ecosystem management interventions. For example, Cohen-Shacham et al. (2019) outline 'core principles for successfully implementing and upscaling Nature-based Solutions,' highlighting landscape-scale NbS and policy integration which could consolidate and widen NbS projects. The Agile Initiative here at the University of Oxford produced a policy brief titled, 'Scaling up Nature-based Solutions in England's National Climate Change Adaptation Programme,' in which they recommend mainstreaming NbS across all sectors, enhancing public and private finance to address the funding gap for UK nature recovery, measuring and monitoring NbS outcomes, and more (Smith and Seddon, 2023). And, in the international environmental governance space, organisations like the UN Environment Programme (UNEP) and The Nature Conservancy have produced reports and run multi-year projects on the 'scaling up' of Nature-based Solutions (e.g. The Nature Conservancy, 2023; The United Nations Environment Programme, 2022). In this work, NbS

takes on the role of an infrastructural solution to an environmental problem which can be scaled-up and rolled out.

This thesis asks what might be lost in the constant 'scaling up' discourse: namely, the 'scaled down,' the hyper-localised, the body-specific. As Nature-based Solutions are made up of an assemblage of more-than-human bodies (Maller, 2021), I argue these bodies, what they do (or are made to do), how they constitute the NbS to varying degrees (infrastructurally), and what this means for them (and NbS more broadly), require more-than-human attention. This thesis presents an argument for the study of 'scaled down' NbS, before we answer calls for 'scaling up,' as it currently stands.

Drawing on, and adding to, literature in Animal and More-Than-Human Geographies, this thesis provides a critical, more-than-human approach to Nature-based Solutions, in particular, through a deep interrogation of the processes of making nonhuman animals into these kinds of supposedly scalable infrastructure, a process termed infrastructuralisation by Andrea Ballestero (2015; 2019), or enmeshment and enfleshment by Maan Barua (2021). While infrastructure is a 'conceptually unruly' concept (Larkin, 2013) with multiple characteristics and conceptual histories, drawn out in Chapter 2, I define it broadly as a relation with material objects that are produced by, and produce, organised practices, one such 'organised practice' being a Nature-based Solution. Thus, a more-than-human geography of Nature-based Solutions necessitates an infrastructural approach that illuminates the discursively framed (Chapter 4), relationally choreographed (Chapter 5), and metabolically, probiotically (re)productive (Chapter 6), relations between animals, environments, humans, fences, grass, water, and more.

In contrast to previous studies in Animal and More-Than-Human Geographies, which tend to consider animal involvement/infrastructuralisation in such projects as inherently negative, exploitative, or instrumentalising (e.g. Barua, 2021; Cavalieri, 2009; Giraud and Hollin, 2016), I take a different approach. Based on my previous ethical standpoint on the possibilities of affirmative forms of human-animal engagement in Nature-based Solutions (Welden, 2023), this thesis is grounded in the possibility of realising multispecies collaborations, in which humans and more-than-human others can both work *and* live together. Rather than consider infrastructuralisation synonymous with instrumentalisation, I seek out the spaces in-between, the *potential* affirmative relations that are constituted by this novel form of environmental governance, the places where consensual work, respectful relations, and shared purpose (Welden, 2023) *may* be found between humans and animals in these spaces. Using infrastructure as an analytic helps to unpack these new, more-than-human relations emerging in NbS, as my critique 'lay[s] bare the wires, pipes, and foundations of a phenomenon' (Hetherington, 2019, p. 7). In the Conclusion (Chapter 7), I reflect on the emergent findings from the thesis to trace the potential futures that are opened up or closed down through this infrastructuralisation of animals in NbS, using my concept of multispecies collaboration to draw out these insights.

It is not a question of whether or not to do NbS, but rather, how can NbS be done *otherwise,* with consideration for the affirmative or instrumentalised more-than-human relations that constitute these interventions. This leads me to expand Barua's (2021) enmeshment/enfleshment typology of nonhumans and infrastructure, giving those two concepts scaled-down, case-based exploration, and importantly adding a discursive category, 'enrolment' as infrastructure. This more-than-human, scaled-down approach to NbS produces insights that are significant to the lived experiences of the current and future animals and/in/as

infrastructure within these current, and future, projects. This thesis is therefore guided by a commitment to understanding, at the scale of the animal body, the processes through which infrastructuralisation occurs and ruminating on how this may be done *otherwise* in imagined and real futures. To meet this aim, I have devised three principal Research Questions (RQs) which guide this thesis:

1. How are nonhuman animals made to be infrastructure—enroled, enmeshed, and enfleshed—within the context of Nature-based Solutions?
2. How does 'animal infrastructure' come to be known by the animals enrolled and the humans involved in particular Nature-based Solutions projects?
3. What is the significance of the infrastructuralisation of nonhuman animals, for both the animals and humans involved?

4. Introducing the Case Studies

To best study the nonhuman animals that make up the material and discursive concept of Nature-based Solutions, I turn to two cases of animals and/in/as Nature-based Solutions in Britain: the reintroduction of beavers (*Castor fiber*) and the managed grazing of cattle (*Bos taurus*) in 'regenerative' agriculture[2]. Such ecosystem engineers, 'animals who manage and modify biotic habitats' (von Essen and Allan, 2016, p. 82), or keystone species, 'organisms with disproportionate ecological significance relative to their abundance,' are valued for their ecosystem restoration capabilities (Lorimer, 2020, p. 26). While many animals fall into this category, I selected beavers and cattle to provide a diverse spectrum of the species enrolled in NbS projects—from wild to domesticated, restoration-focused to agriculture-based, riparian to

[2] Acknowledging that 'regenerative agriculture' is not a universal term used by farmers and—like Nature-based Solutions—has its critiques and ambiguity, I use it in this thesis to encompass farming practices which focus on soil health through low to no fertilizer input, rotational grazing of livestock, cover cropping, and more.

pasture environments. Further, the human actors involved in these two NbS projects differ, as restorationists, land managers, rangers, farmers, organisation directors, and more converge to 'manage' animal bodies under the umbrella of NbS. These different, more-than-human bodies and perspectives are captured within my study, providing a diverse understanding of the situation of NbS in Britain. In the next section I outline these two NbS interventions and their logics and practices: beaver restoration and managed grazing of cattle in Britain.

4.a. Beaver Reintroduction

One intervention commonly cited as a Nature-based Solution is beaver reintroduction, and it is a proven case with which to think through Nature-based Solutions critically, with a more-than-human lens (e.g. Lorimer, 2020; Welden, 2023). Exterminated from Britain in the 16th century, beavers are now being 'brought back,' lauded for their abilities to transform landscapes, namely through natural flood management and biodiversity generation (DEFRA, 2021; Gow, 2020). Following an ethological cue to stop flows of water, beavers build dams with the materials available to them, often felling and coppicing trees around a stream or river. This creates a beaver pond behind the dam, providing safety for the animals from predators[3] (Campbell-Palmer et al., 2016). Their building extends beyond a single dam, as beavers create lodges (by digging into banks or building structures—both with subsurface entrances), often build multiple dams along a riparian system, and dig canals to transport their building materials (Campbell-Palmer et al., 2016). Felling trees with their teeth, common signs of beaver activity are woodchips and pencil-tipped stumps, alongside a 're-wetted' landscape full of layered ponds and wetland mud (Figure 2).

[3] Many of whom have likewise been eradicated from Britain: wildcats, wolves, lynx, white-tailed eagles, etc.



Figure 2: A drone photograph of a licensed beaver enclosure in England. Copyright, with permissions, Alan Puttock, University of Exeter

In Figure 2, the landscape structure created by beavers living in that place is evident: felled trees, canals, and multiple dams spreading water make for a diverse and dynamic place. Because of their 'ecosystem engineering' (Goldfarb, 2018; Poliquin, 2015), beavers' 'works' have been cited as natural flood management techniques—as peak stormflow effects downstream are reduced (Brazier et al., 2021; Puttock et al., 2021)—biodiversity enhancers—as other species return to beaver-inhabited landscapes (Campbell-Palmer et al., 2016)—water filtration specialists—as beaver dams have been shown to filter sediments, potentially pollutants, from water (Bradbury et al., 2023)—and drought preventors—as more water is held in the beaver-created wetland (Campbell-Palmer et al., 2016; Hood, 2011).

Because of these benefits—and their 'ecosystem engineering' abilities to transform landscapes (Goldfarb, 2018)—beaver reintroduction is considered a Nature-based Solution (e.g. Welden,

2023). In Britain, they are 'brought back' to modulate or reverse modern, or antibiotic, land management practices in a probiotic manner (Lorimer, 2020). For this reason, beavers have had a 'managed reintroduction' to Britain, often placed in Natural England-licensed enclosures in England (Pouget and Gill, 2021), explicated in more detail in Chapter 5.

This reintroduction in Britain was, and is, not without its politics, much of which has been explored by social scientists (e.g. Crowley et al., 2017; Lorimer, 2020; Ward and Prior, 2020). In particular, many in the farming community were resistant to beaver reintroduction due to the isolated flooding potential on their fields, potentially reducing a farmer's arable land (Auster et al., 2020; 2022a). Further, beavers are an animal with which no humans in Britain have lived before[4], requiring something beyond coexistence: 'renewed coexistence' as coined by Auster et al. (2022b), or being 'made present' (Hinchliffe, 2008) conceptually and physically (Crowley et al., 2017). The ways in which beavers have been reintroduced to Britain is different in each devolved government.

4.a.i. Scottish Beavers

Scotland [specifically, Scottish National Heritage (SNH)] was the first to decide to reintroduce beavers in 1994, but the first beaver release in Britain was not coordinated by SNH but rather was an escape by beavers from a private wildlife park into the Tay in the late 1990s (Gow, 2020). This was followed by a government-organised Scottish Beaver Trial of 'wild' releases from 2009-2014 (Jones and Campbell-Palmer, 2014; Scottish Wildlife Trust, n.d.). As explored by Ward and Prior (2020), the two ways in which beavers were released in Scotland (wild releases—planned or accidental—and enclosed releases) illuminated the ways in which the different forms of releases affected the animals' sovereignty alongside the human-wildlife

[4] unless the person had lived outside Britain, with beavers.

conflicts. In essence, the more managed the beavers were, the less sovereign autonomy they had and conflict there was.

4.a.ii. English Beavers

Further south in England, the reintroduction story began a bit differently, with the devolved governments of England and Wales more hesitant about the reintroduction of a species. While zoos and private estates had beavers—many of them organised, imported, and quarantined by beaver restorationist, Derek Gow, in the early 2000s—escapees or illegal releases appeared in the River Otter in Devon, with their presence acknowledged by Natural England in 2014. Even in these 'wild' spaces, though, England's Department for Environment, Food, and Rural Affairs (DEFRA) attempted to manage 'wild' beaver behaviour and (re)capture transgressive beavers, as chronicled by Crowley et al. (2017). Later, in 2018, DEFRA released two beavers into a fenced enclosure in the Forest of Dean, marking the start of a series of releases into fenced enclosures in England, all requiring licenses by Natural England (Gow, 2020). However, the politics in this space continue, as DEFRA ran a years-long public consultation on beaver presence in Britain (DEFRA, 2021) and Natural England concluded that beavers can be released outside enclosures, in approved places (Pouget and Gill, 2021). However, under current government leadership, DEFRA ministers are refusing to sign off on Natural England's advice (Horton, 2024).

4.a.iii. Welsh Beavers

The last place in Britain to have beavers return is Wales. Citing concerns around interspecies pathogen transfer, the Welsh government has not officially reintroduced any beavers (Gow, 2020), though the Welsh Beaver Project is applying for a license to Natural Resources Wales (NRW) to conduct a managed release into the River Dyfi (North Wales Wildlife Trust, n.d.).

However, beavers are mobile—able to travel roughly 12 miles per day (Campbell-Palmer et al., 2016)—and thus the first wild beavers in Wales appeared in Pembrokeshire in 2023 (Halliday, 2023).

4.a.iv. (Critical) Social Science with Beavers

Beavers have sparked critical social science around human-wildlife biopolitics (Ward and Prior, 2020), human-animal and human-environment relations (Woelfle-Erskine, 2019; Woelfle-Hazard, 2022), probiotic value (Lorimer, 2020), animal labour and multispecies collaboration (Welden, 2023), British environmental politics (Crowley et al., 2017), and more. Beavers are thus unique animals with whom to think: often invisible themselves while also visibly changing landscapes and made visible in the British media. This thesis leads to an expansion of the critical social science on/with beavers, as I explore how this species—in their involvement with/as Nature-based Solutions—can become discursively entangled into environmental interventions (Chapter 4), have choreographed relations with humans, environments, and technologies alike (Chapter 5), and labour metabolically, probiotically, and reproductively to produce and reproduce themselves as Nature-based Solutions (Chapter 6). Each of these Chapters adds to the beaver literature as well as expanding the more-than-human literature in this animal-infrastructural register.

4.b. Cattle Grazing in Regenerative Agriculture

Distinct from beavers in a multitude of ways, cattle are the other focal animals in this thesis. Rather than 'wild', they are often considered 'domesticated,' not needing to be reintroduced to Britain, but rather part of British pastoral identity (Chapter 4) and easily visible in the countryside. In an Anthropocene context, cattle are often discussed as environmentally-destructive—emitting methane through their digestive, rumination process, and thus advancing

'anthropogenic' atmospheric warming (Garnett et al., 2017; Velten, 2007). Much of the criticism surrounds cattle reared in intensive agricultural production systems, for beef or dairy, where they are housed indoors and fed supplementary grain and imported fodder (Revell and Oldham, 2024). However, the cattle that feature in this thesis are outside the scope of intensive, mass production; instead, they are considered fundamental to the holistic farming practice of 'regenerative' agriculture, a land management practice that aims to enhance ecosystems and soil health (Cusworth and Garnett, 2023; Revell and Oldham, 2024). The cattle's grazing is managed to enhance on-farm biodiversity, soil health, drainage, and more. Animals reared in this way are being 'rebranded' as Nature-based Solutions to climate change and biodiversity loss within the context of regenerative agriculture (Cusworth et al., 2022).

Grounded in soil health, or regenerating soil organic matter, regenerative agriculture includes grazing ruminant livestock rotationally—moving them from small field to small field—to achieve these goals (Schwartz, 2013; Rodgers and Wolf, 2020). This grazing is high impact, as the herd is contained within a small 'cell' for a set amount of time, but with long recovery periods as the cattle are moved from one 'cell' to the next, sometimes daily depending on the conditions on the farm (Cherry, n.d.). With this frequency in rotation, the cattle only eat 50% of the grass stalk, allowing it to easily recover and continue photosynthesizing, producing more pasture and making room for a diversity of grasses. The herd's rumination, and the consequent excrement, is ground into the soil with their hooves (Chapter 6), fertilizing the soil in one cell before they are moved to the next, spreading their muck more evenly across the farm. Termed mob grazing, managed grazing, adaptive multi-paddock grazing, cell grazing, and more, these regenerative grazing practices, and the resulting soil health, are lauded as the key to biodiversity gain, carbon sequestration, reduction in topsoil runoff, and more (Figure 3) (Rodgers and Wolf, 2020).

[The infographic depicting and describing managed grazing versus set stock grazing originally presented here cannot be made freely available via ORA because of copyright. The infographic was sourced at https://www.sacredcow.info/helpful-resources.]

Figure 3: An infographic from Rodgers' and Wolf's (2020) book Sacred Cow, *detailing the proposed benefits of managed grazing compared to set stocking in a field.*

Such regeneration is measured through surveys of on-farm biodiversity (with key indicators like the dung beetle), monitoring of soil health (with key indicators being worm count, soil consistency, and soil carbon biomass), and (often, ultimately) 'healthy' beef production (Rodgers and Wolf, 2020). However, it is important to note how difficult measurement is and how 'leaky' a regeneratively grazed system is. In Garnett et al.'s (2017) report on forms of 'regenerative' grazing and its claims of carbon sequestration, they write:

> These then, are the basic routes by which grazing animals potentially aid the sequestration of carbon in soils: by stimulating plant growth (through grazing, and through nutrient cycling) including, importantly, root growth; and by helping carbon be moved from above ground (in the atmosphere, in vegetation) to below ground (buried manure, plant roots) where it can less easily be disturbed (p. 46).

However, Garnett et al. (2017) contextualise these 'basic routes,' discussing how these are the ideal, not necessarily the norm, for regeneratively grazed systems. Part of attaining the ideal (or not) depends on the farm and its environment, on the farmer's decisions, on the policies surrounding/influencing these decisions, and ultimately on the cattle themselves. Other critiques surround the efficiency of regenerative agriculture in terms of food production measured against land use (Revell and Oldham, 2024). However, this thesis is less concerned with testing or analysing the impacts and claims of regenerative agriculture as a whole; instead, I focus particularly on the ways in which cattle are utilised to achieve the goals and realise the claims of regenerative agriculture.

As will be described in more detail in Chapter 6, the specific bodies of the cattle *matter* to the regenerative projects, with selective breeding occurring for ideal regenerative grazing traits: stocky for crushing tall grasses and moving through woodland environments, strong-legged for aerating the soil with their hooves, short enough to be moved on foot, efficient in forage consumption and breeding, etc. (Wells, 2021). This is steeped in British history, as Britain is considered the birthplace of selective cattle breeding, considered 'beefeaters' by the 17th century (Velten, 2007). Further, some regenerative farmers select 'heritage breeds,' so as to maintain a naturalness, working towards an ecological baseline—a past time towards which a restoration (or rewilding) project is aiming (Marris, 2011) (Chapter 4). This demonstrates regenerative agriculture's associations with rewilding (Fraanje and Garnett, 2022), as explored in Cusworth et al.'s (2022) exploration of how regenerative agriculture draws on American imaginaries of a valued, pastoral past, to naturalise the regeneratively grazed cattle of today.

4.b.i. Regenerative Grazing in Britain

While regenerative agriculture has developed from some of these pastoral, American imaginaries, the regenerative grazing of cattle has grown in popularity in Britain. There are various organisations and conferences affiliated with promoting and supporting regenerative agricultural practices, including the Pasture Fed Livestock Association (PFLA), the Sustainable Food Trust, the Soil Association, Highlands Rewilding, the National Trust, the Nature Friendly Farming Network, Groundswell, Farm Ed, the Oxford Real Farming Conference, and more. Each with a slightly different angle—community-building, education, policy impact, etc.—these organisations all consider managed grazing of cattle as part of a Nature-based Solution, particularly for biodiversity gain, and many promote it as such.

Like the beavers, cattle reared in these systems are also affected by the political forces of Britain. Most impactful to agriculture broadly was Brexit, ending European Union farming scheme and starting trials for the Environmental Land Management Scheme (ELMS). Many farmers were uncertain with what ELMS would/could do to their systems and payments, given the changing, precarious, conservative political climate, and many who participated in the creation of this thesis were not confident in its potential to support farmers who have already transitioned to regenerative agriculture or to have a transformative impact on the British environment. Currently under ELMS, the operational payment scheme for regenerative farmers falls under the Sustainable Farming Incentive (SFI), which pays for farmers to increase their environmental land management actions—like animal welfare monitoring—short term nature recovery projects, or more long-term landscape recovery initiatives (DEFRA, 2023). Also under ELMS, Countryside Stewardship has been continued to pay farmers for land management outside of food production, like habitat creation or restoration (Hughes, 2023).

4.b.ii. (Critical) Social Science with 'Regenerative' Cattle

With regenerative agriculture growing in popularity, some social scientists have begun to attend to the movement. From an epistemological standpoint, Kearnes and Rickards (2020) focus on knowing soil and the politics of regenerative agriculture, building off Krzywoszynska's (2019) seminal paper on caring for more-than-human soils. In a discursive register, Gordon et al. (2022) identify the discourses employed in regenerative agriculture for transforming food systems, and Cusworth et al. (2022) explore how the movement has attempted to shift cow narratives from climate villain to climate hero in a 'green rebranding' of agriculture. More recently, I co-authored an article considering regenerative agriculturalists as key agents in Tsing et al.'s (2019) 'patchy Anthropocene,' viewing their farms as multiscalar systems with sites of fields, soils, and livestock stomachs to think through their more-than-human positionalities and responsibilities (Cusworth et al., 2023). But, while we considered livestock stomachs as a focal site in the paper, we did not expand into the cattle subjectivities, movements, and labour. This is where my thesis expands beyond that previous work, bringing together the critical social science on regenerative agriculture with critical social science on cattle (often in intensive systems) (e.g. Holloway, 2007; Ormond, 2020; Turnbull and Oliver, 2021, etc.). Cattle in Nature-based Solutions are still entrapped in a system of meat production (Chapter 7), but in a space that, through their bodies, is attempting to produce other life (Chapter 6). Thus, new critical social science scholarship at the intersection of regenerative agriculture and cattle subjectivities and bodies is critical to understanding this unique intersection of agricultural and environmental production.

4.c. Unlikely Bedfellows: Beavers and Cattle and/in/as Nature-based Solutions

The cattle—as 'domesticated' subjects wrapped up in a Nature-based form of agri-environmental production—provide contrast to the 'wild' beavers being reintroduced (often

into fenced enclosures) across Britain. While distinct in their histories, evoking different imaginaries of 'nature' (Chapter 4), these two unlikely species are brought together in the Anthropocene as Nature-based Solutions[5]. This thesis could have focused on just one or the other case; but, by bringing them into conversation with each other, a more complex and nuanced account of the impact Nature-based Solutions as a concept has on the more-than-humans wrapped up in its projects is offered. By witnessing the infrastructuralisation of cattle in regenerative agriculture and beavers in restoration, my theories of animal enrolment, enmeshment, and enfleshment are bolstered, as they apply across species divides, under the organisational remit of NbS.

5. Thesis Outline

The work that follows begins with a literature review, tracing the different disciplines in which animals and infrastructure have been discussed, landing on a more-than-human approach to best address my research questions (Chapter 2). Chapter 3 then outlines my methodology, discussing the ways in which I have innovated the go-along method to capture the more-than-human, with humans. It also gives context on my positionality and ruminates on the ethical implications of this research. After this, I delve into my three analytical Chapters: Enrolment, Enmeshment, and Enfleshment, which I outline below. Finally, I conclude the thesis with an in-depth discussion of the futures opened up or closed down by the enrolment, enmeshment, and enfleshment of animals as the infrastructure of Nature-based Solutions. In this, I use my concept of multispecies collaboration to interrogate the relative affirmation or instrumentalisation occurring in these novel, emergent more-than-human relations.

[5] In fact, some regenerative farmers had reintroduced, or were in the process of reintroducing, beavers on their farms.

5.a. Chapter 4, Enrolment

Building directly off the context of the two cases, making explicit the connections between regenerative agriculture, beaver reintroduction, and NbS, Chapter 4 focuses on how beavers and cattle are framed as nature, as nature-based, and as Nature-based Solutions, thus *enroling* them as infrastructure. Once (and still) characterised as climate villains—in the case of cattle—or conflict species—in the case of beavers—these animals are now being discursively recast as natural climate and biodiversity heroes through their associations with NbS (e.g. Cusworth et al., 2022). This Chapter outlines this layered framing, bringing literature from Communication Studies into conversation with More-Than-Human Geography, to make explicit the links between animals' stories, animals' lives, and how these stories create and are created by animal enrolment as the infrastructure of Nature-based Solutions. In addition to a framing analysis, it also draws upon go-along and semi-structured interview data to demonstrate how narratives themselves are multiscalar, like infrastructure (Larkin, 2013), and affect the ways in which animals are infrastructuralised in embodied ways—as keystone species, ecosystem engineers, tools, etc. Framed as 'nature' within NbS, animals are also cast to fix 'nature,' and this Chapter critically unpacks that paradox. By providing such high-level analysis, this Chapter provides the foundation on which the rest of the thesis builds, beginning with a discursive critique of NbS and animal infrastructure and leading into its embodied, metabolic ramifications.

5.b. Chapter 5, Enmeshment

Chapter 5 considers how animals in NbS are *enmeshed* with the fencing technologies employed to hold an intervention in place, or make it move (Lorimer, 2020), to become infrastructure. Further exploring Barua's (2021) concept of enmeshment, in which nonhumans are entangled with pre-existing infrastructure or technologies, I question how this feeds into the process of infrastructuralising animals in NbS and how these relations are known to those involved. By

tracing the stages of enmeshment, emergent from my data, I develop the concept of more-than-human choreography as a form of human-animal engagement, beyond resistance or excess. Through the Chapter, I trace the emergence and maintenance of choreography between humans, animals, and fences, describing how fences must be learned (Netz, 2004; Søraa and Vik, 2021) or trained (Fox et al., 2022; Game, 2001), demonstrating how choreography emerges as a human facilitation of probiotic mobilities, an experimental partnering (Roe and Greenhough, 2014), and showing how more-than-human choreography and enmeshment encourages a more-than-human emergence.

5.c. Chapter 6, Enfleshment

Chapter 6 then delves into Barua's (2021) concept of enfleshment—how animal bodies are made infrastructure through a cooptation of the cycles of labour that go into producing those animal bodies (Wadiwel, 2018). Centring my critique of more-than-human labour around an Arendtian (1958) labour theory, which I contend opens space for a more-than-human theory of labour, I draw out the layered cycles of animal labour that produce and reproduce Nature-based Solutions. Grounded in theories of labour, metabolism, and reproduction, this Chapter shows how cattle labour metabolically, producing their own bodies as meat products, in the traditional definition of metabolic labour. But, they are not only labouring to produce themselves as meat, but to produce themselves as probiotic labourers, using their bodies to create the conditions for other life. The beavers also emerge as probiotic labourers to produce lives beyond their own. Then, I consider the reproductive labour that goes into maintaining and (re)producing Nature-based Solutions, in the aim of reproducing the system intergenerationally (Landecker, 2013; Collard and Dempsey, 2013). Through this, animal bodies are enfleshed as the infrastructure of Nature-based Solutions drawing out some significance for animal lives and bringing metabolism into conversation with infrastructure.

6. An End to the Beginning

And so begins an exploration into animals and/in/as the infrastructures of Nature-based Solutions. The theories I draw upon and develop throughout the next six Chapters are those that help to explore the cases, expand and draw out novel theories from the cases, and also work to expand the field of More-Than-Human Geography more broadly. This thesis is for the field, but it is also for the animals enroled/enmeshed/enfleshed as the infrastructure of Nature-based Solutions. Let this be a journey into their worlds and an exploration into what their infrastructuralisation may mean for them now, and in the future.

Chapter 2: Literature Review

To best answer the research questions set out in Chapter 1 and to explore the cases of animals as Nature-based Solutions infrastructure, I turn to scholarship from more-than-human-geography, political ecology, and biopolitics. Outlining how each of those fields consider animal geographies and infrastructure, I land on a more-than-human theoretical approach, bringing this into conversation with theories of framing, choreography and animals' mobilities, and metabolic labour, in turn, bringing these theories into the realm of the more-than-human (MTH). In this Chapter, I provide an overview of these fields and concepts, a justification for their use in this thesis, and ultimately a justification for my research.

1. Animal Geographies

The field of animal geographies is, at its core, concerned with critically investigating two things: human perceptions of where animals belong (animal spaces) and how animals' lived experiences (beastly places) are shaped by the ways in which they are entangled in a world shaped by anthropocentric forces (Philo and Wilbert, 2000). While recognising the push of animal spaces embedded in some NbS discourses, this thesis adopts a beastly places approach, 'seek[ing] to understand how animals affect the lives of humans and vice versa' (Lorimer and Srinivasan, 2013, p. 4). To take a beastly places approach is to recognise animal agencies, to destabilise the human-animal dualism, and to promote a politics *with* animals at the centre (Buller, 2013).

There are three primary strands of work through which animal geographers have approached beastly places: i) with a focus on the more-than-human, considering how relational networks or assemblages co-constitute nonhumans and humans (e.g. Haraway, 2003; 2008; Latour, 2005; Tsing, 2015); ii) using political ecology, analysing power and capital wrapped up in

human-animal relations (e.g. Barua; 2022; Collard and Dempsey, 2013; Escobar, 1996); or iii) through the concept of biopolitics, considering the ways in which animal and human lives (and deaths) are governed at different scales (e.g. Asdal et al., 2016; Lorimer, 2015; 2020). Below, I review the (interconnected) ways in which these perspectives have approached and developed animal geographies as a whole and where this thesis is situated within them.

1.a. More-Than-Human Geography

More-than-human (MTH) geography is a field which addresses the human-nature dualism by emphasising the connections between—and assemblages of—humans, animals, plants, machines, technologies, and more (Cresswell, 2013). Following (and too-often ignoring) Indigenous ontologies of human-environment connections (Todd, 2016), MTH geography's development was heavily influenced by (feminist) science studies, namely, Bruno Latour's critique of the dualistic 'modern constitution' (1991) and his response in Actor Network Theory (2005), Donna Haraway's concept of boundary-crossing cyborgs (1985) and human-animal companions (2003), and Sarah Whatmore's (2002) theory of hybridity, emphasising co-constitution of natures and cultures in science, among others. MTH geography was also influenced by biophilosophy and vitalism (e.g. Deleuze and Guattari, 1988) and non-representational theory (Thrift, 2008), which together with feminist science studies bring nonhuman animals (in addition to machines) to the forefront of MTH thinking (Greenhough, 2014). Thus, animal geographies and MTH geography have become more and more intertwined, as the fields draw from and develop each other, and scholars cross between the two. Following this 'more-than-human turn' in animal geographies (Lorimer, 2009), my previous work (e.g. Welden, 2023) and this thesis have existed in this crossover, considering animals as key more-than-human beings to *think with* in the cases I investigate, like beavers and cattle in their complicated, assembled relations with humans, infrastructures, technologies, and more.

In this thesis, I engage with the foundational literatures mentioned above, along with more recent work, concentrated on animal narratives (Cusworth et al., 2022), animal subjectivities (Holloway, 2007), animals' mobilities (Hodgetts and Lorimer, 2017), human-animal experimental partnering (Roe and Greenhough, 2014), and animal (metabolic) labour (Wadiwel, 2018; Welden, 2023). I draw out each of these individual works in more detail in the analytical Chapters, as I engage with them to develop my theoretical contributions to the MTH and animal geographies literatures: more-than-human framing (Chapter 4), more-than-human choreography as a mode of engagement (Chapter 5), and the cycles of metabolic labour in the animal body (Chapter 6).

Returning to the foundations of animal geographies, this thesis is grounded in the idea that the identities of animals and humans are co-constitutive and created in relation (Buller, 2013). Thus, a MTH animal geographies approach to the cases I have presented in the previous Chapter draw out the *becoming with* (Haraway, 2008) of animals and infrastructures in the context of Nature-based Solutions. However, this also brings forth a common critique of more-than-human geography as being too focused on a co-*becoming* relation and not focused enough on structures and power (Castree, 2002 in Greenhough, 2014). My thesis addresses this by not only focusing on the hyper-local, the individualised bodies, and the ways in which they are made to be infrastructure, but also by focusing on the structural, political scale of how these bodies come to be enroled as such (Chapter 4). To do this, I bring in animal geographies literature that draws from work in political ecology.

1.b. Political Ecology

Political Ecology, a field which emerged from the convergence of Political Economy, Cultural Ecology, and Development Studies (Neumann, 2009; Watts, 2015), focuses attention on

relations between society and nature within the context of power (Escobar, 1996). It problematises what the environment means, and to whom, tracing who, or what, benefits from particular forms of environmental governance (Watts, 2015). A political ecology analysis traces environmental change through the interconnections between social, economic, and political relations, looking beyond those set in time and place, expanding both spatial and temporal scales to understand how power is functioning in a given [socio-ecological] system (Agrawal, 2006; Neumann, 2009). Such power is considered to produce nature, through biopolitical or capitalist processes, shaping and producing the discourse and the material simultaneously (Smith, 1984; Watts, 2015). Because of this, though, political ecology is often criticised for being anthropocentric, focused on human governance and the power of capital (Neumann, 2009).

However, animal geographers have expanded the theory to include more-than-human actors, demonstrating that by paying attention to the power exerted over, or by, such actors, we can glean further critical insights into society-nature relations and power itself (Barua, 2014; Collard and Dempsey, 2013; Gesing, 2019). For example, Barua (2014) investigates society-nature relations by focusing on human-elephant relations in India. He theorises a 'dwelt political ecology,' which illuminates 'how more-than-human bodies fabricate landscapes whilst they are collectively caught up within fields of power' (Barua, 2014, p. 916). This recognises animals' roles in environmental politics (Crowley et al., 2017; Dempsey, 2010) and demonstrates, not the separation between humans and animals, but rather the interconnections. Barua has continued to produce scholarship at the intersection of animal geographies and political ecology, with his book *Lively Cities: Reconfiguring urban ecology* (2023) following animals in urban spaces to illuminate the 'liveliness [in] the heart of capital' (p. 236), where

economic agency is not only held by humans and capital, but by animals and other more-than-human entities as well.

A key meeting place of political ecologists and animal geographers is in the study of animal labour, which first began with studies focused on agricultural animal productivity, 'animal body-work to make consumable products' (Barua, 2018; Porcher, 2015 in Welden, 2023, p. 3). However, this has expanded beyond the farm—including in this thesis—to consider 'wild' animals as workers or labourers (Barua, 2016; Lorimer, 2020; Welden, 2023). A Marxist approach to animal labour is centred on the production of value, be that use value, like in agricultural production (Porcher, 2015; Wadiwel, 2018), or encounter value, produced *when species meet* (Haraway, 2008). However, in my turn to animal metabolic labour in this thesis (following Beldo, 2017; Wadiwel, 2018), I shift from the traditional, political ecology-affiliated Marxist approaches to labour to an Arendtian approach to labour, where labour is productive of life (Arendt, 1958). As this development constitutes Chapter 6, I leave its review to Section 5, below.

1.c. Biopolitics

Another way in which animal geographies is approached in relation to power is through a biopolitical lens, focusing on the ways in which animals are governed—and govern—(Asdal et al., 2016), made to live or let die (Foucault, 1978). In conversation with animal geographies, biopolitics is not only a human endeavour, with both animals and humans as biopolitical agents within 'biopolitical entanglements' (Hinchliffe and Bingham, 2008). However, even though humans are not the only agents to exert biopower (Hinchliffe, 2016), animals are often the objects—not the subjects (Hodgetts, 2017). The scale at which biopolitics is applied is discussed by animal geographers, with Haraway (2008) focused on the governance of

individual bodies, biopolitics existing as a material becoming between two beings (Lorimer and Driessen, 2013). However, particularly in the study of conservation biopolitics, the scale of biopolitics shifts to the species population level, to 'secure the future of a valued life' (Lorimer, 2015, p. 12). The third scale of biopolitics extends to the governance of circulations, or ecological functioning (Anderson, 2012). Helmreich (2009) terms this symbiopolitics, the 'governance of relations among entangled living things (p. 15), which has been applied by those studying the governance of ecosystems and restoration (e.g. Lorimer, 2020).

While this thesis does not attend to biopolitical theories directly, I do draw on work within animal biopolitics and symbiopolitics to discuss the case of Nature-based Solutions, as it aligns with the symbiopolitics wrapped up in governing what Lorimer (2020) terms 'probiotic' interventions. Like in rewilding, where species—like beavers—are reintroduced into a landscape, the humans designing NbS are making biopolitical choices to secure particular animal life to 're-creat[e] missing processes' (Lorimer & Driessen, 2016, p. 3), for biodiversity gain or ecosystem services (Tsing, 2017). Biopolitics thus runs as an undercurrent through this thesis, as animal bodies are governed and organised through NbS to be the infrastructure of the system.

2. Infrastructure

Like the more-than-human turn in animal geographies, there has been an infrastructural turn in geography, in which infrastructure as a case study, concept, and interpretive tactic has (re)emerged in the context of the Anthropocene, where the distinction between the environment and infrastructure is blurred (Hetherington, 2019). A popular definition of infrastructure used in many of these emerging studies is: 'matter that enable the movement of other matter' (Larkin, 2013, p. 329). However, I find this definition so broad, it renders almost everything infrastructural. As Larkin (2013) himself puts it, infrastructure is 'conceptually unruly' (p.

329). Thus, in this thesis I attempt to refine and nuance infrastructure, as it pertains to animals in Nature-based Solutions. Based on the literature reviewed below and my data, I define infrastructure as material relation which produces—or is produced by—organised practices (like Nature-based Solutions).

First, to understand the infrastructuralisation of animals, we must understand what infrastructure is, how it is made, and what it does, drawing on the concept's emergence in Science and Technology Studies (e.g. Bowker, 1994; Star, 1999; Star and Rudhler, 1996). While infrastructure is thought of usually in terms of transport, buildings, or communications, infrastructure as a concept developed in STS as both an *analytic moment* where an invisible infrastructure (Star, 1999) is brought to the foreground through infrastructural inversion (Bowker, 1994) and a *material form*, where 'desired futures and the order of political life are lived, opened up, or closed off' (Coleman, 2014 in Ballestero, 2019, p. 21). Like in animal geography, infrastructure has been studied in more-than-human geography, political ecology, and biopolitics, all of which I review after a brief history of infrastructure.

In my review of the foundational infrastructural literature, I find it to be a concept that is relational, rhythmic, multiscalar, political, and more-than-human. These themes too emerged from my empirical data (Chapter 3), not only showing that some animals are made infrastructural in NbS, but also demonstrating the different ways in which this process occurs. In a foundational piece, Star and Ruhleder (1996) note infrastructure's relationality; it is made real in relation to organised practices, and as Berlant (2016) puts it, infrastructure is the 'living mediation of life's organisation' (p. 393). Thus, there is a lively rhythm and movement to these practices which make infrastructure, temporally extending it beyond a single event or object (Star, 1999). Infrastructure binds bodies to the world in movement, converging force and value in patterns, habits, norms, and 'scenes of assemblage and use' (Berlant, 2016). Thus,

infrastructure is made through relation—with practices, bodies, and things—and is sustained through the movement of such things. I explore this in depth in Chapter 5 when considering how fences and animals become relationally and physically enmeshed as infrastructure through choreographed rhythms of movement.

With this, we can consider infrastructure as a series of multiscalar networks. It simultaneously operates at multiple levels (Larkin, 2013) and is layered, complex, and localised all at once (Star, 1999). In the broader case of NbS, it is clear how the series of localised technologies converge to become a network of NbS infrastructural projects and how animal bodies are wrapped up in the infrastructure at both the policy- and project-scales. By tracing the everyday, embodied movement of infrastructure with the global, networked narrative, I am able to draw out the significance of what it means for animals to be rendered infrastructural at different scales, in different places. This leads to the political elements of infrastructure. Mrázek (2002) claims that infrastructure produces both sensorial and political experiences, and Larkin (2013) shares how infrastructures can 'be read' to reveal those forms of political rationality built into them. Thus, the ways in which NbS infrastructures are constructed, with and by animal bodies, will both inscribe politics within them and produce political experiences. If the infrastructure is made up of the animal body, what does that mean for the animals' experiences, at different scales? Are they invisible, as Star (1999) claims infrastructures to be, operating in the background? Or, does their animal liveliness make them inherently visible, the relationality visible to the senses (Larkin, 2013)?

2.a. More-Than-Human Infrastructure

Increasingly, more-than-human scholars have begun using infrastructure as a case study and an analytic, considering infrastructure as more-than-human, more-than-human interactions with infrastructures, and more-than-humans as infrastructure themselves (Barua, 2021; 2023;

Wakefield and Braun, 2019; Wakefield, 2019). The relation between more-than-human *animals* and infrastructure has also become a recent topic of interest (White and Sulek, 2022), as the more-than-human agencies that go into making and maintaining infrastructures are investigated (Carse, 2014; Hetherington, 2019). For example, Barua (2023) notes how infrastructure affects—and is affected by—nonhuman life, constitutes animal habitats, modulates animal habits, and may even be made up of animal bodies. In the latter instance, these 'vital' infrastructures are unique in that they are constituted by, and conditional upon, living beings—in relation to material elements (Fredericks, 2018). As Wakefield and Braun (2019) write, these more-than-human infrastructures can shift human-nonhuman relations, with humans shifting reliance to nonhumans (oysters) for coastal resilience, for example. The 'infrastructures' with which this thesis is concerned are not only made up of life, but they are also in place to maintain or manage other life (Lorimer, 2020). Drawing on my infrastructural definition above, when taking a more-than-human perspective on infrastructure, the material relation between animals and environmental elements (water, soil, grass, etc.) produce—and are produced by—the organised practice of NbS discourses and specific NbS projects.

In a review paper of nonhuman infrastructures, Barua (2021) provides an ontology in which there are three currents of infrastructure: 1) architectures of circulation of matter, those which enable the movement of matter (Chapter 6); 2) systems of relational substrates creating environments and the everyday (Chapter 5); and 3) settlers of social order, 'becoming frames to recast and rethink the political' (Chapter 4) (p. 1468). As noted, each of these currents is drawn out in my three analytical Chapters, and each are included in my updated infrastructure definition. One area in which I believe Barua's (2021) review needs development is in his other typology of nonhuman interaction with infrastructure: what he calls *enmeshment* and *enfleshment*. In the paper, he calls nonhuman interaction *with* human-created infrastructure

'enmeshment,' as in the case of macaques using phone wires (communications infrastructure) for mobility, and he calls the bodily involvement of nonhumans *as* infrastructure 'enfleshment,' as in the case of beavers metabolically labouring as ecosystem service providers. First, I adopt those titles for Chapter 5 and Chapter 6, respectively, adding nuance and case-based data to those named processes. Second, I add to that typology a term and infrastructural process I find missing in Barua's account: a discursive *enrolment* as infrastructure (Chapter 4). Ultimately, this infrastructuralisation of life bears significance as 'environmental entities are conceived via their function: maximizing, minimizing, interrupting, or transforming life' (Ballestero, 2019, p. 21) and animal bodies are physically organised into relation with material objects to produce such functions.

Another recent way in which infrastructures have been approached from a MTH perspective is in conversation with Anna Tsing's Patchy Anthropocene—where addressing this moment of climate change is best understood from particular places, in patches, rather than globally (Tsing, 2019). In her keynote address to the Institute for Advanced Study on the 'Feral Impacts of Infrastructure,' Tsing (2023) defines infrastructure as material apparatuses that produce feral effects, outside of the infrastructure's defined use. While her feral infrastructures discussion does consider power, place, and environmental (in)justice, it discusses the more-than-human as a response to infrastructure, rather than the infrastructure itself. This aligns with other prominent discussions on fencing infrastructure in conservation, designed to contain or exclude particular animals (predators, livestock, reintroduced species, etc.) in a biopolitical move (Hawkins and Paxton, 2019; Poerting, 2023). These fencing infrastructures are considered 'more-than-human' in their capacity to provoke novel natures within the enclosure while affecting the predators they exclude (Hawkins and Paxton, 2019) or as mediums of life, where new MTH formations emerge (Poerting, 2023). In both cases, infrastructures are taken as a

human-created given, aligned with the infrastructural producers of 'feral effects' (Tsing, 2023) rather than considered as extended infrastructures of conservation beyond the fence to the animal bodies contained or excluded. Chapter 5 speaks to this absence, as my case brings in the fences as MTH infrastructures in themselves, while also analysing how the animal bodies enmesh with the fences to become themselves infrastructures of conservation/NbS. Using Barua's (2021) concept of 'enmeshment' then leads to my development of more-than-human choreography as a better way to capture more-than-human relation beyond resistance, ferality, or excess (to fencing, for example). Tsing's (2023) Patchy Anthropocene approach to infrastructure straddles the MTH and political ecology approaches to infrastructure, which may explain the divide between the human-made infrastructures and the feral impacts of the more-than-human.

2.b. Political ecology of infrastructure

Infrastructure has also seen a resurgence in political ecology, beginning with Swyngedouw's (2004) discussion of infrastructures for urban metabolism, those materials that enable the flow or circulation of water—in his case. As he explores from a political ecology perspective, infrastructure becomes indicative of state power and priorities, leaky and made visible in its breakdown (Star, 1999). In this case, Swyngedouw's (2004) analysis follows Bowker's (1994) infrastructural inversion, in which 'class relations, conditions of possibility, or semiotic structures are revealed as the infrastructure subtending cultural or social phenomena on the surface (Hetherington, 2019, pp. 6-7). From this political ecology standpoint, infrastructure is viewed as reflective of power and hierarchy (Carse, 2016), though I argue some of these approaches to infrastructure share the same issue I find with Tsing's (2023) approach. The infrastructure is often taken to be human-created, while the more-than-human resists it or is something that is merely representative of capitalist processes and flows. Thus, while this thesis does engage with some political ecology approaches to infrastructure, it is grounded in a more-

than-human, or 'dwelt' (Barua, 2016), political ecology of infrastructure which considers the infrastructure itself as MTH.

As mentioned in Section 1.b., political ecology is focused on how capital influences the environment. In this vein, Nelson and Bigger (2022) discuss infrastructural nature, specifically focused on how nature is valued monetarily as an infrastructure that provides services to humans. This is particularly relevant when thinking about the affiliation of Nature-based Solutions with ecosystem services (e.g. Bekessey et al., 2018; Welden, Chausson et al., 2021), as discussed in Chapter 1. By this logic, Nature-based Solutions are broadly infrastructural. However, this only scratches the surface, not digging into the specific, localised elements or beings which make up the infrastructure of the 'solution,' which is why this thesis draws more from MTH, which accesses those nuances.

However, there is some crossover with the animals themselves, most notably from Doherty (2019) in his case-based study of storks as waste infrastructure in Kampala or Barua (2023) in his study of recombinant infrastructures, lively capital enmeshment in London. In the former study, Doherty (2019) demonstrates how storks are rendered disposable by the state while also being necessary waste-picking infrastructure the state requires, the 'patchy ecologies and economies that sustain the municipal waste stream' (p. 321). In the latter case, Barua (2023) considers how parakeets caught up in international trade as lively capital, from Collard and Dempsey (2013), form new, 'recombinant' urbanisms with London-based peregrines and urban infrastructures. In short, the trade infrastructure and, the capital that perpetuates it, creates new ecologies and animal-infrastructural enmeshments. While this thesis recognises the contributions of these works—and the importance of what a 'lively' infrastructural analysis may tell us about the state—it remains focused more on the relations between animals, bodies,

environments, humans, and more, and their infrastructuralisation (Ballestero, 2015; 2019) through material relation, rather than through the state.

2.c. Biopolitics of Infrastructure

The initial biopolitical studies of infrastructure are aligned with political ecology, as Collier (2011) focused on what studies of infrastructure could show about practices of biopolitical government. Alternatively, biopolitics was studied as that with 'which late liberalism imagined how to build the infrastructures of the good life,' securing human life through infrastructure (Li, 2009; Ferguson, 2006 in Hetherington, 2019, p. 9). However, as Hetherington (2019) points out, the Anthropocene reconnects human life with other forms of life, where these biopolitical infrastructure projects are inherently more-than-human. Thus, there has been an influx of studies tracing the more-than-human biopolitics of infrastructure.

One of the most influential to this thesis is Wakefield's (2019) study of the ways in which oysters were biopolitically ordered into being coastal resilience infrastructure in New York City. She writes how making animals into infrastructure is, itself, biopolitical. This again, speaks to how biopolitics runs as an undercurrent to, or foundation of, this thesis. Making 'nature' infrastructure is always biopolitical, and in this thesis, I accept Wakefield's (2019) assertion and dive into the different ways in which this animal enrolment, enmeshment, and enfleshment occurs. By making oysters live and securing oyster life, assuming oysters live and behave as expected (Wakefield and Braun, 2019), they are being ordered in an attempt 'to secure the conditions for human life' (Wakefield, 2019, p. 17). Nature-based Solutions as a(n) (infrastructural) concept also holds this biopolitical assertion, as they are defined as providing both human and biodiversity wellbeing (Cohen-Shacham et al., 2016).

Beyond the biopolitical entanglements of human and animal life, Lorimer (2020) also discusses probiotic interventions as symbiopolitical endeavours, where nonhuman life is used (or ordered) to manage other life, as beavers are used to manage wetland ecosystems. In this thesis, I look at these interventions through an infrastructural lens, allowing me to ask questions around how this plays a role in making animals infrastructure. Does this infrastructuralisation promote a 'controlled decontrolling of ecological controls' (Lorimer, 2020, p. 107), or as I discuss in Chapter 5 and Chapter 7, does the infrastructuralisation of nonhuman animals make them more 'controllable?' Thus, using the more-than-human infrastructural literature allows me to question infrastructural and animal biopolitical governance in a new way (Wakefield and Braun, 2019).

3. Framing (Chapter 4)

3.a. Framing and the More-Than-Human

While scholarship in more-than-human geography often includes discussion of how something is framed and by whom, it often ignores the theory underlying the concept of framing. In this section, I outline such theory, which I argue adds depth to claims of how arguments around the more-than-human may be framed. This discussion is particularly relevant to Chapter 4, in which I apply framing theory to understand how animals are enroled as Nature-based Solutions infrastructure.

Framing theory was initially developed around the 1970s in two different fields: psychology and communication by Fillmore (1968) and Goffman (1974), respectively. While Fillmore (1968) defined frames as signifiers, or the background information needed to understand a concept, Goffman (1974) defined frames as communication strategies that prompt thinking patterns. The thesis follows the theoretical foundation set by Goffman, tracing communicative

arguments around animals in/as NbS and their effects, due to communication studies' alignment with discourse, linking it to previous work in MTH geography.

In a review of communicative framing, Entman (1993) defines it as the selection and salience of information within a text (e.g. policy, documentary, speech, etc.). In selection, some information concerning 'reality' is presented—some is omitted (Edelman, 1993)—and some information is made salient, highlighted within the communication. Thus, the information left out of the text is doing the work of framing, as is the information left in and made salient. As Edelman (1993) writes, 'the social world is a kaleidoscope of potential realities which can be readily evoked by altering the ways in which observations are framed and categorised' (p. 232). Entman (1993) summarises the process through which framing occurs in four steps: problem definition, causal diagnosis, moral judgement, and remedy suggestion. In Chapter 4, I trace how this process tracks on to Nature-based Solutions, as environmental degradation and its costs are identified as problems, climate change and biodiversity loss are diagnosed as primary causes, nature and nature-based interventions are deemed as morally better than 'unnatural' interventions, and nature (and the nonhuman animals associated with it) is (are) put forward as the remedy—the solution—to the problem.

Ultimately, this process of framing is designed to influence thinking. There is never universal effect (Entman, 1993), but framing still exerts power. As frames shape the way we think, they shape the way we live (Lakoff, 2004). For example, Stirling (2008) posits that frames can 'open up' or 'close down' governance commitments in science and technology. As framing identifies problems and solutions (Entman, 1993), it is clear to see how selected problem/solutions would influence the ways through which governance is done, whether it is open to critical reflection or streamlined as a technocratic commitment (Stirling, 2008).

Thus, frames have been considered in relation to environmental decision making, and in particular, human thinking around 'nature' (e.g. Lakoff, 2010; Osaka et al., 2021; Sullivan, 2016). Nature is both a frame and can be framed. For example, Nature-based Solutions evoke a 'natural' frame, from which the concept and subsequent interventions benefit (Osaka et al., 2021). 'Nature' can also be framed. Lakoff (2010) asserts that the ways in which 'nature' is framed matters; in his study, he finds that the most common framing of nature is that which is separate from humans, with such repetitive framing making and remaking human-environment relations. Citing Latour (1993, 2010), Sullivan (2016) shares, 'the ways that life and 'nature' are uttered, imitated, represented and thereby brought forth by humans have meaning as constitutive of the world' (p. 750). In a constructivist way, the framing of nature thus creates nature, constitutes the world and the ways that humans and nature relate.

This then justifies framing's necessity as a concern for more-than-human scholarship, given its focus on human-nonhuman relations and the web of relations which constitute different places. In fact, Sullivan (2016) in her framing analysis of the environmental film festival, Wildscreen, shares that frames that capture more-than-human multiplicity matter for human-environment relations. She writes how engaging with how nature is framed (MTH or not) illuminates 'how people make and are made by the nature frames they privilege' (p. 750). So, through framing, MTH scholars can see the power of frames as constitutive of 'nature' and humans in turn. Further relevant to MTH scholarship is Lakoff's (2010) assertion that frames are not purely verbal/linguistic. Rather, they are made through bodily experience with the environment and culture, made through affect. Thus, more-than-humans have the capacity to influence frame-making, as becomes clear in Chapter 4. Natures are both material and communicative (Sullivan, 2016) and thus require a mix of theories that can attend to both.

4. Choreography, Animal(s') Mobilities, and Fencing (Chapter 5)

4.a. More-Than-Human Choreography

In the current MTH literature, nonhuman animals in their relations with human design or infrastructure are often discussed as resisting or exceeding human design (e.g. Holloway and Morris, 2012; Philo and Wilbert, 2000), disrupting the planned or predicted (Tsing, 2023; Wakefield and Braun, 2019). However, in this thesis—and in Chapter 5 in particular—I question whether resistance or excess is the best way to discuss animal or more-than-human agency in relation to humans, organised practices, and infrastructures. Instead, through infrastructure and a focus on the body, I explore and develop the concept of choreography as an experimental (Roe and Greenhough, 2014), and/or collaborative (Van Patter et al., 2021; Welden, 2023) form of more-than-human engagement that better captures the experience of bodies in relation and co-constitutive becoming.

As NbS projects *organise* 'keystone' animal bodies *in space* to perform ecological functions, my case studies catalyse discussion on a more-than-human choreography emerging in these projects. Originally, studies of choreography were situated in performance studies, where it has been defined as the organisation or structuring of movement in time and space (Klein, 2013), or a more controlled system of movement regulation (Lepecki, 2007). In performance studies, though, some foundational conceptualisations of choreography drew (consciously or not) from the more-than-human, starting from a nonhuman choreographer, rather than human design or regulation of movement. For example, Lefebvre (1991) used an anecdote of a spider in its web—creating the technology that constitutes its extended body: a spider is not a spider without its web. In this way, choreography is what makes things (a spider and a web), in relation. McCormack (2014) brought Lefebvre's theory into conversation with geography literatures, analysing how Lefebvre (1991) considers movement to be a world-producing technology, 'a

choreography of worldly arrangement expressive of rather than reductive of difference' (p. 171). Likewise, Laban (1966) from performance studies considers choreography to be chosen movement that is 'natural,' that makes sense. In its direction of movement, and infrastructure's constitution through movement (of matter) (Berlant, 2016; Larkin, 2013), choreography is one of the ways in which infrastructure can be made.

More explicitly tying together choreography from performance studies and more-than-human theory, Frischkorn (2023) conceptualised a 'more-than-human choreography' to understand how one (human) can move as a thing among other things. Building on Hewitt's (2005) social choreography of embodied behaviour, Frischkorn (2023) considers choreography as a form of more-than-human attunement and relation: an iterative, felt, and embodied way of reconfiguring MTH worlds. However, Frischkorn's focus remains primarily on the human subject, considering—from his standpoint as an artist and performance studies theorist—how humans relate to matter. Thus, I draw from his definition of choreography as an embodied, MTH attunement, but shift the focus from human relation to matter to more-than-human relation to matter: as something that is both *choreographed* by humans and organised practices, and *choreographing*, from the animal bodies enmeshing with fences, to form the infrastructure of NbS.

4.b. Animal Movement and Animals' Mobilities

In all the definitions of choreography described above, they centre around the concept of movement, whether it be the structuring of (Klein, 2013), the control over (Lepecki, 2007), or the natural emergence of (Laban, 1966 in McCormack, 2014) the movement of bodies and matter. In Chapter 5, I bring this into conversation with the animal movement and mobilities literatures from animal geographies. In this literature, movement conveys agency, human-animal relation, and being itself (Buller, 2012). Movement has been extended, in conversation

with power, to study animal mobility and animals' mobilities: how animal movement is affected by the actions of others (animal mobility) and the embodied lived experience of the animal itself (animals' mobilities) (Hodgetts and Lorimer, 2018).

Much of the scholarship on animal(s') mobilities centres on tracking and modelling 'wild' animals for conservation (e.g. Hodgetts and Lorimer, 2018), and the technologies used for such tracking (Palmer, 2021). However, within the probiotic turn, technologies are being used not only for tracking, but for influencing and differentiating between desired and undesired mobilities of ecosystem engineers (Lorimer, 2020). For example, in a seminal piece by Thompson (2002) on elephant management for biodiversity in Kenya, the regulation of elephant bodies shifts from their population numbers to the 'appropriate movement of elephants through space in relation to other wildlife, human activity, and livestock' (p. 175). This 'choreography' of elephant bodies—determining their desired or undesired mobilities—is designed in response to their relation with other beings and things in the ecosystem assemblage and ultimately determines an individual elephant's fate. This ontological choreography both affects the lives of elephants—and those they come into relation with—and constitutes the system of regulation of their bodies in the first place (Thompson, 2002). 'Wild' animals' mobilities are not the only ones being studied. With 'domesticated' animals, the animal mobilities literature has placed much of its focus on training, and usually in relation to things or technologies like fences (e.g. Fox et al., 2022; Game, 2001; Haraway, 2003). In this thesis, my cases are situated between the wild and the domesticated, exploring the mobilities of beavers and cattle—and the choreography of (and from) such mobilities in the production of carbon sequestration and biodiversity gain. The choreography of such mobilities, as in the case of the elephants (Thompson, 2002), I argue enmeshes the animals as NbS infrastructures (Chapter 5).

Much of the current work on infrastructure and animals reviewed above focuses on how human infrastructure shapes animal movement or mobility (e.g. White and Sułek, 2022). For example, Barua (2022) interrogates the politics of 'reconciliation infrastructures' which facilitate animal mobility around roadways and ultimately 'accommodate, foster and modulate other-than-human life' (p. 37). However, as more critical attention is being paid to animals *as* infrastructures themselves—discussing oysters made to be breakwater infrastructure with their mobilities assumed in human design (Wakefield, 2019) or storying how storks become enrolled as waste infrastructure, enabled by their ability to fly (Doherty, 2019)—animal movement, and its control or co-option, is key to animals as infrastructure. Bringing together animal mobility and infrastructure thus allows for an interrogation of more-than-human relations amongst humans, animals, societal structures, technologies, and more.

4.c. More-than-Human Fencing Technologies

Both movement—and movement's other, stillness—can be choreographed, by humans organising bodies in space, and emergent through experimental MTH relation (McCormack, 2014). One of the more-than-human choreographers that emerges in Chapter 5 is the fencing technology which organises the movements of animals' bodies in NbS. Being made to move or held in place—particularly in the Lepecki (2007) sense of control over movement—requires force upon bodies; this force is what fencing can provide (Netz, 2004). Netz (2004) describes the transformational power of fencing technology, sharing how it can transform space by both preventing and instigating motion. Thus, fencing—like infrastructure—can be biopolitical (Section 2.c.), as a fence 'actively constitutes new forms of biopolitical governance through its ontological effects, through the way in which it participates in modulating life' (Hawkins and Paxton, 2019, p. 1017). In fact, Poerting (2023) calls fencing in conservation an act of

infrastructuring, which is embedded in biopolitics. As the fences modulate habitat, and contain or exclude particular animal bodies, fencing is a biopolitical practice.

Even with its transformation of space and modulation of bodies, fencing is not only a one-way relation. It is also made up of the bodies affected by it—it is relational (Netz, 2004)—and it too can be affected through the force of animals' bodies (Holloway, 2007). While Netz (2004) argues the relationality of fencing through force is inherently violent, Søraa and Vik (2021) counter that in the co-constitution of bodies and fencing, animals can be enhanced by and through fencing technology. In particular, they explore digital fencing in goat farming, where the 'cyborgification of livestock' makes goats, fences, and landscapes anew (Søraa and Vik, 2021), 'provoking' new natures within the enclosure (Hawkins and Paxton, 2019). This shows how fencing is a relational technology, materially changing the animals (Swanson et al., 2018) and their 'jobs' (Søraa and Vik, 2021), through their movements and in their interactions with the fence. Additionally, fences are created or adjusted based on the animals they are designed to contain or exclude—both fences and animals are materially affected by their relation (Hawkins and Paxton, 2019).

However, as I'll develop in Chapter 5, the effects are not pre-determined; as with Haraway's (1991) cyborg—a hybrid of machine and organism, technology and nature—there is an ability to rebel against the intentions of their makers. Thus, while the animals' bodies and jobs may be materially changed by the fences, they retain some agency and power within the system of infrastructuralisation, not always moving in the ways expected of them (Wakefield and Braun, 2019), or 'forced' upon them by a fence (Roe and Greenhough, 2014). Roe and Greenhough (2014) discuss the case of humans moving cattle from one field to the next with fencing, expecting the force of the fence to guide the cattle's movement. However, in a 'rebellion' that

is then responded to by the farmers and the researchers, the cattle behaved in unexpected relations to the fence, pushing through it, an interaction the authors term, experimental partnering. This 'unexpected' behaviour, or spontaneity in more-than-human relation is indeed not so unexpected or spontaneous from a more-than-human perspective (Barua, 2023). Taking on this perspective, Chapter 5 pushes beyond 'rebellion' or 'resistance' of human design to align with experimental partnering and more-than-human choreography, which attends to the push and pull of different visions for what an ecosystem should be (e.g. Welden, 2023).

5. (Metabolic) Labour (Chapter 6)

5.a. More-Than-Human Labour, Metabolism, and Reproduction

As mentioned above, more-than-human labour is one key strand of animal geographies; and, based on the data from my study, I focus in on the animal *metabolic* labour that enfleshes animals as infrastructure (Barua, 2021). In order to understand these labour processes occurring within, and constituting, nonhuman infrastructure for NbS, I ground myself in foundational definitions of labour from Marx and Arendt. First, Marx defines labour as the metabolism between humans and nature, the flows of matter and relationality between the two. Notably, though, Marx excludes nonhumans from the labour process, casting them only as raw materials (constant capital). Arendt critiques and builds upon Marx's work, opening space for the inclusion of nonhuman labourers, indeed connecting humans and nonhumans through the labour they do, *for* life. In Arendt's definition, labour is that which provides the conditions for life, the cyclical, metabolic process of production of these conditions and consumption of such. Life itself depends on labour, but it can be organised so that 'the labor of some suffices for the life of all' (Arendt, 1958, p. 88); some organisms' labour produces the conditions of life for other organisms. In Arendt's writing, this labour was done in Ancient Greece by slaves and women: those relegated to the domestic realm to meet the biological needs of the household,

though is in 'modern' times reemerging in the production of consumable goods, as moderns become defined by labour, and in the reproduction of civil society. While Arendt's concept of labour from her book, *The Human Condition,* concerns human labour, I believe Arendt's labour theory is empirically generative to engage with when considering labour beyond the human.

While generative, it is also critical to recognise the context in which Arendt was writing, as *The Human Condition* emerged as a philosophy on humanity in the wake of WWII, the Holocaust, the atomic bomb, and space exploration, and followed the publication of her first book *The Origins of Totalitarianism* (Harcourt, 2020). She thus theorises political action—vita activa—through three different forms of production (labour, work, and action), comparing these categories as they emerged in Ancient Greece to the 'modern' world in the midst of crisis. While some have thought through her work in the current crises of climate change and the Anthropocene (Harcourt, 2020; Hyvönen, 2020), I recognise the differences in these crises and the risks of applying Arendt's work to a different context, as her work was formed as a response to the times in which she was writing. Thus, I proceed carefully in this thesis, exploring Arendt's theory of labour in the context of animals—as Rossello (2021) has done—and climate change alike, while being mindful of its origins. Like Rossello (2021), I encourage skepticism of this extraction of Arendt's work, though I am steadfast in my assertion that this application presents a novel lens through which to view animal labour.

To justify my use of Arendt's theory of labour in this thesis, I lay out some key elements where Arendt's labour moves beyond Marx's in ways which speak to my study. In addition to an acknowledgement—if not an inclusion—of the nonhuman organism as a labourer, Arendt's theory of labour recognises the necropolitical stakes of labour, considering life and death as drawn into labour: in its continuation or in its end. I do not seek to equate the experience or

subjectivity of slaves and women in Ancient Greece—nor humans writ large—with that of beavers and cattle in Britain. I do, though, seek to consider how this element of Arendtian labour may speak to the justification for animals in/and/as Nature-based Solutions and the significance for their lives until death. The labourer in Arendtian terms is not alienated by capital per say, but is instead appropriated through the body to produce the conditions for life amidst crisis. While the stakes may be different for humans and animals in this register, such bodily appropriation is shared. With this, Arendt's theory foregrounds reproductive labour, explicitly discussing the labour that goes into reproduction of (new) life in the domestic sphere. This is an important expansion beyond Marx's labour which serves to again centre life (and death) as the driver and product of labour. I again do not seek to draw parallels between the reproduction of humans and nonhuman animals, but I do recognise how valuable this foregrounding of reproductive labour is when considering cases like animal breeding. As will become clear in Chapter 6, these critical departures from Marx expand the analysis of my two cases in generative and important ways. I expand upon these, and tie them in with theories of metabolism and feminist reproductive labour below.

In its connection with life, Arendt argues that labour is a cyclical process, metabolic in that labour is prescribed by the biological body of the labourer to sustain its life. The cycle—or metabolism—is sustained through consumption, which regenerates the life process, folding labour and consumption into each other. So, not only does labour produce life, but metabolism is a defining characteristic of such life (Landecker, 2013). Thus, to fully understand labour, I turn to metabolism. Historically theorised from multiple fields, from the medical sciences to philosophy, the concept of metabolism is grounded in the conversion of matter into different forms, often by an organism's body (Landecker, 2013). In Landecker's (2013) idea of the new metabolism, she considers the metabolism to be a regulatory zone [rather than a factory, as it

was previously understood], a web of cellular signals responding to the body's environment and a system of interlinked processes (Landecker, 2019). Beyond a process, one can take metabolism as a methodological orientation in which 'the topic under investigation is not limited to humans and what they eat, but captures some small part of a ceaselessly churning scene of incorporation and excretion in which machines, bodies, microbes, enzymes, toxins, and nutrients are moving and converting matter into different forms' (Landecker, 2019, p. 542). In Chapter 6, I thus link metabolism and infrastructure through such material conversion and relation.

This conversion of matter into different forms connects metabolism with life. In new metabolism, Landecker (2013) argues, matter not only flows through the body, but is assimilated into it to better adapt it for life in a future environment. *Circling* back to Arendt (1958), metabolism involves cycles (Landecker, 2019), rhythms (Wadiwel, 2018), and circulation (Swyngedouw, 2004) in flows of matter constituting life. For example, Wadiwel (2018) focuses on metabolic rhythms of growth, defining metabolism as a self-generative process, where the body is constantly becoming itself[1].

Metabolic labour sits within, or emerges from, the cyclical nature of labour for life described by Arendt (1958). In regenerating the life processes, bodies are labouring metabolically. This has been taken up by some animal and more-than-human scholars considering how animals produce themselves (Wadiwel, 2018), often within capitalist processes. In his exploration of vegetal labour, Palmer (2021) delineates the metabolic activities of trees—growth, carbon sequestration, photosynthesis—as labour. He shows how certain trees may be chosen for

[1] At this scale, metabolism is referred to as corporeal; however, metabolism can also exist at the planetary as a reconfiguration of nature and society (Moore, 2017).

particular forestry projects due to their superior capacities to labour metabolically. Likewise, much attention on nonhuman metabolic labour has been directed towards animals enlisted in agriculture. Both Wadiwel (2018) and Beldo (2017) investigate the metabolic labour of chickens. Wadiwel (2018) defines metabolic labour as a self-generative, growth process in which animals produce themselves as (lively) commodities, their value predicated on their liveliness (Collard and Dempsey, 2013). This value generation is multispecies as it requires both metabolic labour of the chicken and the human management of metabolic labour (Beldo, 2017; Wadiwel, 2018). Nonhuman metabolic labour is harnessed, according to Beldo (2017), as nonhuman vitalities are counted on to exceed human inputs, producing surplus value. This can occur because the animal is more than a machine made up of human labour and knowledge and instead their vitalities—or metabolic capacities—are made to labour.

Further, the body not only produces itself, but reproduces across bodies in intergenerational cycles through metabolic reproduction (Landecker, 2013). Reproduction—and reproductive labour—is thus tied to metabolism, as metabolism functions to produce *and* reproduce lives and bodies. As Prouse (2021) writes, 'labouring and metabolism are also fundamentally about reproducing human life' (p. 106). Stemming from foundational feminist theory, reproductive labour is often devalued work in the domestic space, which reproduces labourers to sustain capitalist economies (Federici, 1998; Katz, 2001). As Katz (2001) writes, it is the 'fleshy, messy, and indeterminate stuff of everyday life' (p. 711). Reproduction, like metabolism, legitimises an organism's (fleshy) vitality (Franklin, 2007). It has been studied in the context of nonhuman animals and animal labour, reproducing lives to extend productivity and profitability, in the case of dairy cows (Gillespie, 2014), or beavers reproducing their bodies to continue labour as ecosystem lively commodities (Collard, 2014 in Welden, 2022). While reproduction looks to the past, as in the back-breeding of rewilding agents (Lorimer and

Driessen, 2013), it too produces varying futures (Franklin, 2007), thus tied to the production of life (Gillespie, 2013), tied to metabolism. Chapter 6 expands this discussion linking reproductive labour to metabolism in a MTH register, drawing out the reproductive labour of beavers and cattle in the (re)production of Nature-based Solutions.

Ultimately, as Chapter 6 draws out, metabolic processes can be intervened in, and regulated by, humans (Landecker, 2013). This can occur through technoscientific interventions (Folkers and Opitz, 2022), choreographed movement of nonhuman animals (Beldo, 2017), breeding for an ideal metabolic body (Holloway, 2007), and the hybridity of human and nonhuman metabolic labour (Battistoni, 2017). In the cases I explore in Chapter 6, these cyclical, metabolic interventions fold together, as metabolic labour—the body work of animals (Barua, 2018)— probiotic labour (e.g. Lorimer, 2020)—creating the conditions for other life—and reproductive labour (Prouse, 2021)—producing new life—become central to the *enfleshment* of animals as NbS infrastructure.

6. Conclusion

The literatures reviewed in this Chapter thus demonstrate the significance of this thesis project, adding to the animal geographies and infrastructure literatures specifically through the development of a more-than-human framing theory and method, choreography as a novel mode of more-than-human relation, and an Arendtian analysis of more-than-human metabolic labour. As is evidenced by this Chapter, and by the theoretical contributions of this thesis, a more-than-human approach is where I situate my work and the literatures from which I primarily draw. As demonstrated by the three different approaches to animal geographies and infrastructure—more-than-human geography, political ecology, and biopolitics—the three are interconnected, with many present studies drawing from at least two of three to explore a more-than-human case study. However, while my thesis does take some theories of labour and

metabolism from political ecology and accepts biopolitics as a foundation of the infrastructuralisation of the nonhuman, I remain firmly grounded in the more-than-human, driven by my research questions (Chapter 1) that are best answered from a more-than-human theoretical standpoint focused on animal experience and relation.

Chapter 3: A More-Than-Human Methodology

To answer the research questions and explore the case studies laid out in Chapter 1, nested within and building upon the literature reviewed in Chapter 2, I developed a methodology that could speak not only to the human designs of Nature-based Solutions, but also to the animals' subjectivities, bodies, and experiences within—or as—the (infrastructure of) Nature-based Solutions themselves. Attempting to push the boundaries of more-than-human research, I develop the go-along as a more-than-human method to harness the benefits of walking methods for animal geographies (Arathoon, 2021) while pragmatically working within situational and ethological bounds that make popular methods like multispecies ethnography (e.g. Kirksey and Helmreich, 2010) difficult to use for all species, in all places. As I have written previously, though, the go-along includes elements of multispecies ethnography (Welden, 2023), in its relational commitments between humans and more-than-humans (Gillespie, 2019); however, it relies primarily on a combination of participant observation with semi-structured interviews (Carpiano, 2009), rather than ethnography. I pair this method with semi-structured interviews (some online, some in-person) (McDowell, 2010), to account for human participants who were unable to 'go-along' with me or did not have access to the places we were speaking about. Finally, I also employed a framing analysis (Entman, 1993; Goffman, 1974) as both a method and a process of analysis for Chapter 4. However, the majority of my methodological developments rest on the go-alongs, and thus, much of this Chapter is dedicated to their overview and explanation.

Over the course of one year (September, 2021-September, 2022), I conducted the fieldwork for this project, including perspectives from: the organisational and policy sides of regenerative

agriculture (8) and beaver restoration (2), farmers who consider themselves 'regenerative,'[1] or employ regenerative grazing practices on their farms (35), and beaver restoration managers (10) and researchers (6) working in/with the beaver enclosures. While the farmers and beaver managers were the human contacts for me—the human conduits to more-than-human worlds—the cattle and beavers were also participants, interrupting or directing human conversation with their sounds, bodily movement, traces, and works.

To foreground this Chapter, I begin with my own positionality, as it influenced decisions surrounding the research design, data collection, and data analysis. These are drawn out, describing the methods used and developed, in the following sections. I conclude this Chapter with a section on ethical considerations, nesting the methodology within my positionality and the ethical dimensions of research on/with the more-than-human.

[1] Due to the multiple, sometimes conflicting definitions of the term 'regenerative agriculture' (Gordon et al., 2022; Newton et al., 2020) some farmers did not explicitly label themselves as regenerative. Rather, they identified as organic or agroecological. However, they all admitted to using grazing practices associated with regenerative agriculture.

1. Researcher Positionality



Figure 4: A photograph depicting, in the most comprehensive way possible, the author's positionality to the research. Author photograph.

The best way to describe the intersections of my identity which position me—the researcher—within my research, affecting my methodological choices and research execution (Rose, 1997), is depicted in Figure 4. This image was taken of me on an American Quarter horse I've known for 16 years, at my friend's grass fed (not finished, nor regenerative) ranch in Northern California, *working* some of his Hereford beef herd. The land in the photograph is the territory of the Amah Mutsun tribe, and the land I grew up on further north is that of the Miwok tribe, their people violently dispossessed of their land by the federal government, due to the Westward expansion that is wrapped up in the pastoral histories of rider and horse and herd and landscape. Thus, my 'Western' agricultural identity—which has grounded my positionality amidst humans and animals in that of multispecies partnership (Hodgetts and Hester, 2016; Roe and Greenhough, 2014) as a trainer of Western horses and a riding trainer for people—is one too that carries with it my positionality as the descendent of white settlers of what is now

California. I acknowledge this latter reality as having affected what I have had the opportunity to be: an environmental geographer at the University of Oxford. Staying with the trouble (Haraway, 2016), I recognise these intersecting identities as constitutive of my positionality, which has thus influenced why and how I chose to pursue this thesis.

This positionality attunes me to the more-than-human. As Hinchliffe et al. (2005) share, such attunement takes time, and for horses and beef cattle, I have—unknowingly—invested that time. While I encountered many different individual cows, heifers, steers, and bulls, of different breeds of cattle, reared in different ways from those I have 'worked' with before, I had some embodied knowledge of their motivations, movements, and communication. And, communication between species is not just interpreted, but felt (Hodgetts and Hester, 2016). This stoked my desire to select regeneratively grazed cattle as a case study for this thesis and allowed me to better understand their behaviours—like bellowing calls and bodily cues—in our encounters and the farmers' perspectives or stories about individuals or the herd. For beavers, on the other hand, my attunement was built from five years of research with them, first in California for my MPhil research, and then in the UK for this DPhil research. Beavers are more visible to humans through their 'traces,' what they leave behind (Govindrajan, 2018), than through in-person, visual contact. I became attuned to these traces, as well as their ethological motivations behind making these traces (dams, canals, lodges, etc.), and their overall behaviours.

The interspecies attunements I built over the years also aided in my rapport building with the human participants I would encounter across my fieldwork. Walking onto a farm with the visible markers of my (culturally-adjusted) positionality—wellies and my Oxford University Equestrian Club jacket—built immediate trust with many of the regenerative farmers. While

an environmentalist, I was also coming from a point of cultural similarity, accustomed to 'working' animals within agriculture that do more than produce food (albeit food production is in the background, even of equestrian and rodeo). Thus, instead of being defensive about meat production, farmers were able to open up about their managed grazing without worry of misunderstanding or judgement over animal 'use' or welfare. Likewise, I was more easily able to build rapport with the beaver researchers and restorationists, due to my previous work on beavers in California. With shared knowledge and interpersonal connections in the beaver restoration world, many people 'working with beavers' were open to inviting me to their reintroduction sites. Especially too with the researchers affiliated with different Universities, my positionality as a beaver researcher at Oxford also aided in this trust-building.

Once rapport was built, my positionality also influenced my decision making about the ways in which I would conduct my data collection, in relation to the research participants. In contrast to how I had conducted research in the past, for this thesis I made an active decision to temporarily accept the positions and arguments posed by my human research participants, setting aside critical analysis for the duration of data collection. I accepted claims of the carbon sequestration potential of regenerative agriculture as they were told to me and accepted other claims of the greater morality of sucker herds. I accepted anecdotes of beavers reversing British land management trends and claims that some beavers should be kept in enclosures. While my critical geographer positionality is always there, situating my knowledge and the ways in which I process information, I did my best to put that positionality to the side, buying into the claims of Nature-based Solutions and leaving critique for after. Upon reflection, a second interview with follow-up questions was sometimes required; but overall, my temporary acceptance of these positions allowed for an openness from the research participants, who shared with me—

someone who shares elements of their cultures and appreciation for their work—their opinions and experiences with enthusiasm.

During this time period, I faced some criticism from colleagues in Oxford who were (perhaps rightly) concerned that I was sharing preliminary findings from my data as 'fact,' without critical inquiry. However, I stand by this tactic as a way to open yourself as a researcher to the field, and shift the power dynamics that so often occur in interviews between researcher and participant (e.g. McDowell, 2010). With this temporary acceptance, you as a researcher are accepting the expertise of the participant, something that will become of critical importance in my development of the go-along as a more-than-human method. I call this acceptance temporary, as after data collection ended in September, 2022, I disentangled myself from the propositions and conversations to view the data with a critical lens, while still retaining the ability to view the conversations from within—not above (e.g. Haraway, 1988).

A final angle of my positionality to note is that of an interdisciplinary researcher: one who worked throughout my thesis consulting for the Nature-based Solutions policy sphere. From collaborating with scientists in Oxford's Nature-based Solutions Initiative in the Department of Biology (products being: Chausson et al., 2023; Welden, Chausson et al., 2021), to consulting for the World Wildlife Fund (WWF) and Unearthodox to produce a policy report on the different meanings of Nature-based Solutions (Chausson et al., forthcoming), to being a research assistant with the International Institute for Environment and Development (IIED) and the Oxford Policy Engagement Network (OPEN), I spent much of my time working in the spaces I was seeking to critique in this thesis. By gaining this experiential and intimate knowledge of the Nature-based Solutions policy sphere, I hope I am better able to approach the concept and the various actors in an informed, nuanced, yet still critical, way.

2. Research Design and Data Collection

To answer the research questions set out in Chapter 1, I needed to design a mixed methodology (Nightingale, 2003) that could capture both the human elements that make up Nature-based Solutions in policy and practice and the more-than-human elements that are choreographed into, and choreograph themselves (Chapter 5), the particular interventions. Thus, in this section, I share my research design, beginning with the sampling strategy I employed to capture the array of perspectives in both British beaver restoration and regenerative agriculture. I then explain my development of the go-along as a more-than-human method, and its supplementation with semi-structured interviews and a more-than-human framing analysis.

2.a. Sampling Strategy:

To sample human participants who are involved with the more-than-human, 'Nature-based Solution' interventions like beaver restoration and regenerative agriculture, I executed a mix of nonprobability sampling strategies—those determined by the 'subjective criteria of the researcher' (Coleman and Multon, 2018, p. 1357). I began with expert sampling to ensure I reached the key informants within these spaces (Patton, 2018) and convenience sampling, levying existing connections with those I knew working in this space (Waterfield, 2018). With these, I developed an initial list of participants whom I invited to participate in my study[2]. From this initial phase of participants, I gained a baseline knowledge of both group and individual experiences with Nature-based Solutions through go-alongs and semi-structured interviews (see below). I then used snowball sampling, where I asked each participant if they had anyone else they recommend I speak with, based on our conversation and my inquiries (Crouse and Lowe, 2018). I chose this strategy to ensure I spoke with those whom I not only identified as key, 'expert' participants, but with those others identified as expert participants. Thus, the

[2] See Appendix 1.A. for the Participant Information Sheet.

knowledge and practice communities came to the fore, illuminating points of connection—and disagreement—within NbS spaces. Because both the beaver restoration space and regenerative agriculture space are relatively small,[3] this mix of targeted and snowball sampling strategies allowed me to access multiple more-than-human sites of animals and/in/as Nature-based Solutions and speak to those human participants attuned to those sites themselves. With snowball sampling, I entered into go-alongs or semi-structured interviews with a grounding knowledge of community innerworkings, and with a heightened sense of rapport with a recommended participant. The community connection and access thus shaped the willingness of the human participants to share their time, spaces, and insights with me, shaping the knowledge produced in this thesis.

However, expert, convenience, and snowball sampling methods are not without their disadvantages. With the former, expertise is subjective, and thus the knowledge gleaned from those interactions is dependent upon who the researcher identifies as an expert, the depth of that person's knowledge, and the availability of all identified 'experts' to participate (Patton, 2018). For example, a key beaver restoration expert I identified did not respond to my invitations to participate, and thus the knowledge produced was swayed by their absence—albeit supplemented with knowledge from their publications. Lack of representativeness is a problem with both convenience and snowball sampling (Crouse and Lowe, 2018; Waterfield, 2018). While I designed my study with nonprobability sampling, thus accepting that population-level generalisability was not a goal, the latter sampling methods do contain the study population within particular, 'convenient' communities, and risk excluding alternative perspectives. Thus, the knowledge in this thesis weights some communities more than others

[3] To note, the beaver restoration space is smaller than the regenerative farming space due to accessibility and context, as reflected in the number of participants from each in my study.

due to the sampling. While I attempted to begin with a broad foundation in the initial stage of expert and convenience sampling, the data collection was then bounded by that foundation, shaping which communities were represented. Additionally, snowball sampling risks the confidentiality of participants (Crouse and Lowe, 2018). While I took steps to ensure the protection of personal data between participants, it risks being breached in advance when one recommends another. Taking into account these disadvantages and recognising their influence on the knowledge produced in the following Chapters, the insights shared here are a reflection of the participants' sharing, my observations of the community, and the interactions between participant and more-than-human environment, especially the beavers and cattle shaping the space.

I concluded my data collection when I reached a data saturation point, which Saunders et al. (2018) define as 'the degree to which new data repeat what was expressed in previous data' (p. 1897). While go-alongs provide individualised, place-based data (see 2.b. below), similar stories and themes were occurring in new go-alongs. In some cases, the same NbS sites were visited multiple times with different participants, which provided valuable different perspectives, but eventually led to Saunders et al.'s (2018) repetition of data. And, given my snowball sampling, many participants had shared community and thus shared opinions or rituals of human-animal interaction. Given the more-than-human influence on the data, as described in Section 2.b. below, there were always opportunities for new events or stories to emerge. However, taking saturation as a process rather than an event (Saunders et al., 2018) allows the researcher to conclude data collection with the recognition that not all knowledge can be collected.

2.b. The Go-Along as a More-Than-Human Method

To research the more-than-human, many scholars employ methods like multispecies ethnography—a method which foregrounds the nonhuman in anthropological ethnography (Kirksey and Helmreich, 2010)—to better understand human-animal relations and the animal lived experiences from those of crows (van Dooren, 2019) to those of pigs (Gillespie, 2019). However, some species are more difficult than others to access for multispecies ethnography (e.g. beavers who are nocturnal) and thus researching them must be done through their traces (Govindrajan, 2018). Additionally, as Hinchliffe et al. (2005) demonstrate, the attunement to animals (required for multispecies ethnography) takes time and must be carefully cultivated. Thus, I argue multispecies ethnography is not always attainable—nor necessary—to study the more-than-human at a more-than-human level. Attunement to a species and their ethology is ideal, but often impossible given a researcher's positionality and limited time or resources to cultivate attunement and expertise in the animal. Additionally, taking animals as subjects—rather than objects (Hodgetts and Hester, 2016)—requires an acknowledgement of their individualities, being able to attune to distinct personalities and beings, and seeing an individual in its relation to the researcher (Gillespie, 2019). Thus, if a researcher is seeking to understand both subjectivities of animals alongside wider stories of them in relation to structures—like Nature-based Solutions—attunement, I argue, can be supplemented through studying humans who have cultivated attunement and relations with the animals (Greenhough and Roe, 2019). These are the human conduits to more-than-human worlds, the humans with whom I go-along (See Figures 5 and 6 for images from go-alongs).

Traditionally, the go-along was developed in disability and mobility studies (e.g. Jones et al., 2008; Bell and Bush, 2020); however, with its mix of participant observation and semi-structured interview while walking/moving around a place of mutual interest to the (human)

participant and researcher (Carpiano, 2009), it has begun to be employed as a more-than-human and animal geographies method (e.g. Welden, 2023). Go-alongs engage these human conduits to more-than-human worlds, who show the researcher points of environmental interest that they themselves have cultivated attunement to, allowing the more-than-human to shape conversation and affective experience as the humans walk through a place (Welden, 2023). Arathoon (2021) claims walking methodologies provide an important contribution to the field of animal geographies, as they 'provide a creative means of exploring the affective, embodied, fleeting and sensuous characteristics of animals' experiences within research, helping to mitigate the challenge of representation and anthropocentrism' (p. 102). This taps into some of the elements of multispecies ethnography, in which both humans and animals are attended to as individual subjects within the study of their relation (Gillespie, 2019; Lestel et. al., 2006). And, with the go-along, relations between the researcher, multiple human conduits, and the multiple animals to whom the human conduits are attuned, can be accessed in ways that attempt to attain both depth of research in the multispecies relation and breadth of research in multiple relations across multiple cases and sites.

As becomes apparent in the following Chapters, the go-along provides such individualised data, thereby disrupting 'dominant norms of where and how other species live, enlivening the possibilities for new relationships to form' (Gillespie, 2019, p. 28). For example, as I reflected in my personal fieldnotes with cattle and beavers:

> *We moved the 35 head of cattle from one pasture to the next by opening the electric fence, and they ran happily through, one bucking and kicking in joy as it moved pastures. 'They know the routine,' said [the farmer]. The farmer was so relaxed around them, sometimes even with his back to the cattle as they ran past and around us. This is not something I would ever do with horses (personal fieldnotes, September, 2021).*
>
> *We [beaver site manager/landowner and I] continued through the enclosure, the [site manager/landowner] pointing out different aspects: the*

> *silt/mud the beaver ponds prevent from running downstream (using his stick to demonstrate the depth of the mud, which I had never considered), the clearings the beavers made of the brambles and small trees to allow other life to come through, their lodges, and the beaver ponds created by their dams (personal fieldnotes, September, 2021).*

As infrastructure is relational (Berlant, 2016; Larkin, 2013; Star, 1999), attending to such relations through an embodied method is necessary to understand the infrastructuralisation process. What can we tell about the bodies and subjects being enroled, enmeshed, and enfleshed as infrastructure through 'embodied empathy' (Despret, 2013 in Hodgetts and Hester, 2016) accessed through a go-along? Further, go-alongs—within the category of walking methods—provide researcher connection to animals' mobilities, as such mobilities can be both embodied and witnessed by the researcher, who becomes a part of the practice being explored (Arathoon, 2021) (Figures 5 and 6), of particular significance for Chapter 5. In sum, I became part of the practice, going-along in-person with 31 'regenerative' farmers and 14 beaver managers and attending 4 'regenerative' farm events. Through this, I witnessed the movement and products of the animals being in the space, interacted with the technologies used to hold and enable such mobilities, and sensuously engaged with the fields themselves—touching, smelling, and sometimes tasting the products of the NbS animal infrastructures.

Delving into the process of data collection, my go-alongs usually began in the same/similar way. After getting in contact with a (human) participant, usually through my initial key informants (Lavrakas, 2008) and the subsequent snowball sampling (Crouse and Lowe, 2018), and providing them with a Participant Information Sheet (Appendix A.1), which overviewed the process of a typical go-along, we would select a time and place to meet. This place would be selected by the participant, and consisted of their place of 'work' with the animals—either a farm/pasture or a beaver enclosure/damming site. Upon arrival, I would walk them through the Participant Information Sheet and have them fill out the CUREC-approved (Ethics

Approval Reference: SOGE 1A2020-100) consent forms, noting whether or not they consented to the go-along being recorded by an app on my mobile phone. Then, I would open the go-along by asking them to show me around the site, and off we would go, walking (or driving) across farms or wading through rivers (Figures 5 and 6) or squelching through mud (in beaver enclosures and on farms). I had a rough interview script in my pocket, but not every go-along is the same. Mixing the participant observation with semi-structured interview (Carpiano, 2009), I would take note of the ways in which the participants interacted with the environments, while we had conversations about the different elements of a site, including the animals. Introducing me to certain animals, the participants may discuss their individual personalities, or the personalities of a herd. For example, while moving their herd with me from one 'cell' to the next, one regenerative farmer shared:

> *There are definitely front leaders, middles, and backs. So, some of the old girls are at the back and One Horn way at the back up there, she, she's an old girl. But it's really good having these moves. I mean, I come down to check them each day.*

Or, in the case of beavers, fewer of whom I was able to interact with body to body, participants would tell me stories of the individuals, their unique habits, particularly inventive escapes, or the policies that led to them being brought to this site. In one example, the enclosure site manager was discussing the possible reasons for a recent male beaver death in the enclosure:

> *Postmortem just showed bleeding on his lung…We think it was that that he was gnawing and [a branch] split whilst he was on it, and that probably hit him. It's either that or he was following the female because she likes to climb and eat, and so we wondered if he followed her and climbed a branch and fell off...as I said the female in here is definitely like—that tree, sort of on its side tree there—she'd get on that tree and climb up it and gnaw around and eat all the bark, and she's quite happy doing that.*

Indicating to the 'scene of the crime,' and the tree that the female beaver enjoys climbing, this site manager shared the individualities of the different beavers, indicating to the female's happiness as she climbs—a rarely-documented behaviour for beavers. With go-alongs, these

subjective traits emerge in the stories from the attuned, often prompted by passing a 'trace' (Govindrajan, 2018).

Like in the beaver example above, a go-along allows for the more-than-human (and their traces) to shape the conversation and affective experience of the method. The conversation can shift in different ways, using the environment as a conversational aid (Arathoon, 2021), as the researcher and the human participant react to the more-than-human behaviours and actions around them. As Roe and Greenhough (2014) note in their concept of MTH experimental partnering, the researcher 'become[s] entangled within the field,' (p. 54) becoming a part of the field which they are observing. This comes into go-alongs, as the researcher may affect the MTH and human participants with whom they are going along. Further, in the case of go-alongs, the environment is beyond a conversational aid and instead a constitutive part of the conversation itself. For example, on one go along with a regenerative farmer, the conversation quickly moved from the pasture's herbal ley to the breeding of regenerative cattle:

> *So in this field, because of all the clover, they're happy to not move. But you can see this is like normally pristine. So, ['Mooo,' from a lone cow we were passing] aww poor girl are you mad? [She walks up to cow and pats it] That cow had a caesarean, so yeah, we look for smaller cattle. This one, we won't breed from again. She's only had two calves, the second one died.*

This abrupt shift occurred as the cow moo-ed at us, drawing us towards her, bringing us to a conversation around the farmer's animal husbandry decisions based on the cow's recent calving trauma. From this multi-relational interaction, I became attuned to the individual cow's experience. The farmer knows this cow intimately, and thus can interpret her behaviours and calls better than I could on a solo interaction with that cow, on that farm. In all these examples, we see the benefits of walking methods, as they 'open up the ability to see the relationship as it occurs, rather than just talking about it,' which is especially helpful if it is part of the practice (regenerative agriculture or beaver reintroduction) being researched (Arathoon, 2021, p. 105).

The go-along is distinct from walking methods broadly in where it is hosted: not in one set location, with a pre-designed route (as in Kusenbach, 2003), but in locations determined by the sites of multispecies relation.

Given these benefits of go-alongs to capture the more-than-human, perhaps in a more comprehensive way than some multispecies ethnography or walking methods, there are still shortcomings. First, there is still (always) a risk of anthropocentrism, as the human conduit to more-than-human worlds is still human, and their spoken observations are interpretive. However, by speaking to those humans, there is a chance of tapping into their embodied empathy for the more-than-human, beyond interpretation, that is the ways in which bodies attune themselves to each other—closer to understanding the other's feeling, seeing, and thinking (Despret, 2013 in Hodgetts and Hester, 2016). Another shortcoming of go-alongs is the high level of accessibility and mobility required from human participants. In order to participate in one of this project's go-alongs, for example, one must have access to private land (farm owner/tenant farmer or landowner with beavers/beaver enclosure site manager/researcher with access). Also, there are mobility concerns—the irony not lost on me, as go-alongs emerged from mobility studies (Bell and Bush, 2020; Jones et al., 2008). In the application of go-alongs to landscapes like farms or beaver enclosures, human participants must be able to 'walk' or move across muddy, rutted, dynamic landscapes in this form of a walking method. I had one participant who chose to drive me across a farm, due to personal mobility constraints, but that shifted the nature of the go-along in itself, and is not an option for all participants. Thus, other ways of speaking with other humans with expertise of the cases—some with cultivated attunement to the animals in/of the site—needed to be developed so as to capture these perspectives as well.




Figures 5 & 6: Two images from go-alongs, depicting how the researcher goes-along with human conduits to more-than-human worlds. Author photographs.

2.c. Semi-structured (virtual) interviews

For those human participants unable to participate in a go-along due to mobility, access, or time constraints, I conducted semi-structured telephone and/or video interviews (19). This enabled me to capture insights from alternative perspectives—like organisation and policy directors who do not have direct access to land—and from those farmers, land managers, researchers, and more who were unable to go-along for various reasons. While this method is less able to capture the more-than-human, leaving out the 'moos' or the embodied conversation/experimental partnering between researcher, human participant, and MTH, it still allows for open conversations with key participants. Semi-structured interviews are less structured and more conversational than traditional interviews, allowing for conversations to be more directed by the participant, shifting traditional researcher/participant power dynamics

(McDowell, 2010). Like in a go-along, emergent insights and topics are encouraged, as the conversation is not required to be rigid or completely directed by the researcher.

It seems prudent to also point out that given the time in which fieldwork took place (2021-2022), COVID-19 was still a global crisis, limiting contact and increasing risk. Thus, an online or phone interview option was necessary to ensure that participants felt safe and comfortable to have a conversation with me without risk of disease contraction. This was listed explicitly as an option in my Participant Information Sheet that I sent to potential participants in my introductory email (Appendix A.1).

2.d. Framing as a theory and method

Often in more-than-human scholarship, we refer to animals or other more-than-humans as being framed in a particular way (e.g. Srinivasan, 2014). These findings often come from a Foucauldian discourse analysis, a method which analyses a text's dominant discourses, or 'frameworks of ideas that structure knowledge and social practice' (Foucault, 1984 in Berg, 2009, p. 215). Alternatively, framing as a term is often used to describe a researcher's interpretation of interview data in the connotations the participant was using to describe the more-than-human. However, 'framing' is a distinct critical theory and method well developed in Communication Studies, which—as reviewed in Chapter 2—can be useful to apply to more-than-human research. By drawing on these deep literatures on framing as a theory and method, I argue in Chapter 4 that more-than-human geography can apply a Communication Studies framing more thoroughly, rather than as a descriptor of discourse.

In Chapter 4, I argue for framing theory's necessary inclusion within more-than-human scholarship. While I spend a significant portion of that Chapter applying the theory

methodologically, I overview it here. Communicative frames are the selection and salience of information presented in a communication (conversation, media, policy, speech, etc.) (Entman, 1993), which affect how an audience perceives the information and the reality it presents (Edelman, 1993; Goffman, 1974). Frames have power (Lakoff, 2010), prompting patterns of thinking (Goffman, 1974) and possible future action, like governance (Stirling, 2008). Thus, by applying framing as a specific method of discourse analysis in my more-than-human study, forms of persuasion, thinking patterns, and governance actions surrounding the concept of Nature-based Solutions, come to the fore. I did this through analysing the way cattle and beavers were *framed* in policy documents (from Natural England, DEFRA, the SFI, the Scottish Government, and the IUCN) and in transcripts from go-alongs and semi-structured interviews. To do this, I manually coded the documents specifically for communicative frames, using Gamson's (1992) four elements of frames and Entman's (1993) selection and salience framework, which is reflected in Chapter 4. However, I treated these different types of data (text and talk) slightly differently, as explicated in Section 3 below. Notably, frames are also created in an embodied, affective, and relational way (Lakoff, 2010). This makes the more-than-human central to the influence and production of frames, and I note this in their presence (or absence) on go-alongs (Chapter 4).

3. Data Analysis

In this section, I detail how I analysed the data collected, first beginning with the 'talk,' the data collected from go-alongs and semi-structured interviews, before moving to the 'text,' the policy data used in my framing analysis for Chapter 4. As the material comes from different contexts—a conversation or a published document—it called for different tools and attention when analysing the data.

3.a. Analysis of Go-alongs and Semi-structured Interviews

To analyse the go-along and semi-structured interview data I collected, I turned to qualitative coding as an act of analysis in itself, to illuminate meanings, categories, and eventually themes and theory (Saldaña, 2016). After each go-along or interview, I downloaded the recording (when consent was given to record) from my personal mobile device to my laptop and stored it in a password-protected folder on an encrypted hard drive. I also spent time each afternoon after data collection writing fieldnotes in my journal, describing memorable instances from go-alongs or in conversations, explicitly attempting to make note of everything from mine and the human conduits' relations to the animals and/or traces of the animals we encountered. During and after data collection, I transcribed all go-alongs and semi-structured interviews and uploaded these recording transcriptions and fieldnotes into NVIVO coding software. As I was transcribing and uploading the documents, I conducted a pre-coding (e.g. Ezzy, 2011), where I noted certain passages in the data that were interesting or important to reflect upon. Once I finished data collection in September, 2022, I began coding the data in my transcriptions using NVIVO software, where I interpreted the data and attributed meaning to different data points for the 'later purposes of pattern detection, categorization, assertion or proposition development, theory building, and other analytic processes' (Saldaña, 2016, p. 3). As I read through the transcripts, noting my pre-coding, I assigned particular words or short phrases—codes—to different passages. Often, two codes would be assigned to one passage, or embedded within different parts of a passage, known as simultaneous coding; there are 'fuzzy boundaries' between codes (Tesch, 1990, pp. 135 –8 in Saldaña, 2016). This was all part of my first cycle of coding, where I assigned codes as they emerged, often noting particular organisations, concepts, or attributes of animals.

In a second cycle of coding, I returned to my codebook (Appendix B) and the passages I had coded, reviewing and refining the codes. A second cycle of coding 'manages, filters, highlights, and focuses the salient features' of the data (Saldaña, 2016, p. 8). I considered each code in relation to the different points of data it represented and the other codes to which it related. In assigning and reviewing codes in this cycle, I began to identify patterns and generate categories, which then ultimately led to the theory generation for this thesis (Figure 7). In my codebook (Appendix B), the second cycle categories are those on the left side of the margin, while the codes are those indented. For example, in the beaver restoration data, 'Work-Labour' is the category, while its associated codes are 'collaboration,' 'ecosystem engineer,' 'regenerative,' and 'reproductive.' This category led me to considering labour—in particular, regenerative and reproductive labour—as one of the themes addressed in the thesis, generating theory around labour within Nature-based Solutions (Chapter 6).

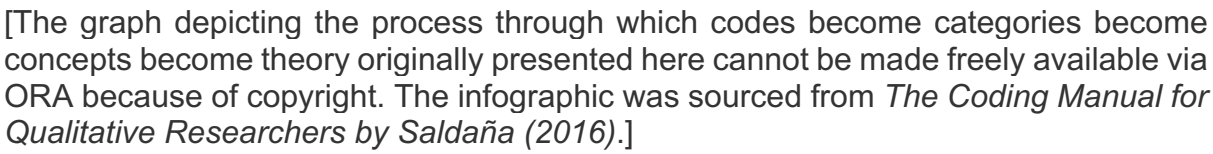


Figure 7: Saldaña's (2016) figure of how codes become theory in qualitative data analysis

In the second cycle of coding, some codes were ignored—and should have been deleted altogether, like 'Ecofeminism' in the Cattle file (Appendix B). Upon a second cycle of review, I realised the data in the code hung together, but did not generate more than a commentary on gender. Perhaps it could have been developed further, but based on the weakness of the data associated with that code and the relative strength of the data in other codes and categories, that code was abandoned. Ultimately, as I reflect upon my coding and data analysis, I find that not only did it matter the order in which data was collected (Section 2.a. above), but it matters the order in which data was analysed, as my interpretations built upon one another. 'Enmeshment' was an early code from both the Cattle and Beaver data (originally labelled hybridity in the first cycle of coding and renamed in the second cycle) and thus shaped the way I was thinking about animals and/in/as NbS, and later infrastructure as a wider category and concept.

3.b. Framing analysis of policy documents

When analysis the data from selected policy documents, I used Saldaña's (2016) method for manual coding, rather than uploading the documents into NVIVO. This included using highlighters to identify key passages and notations in the margins for categories and codes. Additionally, it was a directed form of coding, as I was conducting a frames analysis. Thus, I had 'rules for inclusion' that were specified ahead of time (Saldaña, 2016). Following Entman (1993), these were a pattern of selected material—what was selected to be included—and a pattern of salience—what was brought to the fore. Additionally, I specified Gamson's (1992) four elements of frames: problem definition, causal diagnosis, moral judgement, and remedy suggestion as 'rules for inclusion.' These six categorical items associated with framing were coded for in the policy documents to produce my framing analysis. Even with 'rules for

inclusion' for categories like the ones above, emergent findings and 'codes,' or 'frames' in a framing analysis, are able to come to the fore (Saldaña, 2016). For example, under the selection and salience categories, the pastoral and post-pastoral, the natural and post-natural, all emerged as frames from those 'rules for inclusion' categories.

As I combined qualitative coding and analysis with communicative framing data analysis, the analysis of talk—from go-alongs and semi-structured interviews—compared to text—from the framing analysis of key policy documents (specific to Chapter 4)—did differ. However, I still represented them in the text in similar ways, as I drew out key categories, patterns, and frames, building theory from the manual and digital codes. There are, however, ethical considerations I took into account when representing the different data, talk and text. With the talk, based on my positionality and commitments to CUREC, I limited my critique. For example, as noted in Section 1 above, my positionality is such that I have similar experiences to many of the farmers who participated in my study. Thus, I took the rapport-building seriously, careful (perhaps to careful) to critique my participants' methods or claims. With text, I found myself more openly critical, finding it easier to critique the words of an organisation over the words of an individual—even if they represent an organisation themselves. Protecting the individual participant's identity, as specified in the CUREC, led to a more closed—and perhaps limited—critique. I continue these ethical reflections in the following section.

4. The Ethics of More-Than-Human Research

Ethics are embedded within more-than-human and animal geography methods. The late Henry Buller (2015) put it best:

> The key methodological endeavour of human-animal relational studies has been to come to some emergent knowing of non-humans: their meaning (both materially and semiotically); their 'impact' on, or even co-production of, our own practices and spaces; and our practical and ethical interaction with and/or relationship to them – or at least to find creative ways to work around unknowing (p. 379).

The ethics between researcher and animal are as much a part of the question as they are a part of the methodological endeavour. Here, I consider the layered, multispecies ethical dimensions in the research design and execution described above. Parsing out the ethics of more-than-human research is difficult in the tendency towards the anthropocentrism of a human researcher (Arathoon, 2021), the interspecies power dynamics (Gillespie, 2019), the same species power dynamics (McDowell, 2010), and questions around animal participation (Hodgetts and Hester, 2016) or volunteerism (Palmer et al., 2023). In this section, I reflect upon how I addressed these MTH ethical challenges through the research, tying some of them back to my positionality outlined at the start of this Chapter.

As Arathoon (2021) considers in relation to walking methods for animal geographies, which aided in the development of my go-along design, a key area of ethical concern surrounds the anthropocentrism of speaking to a human, rather than conducting a multispecies ethnography. However, as I addressed in the go-along section, such walking methodologies take steps to address this in their embodied nature. As Arathoon (2021) writes, 'walking methods challenge [anthropocentrism] because animals can be actively involved in the research rather than passive objects represented through human experiences' (p. 109). While power dynamics still exist between animal and researcher, the go-along addresses some of these ethical concerns by opening space for more-than-human input and influence over the conversation and affective experience.

Even with a go-along, or multispecies ethnography, as in the case of Gillespie (2019), there are ethical risks of instrumentalising animals as characters within the research. She writes that 'researchers/educators/students should be constantly attentive to how easily this instrumentalization might occur' (p. 29). Thus, throughout my writing (as a methodological

practice in itself), I do my best to acknowledge the individual animals and their experiences that went into producing this work. While the scope of my research is broad, including multiple herds of cattle and multiple beavers in enclosures across Britain, I make an effort in the representation of their experiences to not generalise, distinguishing particular individuals from the national scope and noting that in certain instances, not *all* cattle or beavers will behave in the ways described in this research.

One of the constant ethical questions surrounding more-than-human research has to do with the ability—or lack thereof—for animals to be (consenting) participants or volunteers for a given research project. As Hodgetts and Hester (2016)—Hester being Tim Hodgetts' dog and research colleague—write in their chapter on more-than-human participatory research, the ethics of more-than-human participation in research surround consent, mutual benefit, and recognition. As I consider the beavers and cattle in my research, I cannot truly say they are 'participants,' as they did not consent to the research—often fenced into enclosures or pastures while I conducted a go-along in their space. The benefit rests primarily with me and some of the human participants, with my ability to contribute to more-than-human theoretical development but less in individual beavers' or cows' welfare. And, the recognition is imbalanced—though I am careful, in response to Gillespie (2019), to write animals as subjects. As Hodgetts and Hester (2016) write about their pine marten conservation research:

> A fully more-than-human approach might well seek to destabilise the architecture of such a project, and call for more prolonged ethological engagements through which to emphasise the martens as 'subjects'. But again, there would be ethical implications arising from increasing engagement – or intrusion – in this way (p. 88).

While my go-alongs did not focus on individual animal subjects for as long as a multispecies ethnography might have, they do take steps to emphasise subjectivity. They also address the latter ethical implications raised by Hodgetts and Hester (2016) in that within a go-along, a researcher can respect the animals' boundaries, being responsive to their movements and

behaviours as directed by the human conduit to the more-than-human world, as experimental partners (Roe and Greenhough, 2014). In this, go-alongs take steps to respect the animals' privacy, especially in the case of beavers, attempting to gain 'wild' animal consent by respecting the boundaries put up by the beavers (Yandaara with Gumbaynggirr County et al., 2021), like in multispecies collaborations (Welden, 2023).

With human participants, there are also ethical considerations to balance power dynamics. While go-alongs and semi-structured interviews take steps to balance the typical power dynamics that exist between interviewer and interviewee (Carpiano, 2009; McDowell, 2010), I wanted to go a step beyond that. Thus, with all my participants, I asked if I could do anything—within my capabilities as a researcher at the University of Oxford—to aid in their work or research. While most just asked to be kept up to date on my findings, as I wrote up and published[4], one regenerative agricultural organisation asked me for direct help, given my academic expertise and title, in exchange for introductions to regenerative farmers affiliated with their organisation. Not only for the contacts, but for the human participants in this project, I wanted to give back with my time, and so I agreed to help them. I dedicated a few hours of my time to reviewing content on their website, having generative feedback meetings with their communications director about this content, and eventually sharing some of my 'findings' on their panel at the Oxford Real Farming Conference. It was an alternative way of leveraging my positionality as an Oxford researcher to gain connections to participants, by *helping* their organisation, helping them. In the end, it led to further trust and rapport-building, and I gained a deeper understanding of their organisation and the cultures of regenerative farming.

[4] I am designing a researcher website on which I could link to my Open Access publications, with short public-facing summaries that could be helpful for those that participated in the project. The website is under construction.

Through these layered, multispecies methods and their associated ethical considerations, this research came to be. I hope my positionality and my commitments to the human participants and more-than-human beings are reflected in the analytical Chapters that follow.

Chapter 4: Enrolment

The framing of animals as Nature-based Solutions infrastructure

> *I think putting the beavers in and just letting them do what they do, doing it where they want to do it. And basically, putting to work their forty million years of evolutionary adaptation to manage water resources is just about as good a nature-based approach that you can have (beaver researcher).*
>
> *[Big food companies] are seeing [regenerative agriculture] as a solution to climate change and carbon. And actually, cows are the key drivers in this system. They're the things that are driving these changes and improving our pastures and our soils and locking this carbon (regenerative farmer).*

1. Introduction

As discourses of Nature-based Solutions (NbS) to climate change and biodiversity loss proliferate within research, policy, and practice spheres (Welden, Chausson et al., 2021), so too do the stories of nonhuman animals *enroled* as the infrastructure of such projects. Beavers become nature-based water managers and cattle drivers of climate change solutions. Within these stories are communicative frames, defined as the selection and salience of information in communication (Entman, 1993), which influences an audience's thinking about the information and the represented reality (Edelman, 1993; Goffman, 1974). For example, as the illustrative quotes demonstrate, these animals are framed not as the full NbS projects themselves; rather, they are framed as 'key drivers' of the Nature-based Solution, 'natural' managers with distinct intellectual and bodily capacities to create solutions to climate change and biodiversity loss. Such framing has power, shaping human-environment relations (Lakoff, 2010) and governance decision-making and commitments (Stirling, 2008), which affect the Nature-based Solutions and the beings—human and nonhuman—that make up the interventions. 'The ways that life and "nature" are uttered, imitated, represented, and thereby brought forth by humans have meaning as constitutive of the world' (Latour, 1993; 2010 in Sullivan, 2016, p. 750). Through an analysis of this framing, the process I term 'enrolment' is

illuminated. An essential addition to Barua's (2021) enmeshment/enfleshment typology of nonhuman infrastructure, enrolment (as infrastructure) is a discursive process which creates beaver and cattle worlds, constituting them as infrastructure.

This Chapter acts as the analytical foundation for the following two Chapters (5 and 6), establishing how animals are framed first as Nature, then as Nature-based, and finally *enroled* as Nature-based Solutions (infrastructure) through this framing. Here, I respond to the overarching research question, how are nonhuman animals made to be infrastructure (RQ1), by developing the concept of enrolment, adding to work from Stephanie Wakefield (2019) who notes that narratives are critical to making nonhumans infrastructural. This Chapter also speaks to the question of how animals come to be known as Nature-based Solutions infrastructure (RQ2) by thinking through frames, which prompt human patterns of thinking (Goffman, 1974 in Sullivan, 2023). It concludes with some consideration of the significance of this infrastructural framing on animal bodies (RQ3), but leaves the majority of such analysis to the following analytical Chapters and Concluding Discussion (Chapter 7).

This Chapter draws both upon data from the go-alongs and semi-structured interviews and from public and policy documents pertaining to beaver restoration and regenerative grazing in Britain. While frame analyses typically pertain to communicative artifacts[1] like the latter policy documents, frames are also made through bodily, affective experience with the environment and the cultural context (Lakoff, 2010). Therefore, to bring frame analysis into the remit of more-than-human research, I consider both the policy documents and the embodied conversations I had on go-alongs as communicative texts. This allows for the more-than-human

[1] Communicative artifacts traditionally refer to texts like speeches, documents, and artwork. However, communication is a constantly-occurring, broad, category and thus research—particularly on the environment—considers artifacts like 'image events' (Delicath and Deluca, 2003) and bodily experience with the environment (Lakoff, 2010) as constitutive of frames.

to have more explicit influence in producing frames through their presence (or absence) on go-alongs. Emergent from the analysis are frames that enrol animals as Nature-based Solutions: framed as different versions of 'nature' and producers of 'nature,' framed in relation to technology or human management as 'nature-based,' and framed as (infrastructural) solutions within 'Nature-based Solutions.'

I start this Chapter by tracing animals' framing as 'nature,' drawing on the wealth of critique on the concept of Nature from scholars like Castree (2005) and Hinchliffe (2007) to understand how beavers and cattle, respectively, are framed as 'nature' or 'natural.' Each animal evokes very different framings of nature, from the unruly and wild (or re-wild) to the pastoral and rural idyll. I trace how this framing works to (re)naturalise animals as keystone species and ecosystem engineers, illuminating the temporal elements of this frame, which naturalise animal imaginaries of the past as 'nature' in the present context of Nature-based Solutions. Once these animals are framed as 'nature,' it opens up space for critical inquiry into the framing of 'nature-based.' Emerging in a post-natural register, what does it mean for animals to be framed as not just 'nature,' but 'nature-based,' explicit in acknowledging human or technological intervention? In this section, I explore a system of frames which highlight the necessary inclusion and relation of fences, humans, and animals within these interventions. In the final section, I trace animals' enrolment as 'Nature-based Solutions' through Entman's (1993) four step process of framing: problem definition, causal diagnosis, moral judgement, and remedy (solution) suggestion. As this analysis illuminates, an emergent—and unifying—frame here is infrastructural. As animals are enroled as Nature-based Solutions, they are framed as infrastructure: material relation put to work in the production of Nature-based Solutions. As frames are situated within knowledge structures and networked systems of frames and their relations (Lakoff, 2004), tapping into one frame may activate another. Thus, it becomes clear

that the enrolment of animals as Nature-based Solutions infrastructure is made possible by the layered network of frames explored throughout this Chapter. This Chapter concludes with considerations and critiques around the enrolment of animals as Nature-based Solutions infrastructure, ruminating on the political economies and ecologies produced when animals are enroled in Nature-based Solutions. I also reflect on how bringing framing analysis into conversation with more-than-human theory leads to richer analyses of discourses that emerge within more-than-human studies.

2. Framing as 'Nature:' The (Re)Naturalisation of Animals

Nature-based Solutions are clearly premised on the concept of 'nature.' While 'nature' has multiple meanings—there is no one nonhuman nature—it is a commonly used term which carries with it particular meanings in particular contexts (Castree, 2005; Hinchliffe, 2007). In essence, 'nature' can be *framed* (Lakoff, 2010). It can also be a *frame*, though its definitional breadth means its use as a frame can also mean different things. Within the context of Nature-based Solutions, nature's definition is twofold: it is both a romantic, pristine nature that is external to humans (Castree, 2005 in Osaka et al., 2021) and an entity to be both protected and *used* by humans (Macnaghten and Urry, 1998 in Osaka et al., 2021). And, it carries with it a positive connotation, benefitting Nature-based Solutions (in contrast to 'unnatural,' human-made, 'hard-engineered' solutions) (Osaka et al., 2021). In either definition, the 'nature' in Nature-based Solutions is framed as nonhuman, encompassing nonhuman animals within it. Thus, in order to enrol animals as Nature-based Solutions (infrastructure), they must first be (re)naturalised, framed as nature.

However, as becomes clear in the subsections below, the animals—beavers and cattle—are framed as different kinds of 'nature.' Beavers are framed as (or as bringing about) wild, unruly natures. As frames exist in interconnected networks of relation (Lakoff, 2004), they thus

connect beavers to past British landscapes, wet, interconnected, and unaltered by humans. Cattle on the other hand, are framed as nature that evokes imagery of the pastoral idyll in Britain, including the cattle as 'natural' features of a pastoral landscape: a landscape with a mythic, rural quality that connects production to nature (Paxson, 2012). And yet, as these distinct animals with distinct histories and distinct natural framings are framed as the 'nature' of Nature-based Solutions, their histories converge and are in part obscured by a framing of ecosystem engineers/keystone species. These animals (e.g. 'nature') and particular relations with humans at those times become 'naturalised and projected into the past as something "moderns" destroyed' (Wakefield, 2019, p. 8). Animals that were removed from the British landscape (beavers) or whose use in commercial agricultural production associated them with environmental degradation (cattle) become (re)naturalised through this framing.

2.a. Which Nature?

2.a.i. Beavers in/and the Wild

As beavers were likely eradicated from Britain in the 16th century (Howe, 2020), their (re)naturalisation was critical to their reestablishment. Many of the arguments for their reintroduction to Britain stemmed from their past existence: they were once 'natural' and therefore they should be re-naturalised in Britain. '*Bring back the beaver'* (Gow, 2020) is a frequently heard rallying cry. This sentiment also emerges in policy and grey literature. For example, a report from Natural England to inform government decisions on reintroducing beavers more widely in England states:

> *The reintroduction of the beaver, as a formerly native species, promotes opportunities to renaturalise both habitat provision and species assemblages thus providing a nature-based solution to tackle the decline of the natural environment in England. This is in line with building more ecological resilience into the way nature is conserved, restoring the multiple natural capital benefits that flow from naturally functioning ecosystems, and adapting to climate change (Howe, 2020, p. 203).*

In this report, beavers are framed as natural, their status as 'formerly native' and their provision of habitat and species assemblages casting them as a part of 'naturally functioning ecosystems.' Making salient their presence in past British landscapes frames them as nature: because they were once present, beavers—and the habitats and species surrounding them—are natural. This frame establishes, as Cusworth et al. (2022) posit, a political ecological baseline, 'invoking a valued past to naturalise present projects that aim to deliver desired futures' (p. 1017). Baselines become the good, the goal of conservation (Marris, 2011). I'll explore the latter part of this concept in the following sections, but here, I focus on which valued past is evoked in this framing of beavers as natural.

The past 'natural' baseline desired in discussions and go-alongs with beaver site managers was one of a wild nature, where beavers from the past created wild, interconnected, and unruly waterways off which early humans lived (Coles, 2006). On a go-along with a landowner and beaver restorationist, he shared that his interest in beavers was peaked when he learned of their existence in the past. As we continued along the maintained walking path adjacent to the 'wild' and dynamic beaver wetland now established on his property, he shared his experience of the beaver-y environments in this place:

> *There's a lot of natural regeneration; you see a tremendous amount of stuff. Some of it's coppiced regrowth...quite a lot is from seed. And you see there were actually a lot of older trees that were felled...all those years for these rotten trees rot down and for various ecological, a whole kind of fungal succession to get going. And for the mycorrhizal fungi to start reinfiltrating the plant life…it's because of the beavers (landowner and beaver restorationist).*

Here, beavers are not only framed as natural, but as creating natural regeneration full of wild, messy, multiscalar 'stuff[2].' Their 'nature' is one that is wild and interconnected, reaching into

[2] More on this creation as probiotic labour in Chapter 6.

a past where their presence in the landscape sparks regeneration of ecologies that are not conceptualised as emerging from nowhere; they are thought to re-emerge from the past. Beavers instigate *re-emergent,* re-naturalised, regenerated past ecologies.

This wild nature framing does not emerge from nowhere; rather, this framing comes from embodied interaction with the environment. Take, for example, the below picture (Figure 7) of the unenclosed beaver wetland the landowner and beaver restorationist was describing, the wetland through which we were walking:



Figure 8: 'Wild,' unenclosed beaver-created wetland in Scotland with felled trees, multiple canals, and a series of dams creating a multi-layered landscape structure. Not pictured is the woodland behind the camera. Author photograph.

As described, there is *'a tremendous amount of stuff'* in the image. There are multiple levels of small beaver ponds that continue up the hill to the right, and down the hill to the left, ending

in the primary beaver pond, where the current family of three resides. Felled trees and beaver coppiced trunks scatter the wetland, extending behind the lens in the woodland. In this image, one can see how the beaver landscape appears 'wild,' outside of human control or design, in comparison to the more homogenous pasture behind it. As Ben Goldfarb (2018) describes them in his book *Eager: The surprising, secret life of beavers and why they matter,* 'beavers are agents of profound change' (p. 35). Derek Gow (2020), one of the figureheads of beaver reintroduction in Britain, describes the products of this change in his book, *Bringing back the Beaver*:

> When [beavers] return, gnawed sticks with flute-shaped ends lie white, stripped of their bark, in tumbled clusters. Felled trees with pencil sharpened stumps are silent in nascent clearings. Embankments raised by Victorian drainers become islands. Streams run back into courses they choose for themselves. Gullies worn down to bedrock become pools. Pools become ponds. Ponds become lakes and lagoons (p. 166-167).

Gow goes on to describe the other nonhuman life that re-emerges in the wetland: small mammals, birds, fish, trees, grasses, deer, frogs. Water too features, 'flowing in broad blankets. Water slowly squelching. Raising the land to form smelly sphagnum sponge' (p. 167). This description of landscape transformation frames beaver wetlands in a way that captures the more-than-human multiplicity of this place (Sullivan, 2016). In this text, Gow makes salient the agency of the nonhumans, where a 'nature' outside of human control is transforming human engineering (Victorian embankments) into islands and where animated streams *choose* where to flow, 'wild.' Gow's description reflects a landscape like the one in the photograph: spongy, watery, structured with tumbled clusters of trees. This is something 'ancient and strong,' connecting to a wild past that 'we [humans] cannot hear' (Gow, 2020, p. 166). From these accounts, it becomes clear that in response to beaver-altered landscapes, the nature associated with beavers is framed as profound, outside of human control, and wild. The wild nature framing of beavers emerges from the beaver landscapes: *'habitat mosaics' (beaver*

restorationist) that are messy, interconnected through beaver-altered hydrological flows, and representations of a wild, 'natural' past.

2.a.ii. Cattle and/in Pastoral Idyll

Unlike the beavers, cattle were not eradicated from Britain, and rather, are currently cited[3] as the cause of the aforementioned 'decline of the natural environment in England' (Garnett et al., 2017; Monbiot, 2022). As one regenerative farmer put it, *'everyone thinks cattle are bad for the planet.'* Perhaps one of the most famous—or loudest—critics of cattle farming is environmental writer George Monbiot, who in his book *Regenesis* wrote, 'all farming, however kind and careful and complex, involves a radical simplification of natural ecosystems' (2022, p. 77), citing the previously discussed beaver-created wetlands as an example of a 'natural ecosystem.' However, through the propositions of regenerative agriculture, cattle are being rebranded (reframed), from climate villain to 'renaturalised' within British environments (Cusworth et al., 2022):

> *Herbivores have always been here. It's us that's the problem, it's not the herbivores. Whole thing, it's not the cow it's the how, you know, how you keep the cows (regenerative farmer).*

If 'bring back the beaver' is the rallying cry of the beaver restorationists, 'it's not the cow, it's the how' (Rodgers and Wolf, 2020) is that for proponents of regenerative grazing practices. Again, reaching to the past, arguments for regenerative agricultural systems frame livestock as natural in Britain, as *'always [having] been here,'* referencing the aurochs, European wild cattle that shaped British landscapes before domestication (Velten, 2007). This framing in regenerative agriculture is closely linked with narratives of rewilding and livestock's 'natural'

[3] This citation most often refers to cattle and sheep production and consumption in the context of industrial farming. However, frames also obscure nuance (Edelman, 1993), and all cattle are grouped within this 'climate villain' frame.

place in a prehistoric Europe (Lorimer, 2020). In their analysis of how livestock are 're-branded' (re-framed) in regenerative agriculture, Cusworth et al. (2022) note: 'when grazing and defecating naturalistically as surrogates for the aurochs, cattle promise to catalyse ecological restoration, producing enhanced plant and microbial biodiversity and delivering ecosystem functions at a landscape scale' (p. 1020).

However, most framing of cattle in regenerative agriculture points to a pastoral past: evocative of one where the rural and the urban, 'nature' and culture are separate (Paxson, 2012), and the British countryside (in the case of the British pastoral) is romanticised. Due to its prevalence in British writings, art, and imaginaries, the rural idyll landscape representation has long been a site of critical inquiry for British geographers (e.g. Rose, 2023). Imagery (Figure 8) characterising this past does not exclude humans, but often depicts livestock grazing in a pasture delineated by hedgerows, with humans and/or human-made features:



Figure 9: Painting by Roberto Angelo Kittermaster Marshall, Way into Abergavenny from Llanfoist*, watercolour on wove paper. Copyright: National Gallery of Art, Open Access CC0 Public Domain.*

Marshall's painting depicts the past natural baseline towards which many proponents of regenerative agriculture in Britain reach. This is not the 'wild' nature of the beavers nor of the rewilded cattle, but the domestic. As British ecocritic Garrard (2011) posits, the pastoral is characterized by harmony and balance between humans and nature. Cattle—nonhumans in this depiction of a natural landscape—are framed within regenerative agriculture as natural, a key part of pastoral nature and balanced, harmonious production in the countryside. In regenerative agriculture, this natural, pastoral balance is contrasted with the aforementioned 'unnatural' industrial farming, which frames livestock as destructive and usurping nature (e.g. Monbiot, 2022). This pastoral nature frame emerges in the regenerative discourse, framing the cattle in the regenerative system as producers of the pastoral landscape:

> *If we didn't have cattle on our farm, it would revert to woodland very, very quickly. We're right near the edges of tonnes of woodland, so you could just see it would convert to woodland. So if we want to preserve the species rich pastures, basically they're absolutely essential to doing that (regenerative farmer and organisation director).*

These biodiverse pastures are fundamental to the nature of the pastoral, and this farmer argues that the cattle are essential to maintaining this type of natural landscape and aesthetic[4]. By calling cattle 'essential' to the production of this nature, the farmer is framing them as a part of the natural order, natural balance on a regenerative farm. Another regenerative farmer shared, *'as close as you can follow nature just seems to make sense'.* Regenerative farmers graze livestock in a way they consider to be natural, framing their practices as following nature, with livestock an 'essential' part of the system. Likewise, the beaver restorationists are also striving to manage beavers in a natural way, though they often have different visions of nature in mind. As I explore in the following subsections, nature—or natural, in its different iterations—is not the only framing enroling animals in these interventions. While reaching for the nature of past baselines, discourses of Nature-based Solutions find particular roles or niches

[4] Indicative of the probiotic labour of cattle explored in Chapter 6

for cows and beavers, framing them as Keystone Species and Ecosystem Engineers: a framing critical for their enrolment as the infrastructure of the Nature-based Solutions themselves.

2.b. Framing Keystone Species and Ecosystem Engineers

The (re)naturalisation of beavers and cattle is not only connected to the temporalities of their existences, but to the effects their (often managed) presence has on the landscape. These species are naturalised through their dual framing as keystone species and/or ecosystem engineers. Slightly different terms, keystone species—beings with disproportionate effects on the landscape relative to their abundance—fall under the broader category of ecosystem engineers—beings which manage and modify biotic habitats (von Essen and Allan, 2016). Barua (2021) elaborates upon the ecosystem engineer definition, writing that they are 'organisms…recruited to modify, maintain, or create habitats and act as controls on material flows' (p. 14). However, these terms are often used interchangeably by practitioners to describe nonhuman animals like beavers and cattle who can be used to manage other life, manage environments (Lorimer, 2020), sometimes drawing on, sometimes obscuring, the different natures that beavers and cattle are framed to evoke. Framing animals in this way is situated in a knowledge system which includes the 'natural,' thus framing them as keystone species and/or ecosystem engineers activates their framing as nature (Lakoff, 2010).

2.b.i Beavers and/in Restoration

As beavers in Britain are reintroduced, the justification for their reintroduction is usually grounded in beavers' ecological restoration potential: the presence of just one or two beavers transforming their immediate environment to benefit themselves and the biotic system around them. An example of this is depicted in Figure 9 from ARK Rewilding Netherlands, which defines 'the Beaver' as a keystone species and lists different ways in which beavers alter their environments and benefit other species in Europe. This argument can be consolidated through

their framing as keystone species and ecosystem engineers, the key(stone)s to restoration on this scale.

[The infographic depicting beavers as keystone species originally presented here cannot be made freely available via ORA because of copyright. The infographic was sourced at ARK Rewilding Netherlands: https://www.webwinkel.ark.eu/producten/schoolplaten-tekeningen/sleutelrol-bever.]

Figure 10: An infographic depicting and describing beavers as a keystone species in the European context. In the descriptions, they are describing beavers as ecosystem engineers. Copyright Jeroen Helmer/ARK Nature

Beavers' framing as 'natural' in the British landscape is solidified through their framing as keystone/ecological engineers. Emerging in conversations with beaver site managers and restoration organisation directors, this framing was prevalent. For example, one beaver site manager said:

> *[Beavers do] big things: flood alleviation, carbon sequestration, all that kind of stuff. But just the enjoyment that people have from them, the majority of people love having beavers in the landscape, to see what it's done for kind of tourism down in Devon. And also, how amazing it can be for biodiversity. So I just think, you know, the habitats that they're creating as a keystone species is just awesome. And it's something that's been missing in our landscape for such a long time. There'll be a lot of species that will depend on very specifically beaver habitat. So to see that kind of coming back and*

> *have slightly wild streams and rivers in our landscape would be amazing. So, these rivers that we've canalised, sort of treated really badly over the years, it'd be nice to see them sort of, you know, getting wild (beaver site manager).*

Beavers are thus framed as keystone species because of the 'big things' they do, hydrologically (with water), geologically (with carbon), socially (with humans), and biologically (with the ecosystem). This site manager highlights how beavers transformed habitats from a human-affected, 'unnatural' state with canals to a wild, 'natural' one of the past. Drawing on the 'wild nature' imaginary and framing beavers as keystone species enrols them in the restoration project (a Nature-based Solution) as the agent of 'natural' transformation.

> *I think putting the beavers in and just letting them do what they do, doing it where they want to do it. And basically, putting to work their forty million years of evolutionary adaptation to manage water resources is just about as good a nature-based approach that you can have. And as I say, all these [human-made] analogues, like building woody debris dams in channels to slow the flow of water […] because that's on vogue, that's one of the popular things to do over here at the moment. They're just pale imitations really of beaver dams ….*

While this beaver researcher does not specifically use either of the phrases, 'keystone species' nor 'ecological engineers,' they are still framing beavers as such. This is done by evoking key elements of the frame, like their transformational 'management' of water and their superior 'natural' knowledge, in comparison to humans, due to the *'forty million years'* of dam building expertise. Such expertise has long been respected (Feeley-Harnik, 2019), leading to beaver dams being recognised as more effective than human-made dam interventions. However, this framing conditions beavers' existences in Britain on their ability to *engineer* ecosystems through dam building, 'putting to work' their expertise.

2.b.ii. Cattle and/in regeneration

Within the context of regenerative agriculture, cattle are framed as the agents of pastoral regeneration, the species on a farm which—if grazed in a particular way—are both 'natural'

ecosystem engineers themselves and producers of 'pastoral nature.' This subsection begins like the section before, considering the framing of cattle—or members of the Taurus family broadly—as keystone species/ecosystem engineers. However, this framing diverges from the beaver one, as the 'nature' sought is pastoral, and thus inherently inclusive of humans in the landscape. The latter half of this subsection considers how the human-cattle relation enables the framing of cattle as ecological engineers. In partnership, the cattle are framed as producers of 'nature.'

Members of the Taurus family, are defined by Rewilding Europe and ARK Rewilding Netherlands, as keystone species (Figure 10).

[The infographic depicting Taurus as keystone species originally presented here cannot be made freely available via ORA because of copyright. The infographic was sourced at ARK Rewilding Netherlands: https://www.webwinkel.ark.eu/producten/schoolplaten-tekeningen/sleutelrol-wilde-rund.]

Figure 11: An infographic depicting and describing the Taurus as a keystone species in a European context. They are described as ecosystem engineers. Copyright Jeroen Helmer / ARK Nature.

Like the infographic for the beaver, this image frames cattle—*Bos taurus* in their species classification—as keystone species. The series of cattle herds depicted—notably more than one, compared to the beaver image—are described as managing and maintaining biotic (and geologic) habitats (von Essen and Allen, 2016) and controlling material flows (Barua, 2021). For example, the cattle are pictured as turning up soil, cutting back trees, and creating/maintaining soil health in the image. While the image was produced in a rewilding context, with different aims to that of regenerative agriculture, regenerative agriculture does draw upon this vision of a taurus body and how the body fosters soil health to regenerate ecosystems (Gordon et al., 2020; Schreefel et al., 2020). From this data and my previous collaborative work, it becomes clear that cattle are key(stone) elements of building this soil through their bodily mobilities and rumination[5] (Cusworth et al., 2023; Gosnell et al., 2020). Regenerative agriculture's goal is that not of a (re)wild nature, but of a pastoral nature. Thus, while cattle are framed in part as 'natural,' wild keystone species in rewilding, they are framed primarily as producers of pastoral nature in regenerative agriculture.

To attain a pastoral nature baseline (Section 2.a.ii.), most regenerative farmers argue that cattle on the farm are *key*. Within these conversations, cattle are framed as natural, so long as their grazing patterns are managed by farmers. As one regenerative farmer—who has taken up the task of regeneration *and* restoration by also having beavers on his property—describes, by managing the movement of cattle bodies, cattle regenerate 'traditional,' i.e. 'natural pastoral,' meadow environments:

> *The cattle are necessary in the regeneration of the meadow pastures, so [it is] stipulated in our management practice that we graze with the cattle because these are hay meadows, traditional hay meadows. When that seed is dropped after the hay making process, the cattle can then come in in the autumn and graze. And there's something about their hooves, exerting a*

[5] More on cattle's mobilities in Chapter 5 and their rumination/metabolism in Chapter 6.

> *pressure, and their dunging and the way that when they move, they turn [the soil] with that hoof (regenerative farmer with beavers).*

In this dialogue, cattle are framed as ecosystem engineers in von Essen and Allen's (2016) definition, described as managers and modifiers of biotic habitats, and producers of hay. Like the beavers, the cattle are framed in this way as workers, their bodies seen as critical to production, their hooves and dung and movement creating and/or regenerating 'nature' on the farm in the form of the hay meadow (Chapter 6). Of course, this example differs from the framing of beaver not only in the 'nature' sought, but in that human management (of the cattle) is selected and made salient. The cattle are not alone in their ecosystem engineering, but are explicitly managed to regenerate the hay meadow landscape. As the natural baseline sought is that of the pastoral, part of attaining that nature is the inclusion of human and cattle together, making the environment. The ecosystem engineering frame builds mutual respect for another species' 'work,' thus setting the foundation for a co-working mode of relation between humans and nonhuman animals (Welden, 2023). What emerges is a dependency of the Nature-based Solution on the *Bos taurus* body and on the human management of the herd.

The framing of *managed* cattle as natural, ecosystem engineers, also appears in some agricultural policy documents (and notably not in others). In the Scottish Government's report, *Delivering our Vision for Scottish Agriculture,* 'livestock' management can provide multiple environmental benefits:

> *Farming, crofting and land management will play an essential role in delivering on our environmental outcomes by managing land, livestock and water in a way that protects and improves the environment. These outcomes include protecting and restoring biodiversity and supporting clean air and water, actions and measures that contribute to flood risk management locally and downstream and healthy soils. (Scottish Government, 2022, p. 21).*

Here, 'natural' outcomes that include biodiversity restoration, flood risk management, and soil health, among others, are attributed to farmers 'managing land, livestock, and water' in an environmentally-friendly way. Agriculture itself is considered 'essential' to environmental change; and, in striving for a future return to a natural pastoral past (Lorimer, 2020), cattle are framed as key drivers of this return/regeneration. This excerpt is critical for its selection (after Entman, 1993) of livestock as part of the solution, which not only reflects how the Scottish Government are thinking, but may further influence the thinking of Scotland's policymakers and farmers. Also notable is a comparable document from DEFRA (2023): the *Sustainable Farming Initiative Handbook*. From the same framing analysis, cattle (nor livestock writ large) are not framed as creators of the 'natural' pastoral environment; rather, they are framed in the negative, as something to keep away from proposed biodiversity buffer strips or hedgerows. This comparison between policies demonstrates how cattle can be framed differently, not always considered 'nature,' even within Britain.

It is important to note the framing of 'keystone' species and ecosystem engineers is not apolitical, nor uncriticised. Many of the critiques come from critical social science on rewilding, centring around the ways in which 'naturalised' animals are not fully natural, or sovereign (Donaldson and Kymlicka, 2011), when carefully managed under rewilding (Lorimer and Dreissen, 2013; von Essen and Allan, 2016). As Emma Marris writes in her book, *Rambunctious Garden: Saving nature in a post-wild world,* 'the keystone species [in the Oostvaderplassen rewilding project] are domesticated animals posing as their wild ancestors' (2011, p. 70). In agricultural cases as well, scholars find the naturalisation of cattle unconvincing:

> The cow cannot be seen simply as 'natural,' even if we acknowledge that their body, behaviour, and subjective experience are 'bovine' in a way that retains something of a genealogical lineage that has become what we refer to as domestic cows. The cow, first, emerges from histories of human intervention (for example, selective breeding

> practices), and, second, exists in relation to the different and specific material and social relationships cows are caught up in' (Holloway, 2007, p. 1045).

Thus, whether in the context of cattle in regeneration or beavers in restoration (and somewhere in between), animals may be 'naturalised' because of the framing around their histories and present behaviours or management. Still, as Holloway's (2007) assertion shows, animals' actual histories, mobilities, and lived experiences demonstrate how the category of 'natural' itself is complicated, not fully outside human control, even in striving for 'wild' nature. This modified, human-affected form of (re)naturalisation does work within the context of Nature-based Solutions, as the solutions are not 'Natural Solutions,' but 'Nature-based.'

3. Framing as 'Nature-based:' The Post-Natural

While predicated on a framing of 'natural' (Osaka et al., 2021), Nature-based Solutions are not all 'nature'. As noted in critiques of keystone species/ecosystem engineer frames from rewilding and agriculture, animals are never fully 'natural,' not only because of the variety of meanings for 'nature' (Castree, 2005), but due to their historical and present interactions with humans and human-created technologies. This nature-based 'nature' of Nature-based Solutions is thus an important, but often ignored, element of these interventions to interrogate and include when critically analysing NbS. This Section does just that. By unpacking and centring the concept of Nature-based, I describe how the wild nature framing of beavers and pastoral nature framing of cattle are opened up and moved beyond: to the post-wild and the post-pastoral.

3.a. Beavers in the Post-Wild: Rambunctious Gardening with Beavers

While beavers are framed as being within, or bringing about, 'wild nature,' they are limited in their abilities to do so, not only because, in the British context, most beavers are reintroduced into *'heavily fortified places' (beaver site manager, landowner),* but also due to the totalising

presence/effects of humans in/on the nonhuman environment making the concept of wild insufficient to describe the world (Marris, 2011). As Marris claims, we are already in a post-wild world, where 'pristine,' or untouched by humans, is one thing 'nature' is not. She proposes a new form of conservation, rambunctious gardening, as an intervention that creates more 'nature' as it goes, rather than putting walls around the 'nature' that is left. In this section, I use her proposition to analyse the way beavers are framed in this post-wild world, where they are reintroduced (by humans) into enclosures (designed, licensed, and built by humans) where they build dams (on or against technological relics of human environmental intervention). I interrogate how this enrolment as nature-based—rather than just 'natural'—shifts the framing of beavers in NbS.

> *Well, this is an old man-made sluice to manage the water, but the beavers have basically said that's not good enough. So they've added to that (beaver restorationist and regenerative farmer).*

In this description of a site on this landowner's property, within the beaver enclosure, the 'wild nature' framing is complicated, as Victorian-era hydrological interventions into the landscape are added to, enhanced, by the beavers. This is an example of the 'nature-based' and an explicit recognition of living in a post-wild, hybrid world, where binary boundaries between humans and nature, humans and animals are blurred (e.g. Whatmore, 2002).

There are different elements of British beaver reintroductions that enrol them as nature-based: human management, biomimic-ed dams, and fenced enclosures all produce particular outputs from beaver activity (Chapter 5). These managed, enclosed beaver reintroductions contain the 'nature,' the beaver and its environmental impacts, within a particular place to provide 'natural' flood management downstream[6]. '*The enclosures are like Jurassic Park,*' I wrote in my field

[6] More on this in Chapter 6

notes (October, 2021), *'with rangers walking the fence line and triple-checking the locks to keep the beavers inside, while their "work" flows outside the enclosure'*. What is often referred to as 'natural' flood management, is complicated in such a heavily fortified place. It is Nature-based Solutions' component of 'nature-based' that becomes key here, allowing for human management and human-designed technological mitigation to determine 'wild nature's' place, where it is held. In a sense, it goes against Marris' (2011) rambunctious gardening, as she argues for the walling of the 'wild' to end. However, what happens within and through the enclosure is a vivid description of the post-wild.

Within the enclosure, the researcher mentions that humans do not have direct control over beaver activity. However, they can choreograph (Chapter 5) certain beaver behaviour through the integration of 'woody debris dams,' often called Beaver Dam Analogues (BDAs) (Figures 11 and 12). BDAs are human-made dams that are 'more-natural' but not quite within the remit of 'nature-based' according to this researcher: *'It's not really just letting nature do itself and having benefits from that.'* The BDAs alone are framed as unnatural, simply speculative (Osaka et al., 2021), not grounded in the evolutionary, geological timescale of beaver dams. However, when beavers build upon the BDA, as the humans expect and desire, their framing switches to nature-based. With BDAs, one sees the convergence of human engineering, building a biomimic-ed structure with 'natural' materials in a place they want a dam to be, with beaver engineering, building upon and maintaining this pre-existing BDA. Together, the human choreography of beaver behaviour and the expected beaver dam-building describe the 'nature-based' frame: a back and forth persuasion of possibilities where humans and nonhumans are in constant negotiation, or collaboration (e.g. Welden, 2023). Of course, this model assumes the animals will build as anticipated and nudged by the humans (Wakefield, 2019), not so when the beavers choose not to dam where the BDA is, letting it be washed away

by heavy rainfall and damming elsewhere they deem fit for their own purposes. Thus, part of 'nature-based' gardening in the post-wild is acceptance of designs outside the human.





Figures 12 & 13: Two photographs of BDAs within beaver enclosures in England. The top image shows a BDA on which beavers have built, while the bottom image shows a newly-built BDA before beaver intervention. Author photographs.

3.b. Cattle in the Post-Pastoral: New Machine(s) in the Garden

Disrupting the classic pastoral framings in Western literature came a new trope—particularly in the US—of industrialisation in the form of a locomotive train rushing through the pastoral landscape in the 19th and 20th centuries. The 'machine in the garden' is what literary historian Leo Marx (1964) coined it, describing the constant interruption of a pastoral nature by industrialisation and technology. An alternative view of the garden to Marris' (2011) rambunctious garden, L. Marx's (1964) garden refers to a pastoral nature with livestock and humans in the countryside in constant company of the machine. Heather Paxson (2012) builds on the machine in the garden trope to describe the post-pastoral (from Gifford, 2013) in artisanal cheesemaking, where the garden is a working landscape. In a 'post-pastoral vision of working landscape, cultured nature—cows grazing on a hillside pasture, or the microbial activity that creates a 'natural' rind on a wheel of cheese—is both productive of commercial goods and also a vehicle for social and aesthetic value' (p. 29). In the post-pastoral, the machine in the garden is to be accepted and worked *with*, while retaining the aesthetic values of nature in the pastoral (Paxson, 2012). The post-pastoral emerges in the narratives surrounding regenerative agriculture, as novel technologies are layered atop stories and practices of human-animal connection, 'ecologising modern agricultural technology' (Cusworth et al., 2022, p. 1016). Here, I explore how 'regenerative' cattle are framed not solely as 'pastoral nature,' but in their relations with modern technology of regenerative agriculture, they are framed as post-pastoral, nature-based. In a way different to the beavers, regeneratively grazed cattle's relation to technology frames them as *more* natural in the present age.

As I reviewed in the keystone species/ecosystem engineering framing, where cattle evoked natural-pastoral imagery, they already were framed as 'nature' in relation to humans. However, cattle become framed as nature-based in regenerative agriculture in their relation to one key

'machine in the garden:' electric fencing[7]. This technology allows for the (re)naturalisation of cattle by choreographing their grazing patterns to regenerate biodiversity and build soil health. This is particularly apparent in a map (Figure 13) from a farm conducting experiments on set stocking versus regenerative, cell grazing:

[The aerial map of a cell grazing study site originally presented here cannot be made freely available via ORA because of copyright. The map was sourced at a presentation by a farmer during a semi-structured interview where permission was orally given to use, but not distribute.]

Figure 14: Aerial map of a farm's planned grazing, experimenting between set-stocking and cell grazing. Difference in size between traditional set stocking (yellow) and cell or managed grazing (orange) pastures are delineated. Image permissions from farmer.

This map shows how cattle are grazed in regenerative agriculture in relation to fencing. As depicted in the map, cattle are moved around a series of 'cells,' marked in orange and bounded by (often electric, movable) fencing. Working with the machine in the garden, they are 'nature-based.' This forms a particular vision of how cattle live, and especially in regenerative agriculture, how they *should* live. Considering the regenerative proposition which (re)naturalises cattle in a future-past, like the wild herds which grazed the great plains of North America (Cusworth et al., 2022) and elsewhere, there is a baseline off which cattle's liveliness

[7] More on the materialities of electric fencing in Chapter 5

is measured. In a video produced by the Savory Institute, an organisation promoting regenerative grazing practices—coined 'holistic management' in their terms—they discuss the regenerative vision of 'natural' bovine behaviour produced through human management, of bovine movement, with fencing infrastructures: 'Holistic planned grazing helps animals get to the right place, at the right time, with the right behaviour, mimicking the way wild herds once grazed' (Savory Institute, 2023). To achieve the 'right' behaviour—the vision of life's liveliness in this case (Wakefield, 2019)—holistic management is key, according to the video. It is about managing and measuring the animals to *make* them exhibit these expected, desired, 'natural' behaviours. In this register, cattle are only framed as nature alongside technologies and human management. This nature-based relation thus sets the foundation for their enrolment as Nature-based Solutions.

Even with futuristic machines positioned front and centre in this framing of cattle as natural, there is still a draw to the past, making this cattle-machine relation in regenerative agriculture a prime example of the post-pastoral:

> *So the other thing I love about regen farming is actually so the basic techniques, you know, are hundreds of years old, cropping, animals on your farm, and rotational, all that kind of stuff. But then this absolutely nuts new technology, which is really making it economically viable and sustainable…I think we're using technology in a way which is far cooler than what is going on in conventional space...it's real innovation (regenerative farmer with beavers).*

As this farmer describes, the farming techniques from the rural idyll, pastoral landscape are integrated with '*absolutely nuts new technology,*' which is framed as superior and more efficient to that used in the 'unnatural,' conventional space. This speaks to Lorimer's (2020) concept of a future-past, where regenerative farmers advocate for a return to a pastoral past while prospecting into the future, and employing modern, even futuristic, technologies (Cusworth et al., 2022). Cattle thus become the figures of this transition, but only in their

relation to such technology. Within the farmer's quote, regeneratively grazed cattle are framed as cost-effective options, aligning with Osaka et al.'s (2021) framing of Nature-based Solutions as cost-effective compared to 'unnatural' environmental interventions. In fact, cattle in this framing are promoted as replacements for the 'expensive' machinery of 'unnatural' solutions. The practice of managed grazing is promoted through discourses of lowering inputs on the farm, including reducing large machinery (e.g. tractor) usage:

> *Everything about [managed grazing] is totally natural. You know, if you think in the old-days you'd have shepherds herding their sheep or cowgirls and boys herding their cows. We're just using electric fencing, so yes I'd say it is [a Nature-based Solution]. As a result, we're not using [large] machinery in any way, so our labour inputs are probably higher, but our machinery costs a lot less (regenerative farmer).*

In this post-pastoral framing, certain technologies are naturalised—like electric fencing—while others are considered unnatural—like large machinery. In its relation with cattle and its ability to evoke particular 'natural' behaviours, electric fencing makes up the nature-based part of a Nature-based Solution; it is an acceptable machine in the garden, so long as the (re)naturalised animal is still central to the system. As Holloway (2007) shares, technologies affect what cattle are expected to be and do: by opting for lower cost farm technologies, cattle's role as technological grazers increases, their roles are redefined as their labour replaces that of the tractor[8]. The cattle become framed as the machine in the garden themselves—framed as the infrastructure of Nature-based Solutions—explored in the Section below.

4. Enrolment as 'Nature-based Solutions:' Animals as infrastructure

So far we have explored how first framed as 'nature' or keystone producers of such nature, certain animals constitute the 'nature' of Nature-based Solutions. Then, in their relations with human management and/or technologies that choreograph their 'ecosystem engineering,' they

[8] Read more on this in Chapters 6 and 7.

become framed as nature-based, making allowable human and/or technological intervention into animals' works. The application of these framings thus enrol particular animals as Nature-based Solutions, framing them as the infrastructure, the material relation that supports the functioning of a Nature-based Solution. In this Section, I first read Nature-based Solutions as a concept through Entman's (1993) synthesis of Gamson's (1992) four elements of framing. This provides an overview of how framing is fundamental to a discursive enrolment of animals as Nature-based Solutions, obscuring some differences between beavers and cattle by framing them as remedies to the same problems. I then trace how Nature-based Solutions, in the way that it itself is framed, frames certain animals as infrastructure.

4.a. Four Elements of Frames

In Entman's (1993) review of frames and framing, he cites and synthesises Gamson's (1992) research on the four primary elements of frames. As reviewed, frames: define problems, diagnose causes, make moral judgements, and suggest remedies. If I consider Nature-based Solutions as a frame rather than a fixed category of environmental interventions, these four elements come to the fore, demonstrating how well Nature-based Solutions acts as a frame and how it works to enrol nonhumans (in particular, nonhuman animals) as the foundation, the infrastructure, of Nature-based Solutions. As I trace the communicative logic that underpins Nature-based Solutions in these next few subsections, I illuminate the inevitability of animal enrolment as the infrastructure of Nature-based Solutions due to the frame itself, a socio-material construction of animals as infrastructure. Enrolment of the nonhuman into Nature-based Solutions is embedded into the very language constituting the concept.

4.a.i. Define Problems:

First, the Nature-based Solutions frame defines problems. Looking at the language in the IUCN's foundational report on Nature-based Solutions (to climate change and biodiversity loss), the problems are self-evident in the very definition:

> Nature-based Solutions are […] actions to protect, sustainably manage, and restore natural or modified ecosystems, which address societal challenges (e.g. climate change, food and water security, or natural disasters) effectively and adaptively, while simultaneously providing human wellbeing and biodiversity benefits (Cohen-Shacham et al., 2016, p. xii).

Some of the societal challenges, or problems, are defined here, framing the context under which the frame can be applied: e.g. climate change. Throughout the document, the authors at the IUCN consider how these ways of 'working with ecosystems' are often preferable to traditional, 'hard' engineering approaches, like seawalls, framing them in contrast to 'unnatural' solutions to the same problems of climate change and sea level rise (Osaka et al., 2021). From the data collected on go-alongs and interviews, I saw the same problems defined, by beaver restorationists and regenerative farmers alike:

> *We're in a biodiversity crisis. With beavers, there's an opportunity to restore a lot of it…we're also a country that is very prone to flooding. And it's likely to get worse with climate change. Beavers are quite a natural approach towards helping with that… (beaver researcher).*

> *Obviously the climate emergency is upon us and, you know, carbon is a very hot topic, so thinking about how we can mitigate against the impact of methane from livestock with soil carbon [sequestration] is really, really important […]. I think obviously nature biodiversity is a huge issue as well … (regenerative organisation director).*

In both cases, climate change—or a climate emergency—and biodiversity loss—or a biodiversity crisis—are defined as problems. There are also affiliated problems that are identified, like flooding and methane emissions, but they are ultimately conditional upon the core problems of climate change and biodiversity loss Nature-based Solutions are framed to address. And in those cases, animals are beginning to be tied into this framing.

4.a.ii. Diagnose Causes:

Another element of the Nature-based Solutions frame is its diagnosis of the causes of climate change and biodiversity loss. From the IUCN report, anthropogenic—human-caused through industrial methods like farming and forestry and thus 'unnatural'—causes of climate change and biodiversity loss are identified:

> When the land sector as a whole, including agriculture, forestry and other land uses (AFOLU), is considered, the contribution is about 24% of annual global anthropogenic emissions (ibid) (Cohen-Shacham et al., 2016, p. 15).

According to the narrative posed in the report, these 'unnatural' land uses result in mass CO2 emissions (excluding methane) which cause climate change and are confounding factors in biodiversity loss. These causes were also identified by the practitioners, farmers, policymakers, and researchers I spoke with, citing human destruction and misuse of the 'natural' environment as causes to the identified problems:

> *So I think there's more and more realisation, we're densely populated, we are destroying our landscape, there is a climate crisis. All these things I think are really started to hit home more to people. I mean, this is before beavers, but there started being a real interest, like, what are we missing? You know, and you go to other parts of Europe, and you're like, whew, there's evidence [of beaver benefits], I think people are quite excited by that, quite romanticize about it (beaver restorationist and organisation director).*
>
> *So our position is, I think it's somewhat unique to the environmental NGOs, but we are very supportive of grazing livestock as being part of the climate change solution. You know, obviously we recognise that globally and, you know, in the UK but also globally we need to reduce meat consumption and that needs to totally eradicate industrial meat production (regenerative organisation director).*

In the first quote, humans are cited as the cause for landscape destruction and connected to the climate crisis, particularly in the acknowledgement of Britain's dense population. This beaver restorationist and organisation director then argues that knowing or recognising these causes to the defined problems contributes to the desire to reintroduce beavers—all under the remit of Nature-based Solutions. In the quote from the regenerative agriculture organisation director,

she identifies meat consumption and industrial meat production—industrial farming—as the causes to the climate change problem, globally and in the UK. Mitigation of these causes and transformations of the systems that create these causes are thus positioned as 'solutions.'

4.a.iii. Make Moral Judgements:

Another element that constitutes a frame is a moral judgement, a normative argument built into the frame itself (Gamson, 1992 in Entman, 1993). As Osaka et al. (2021) identify, Nature-based Solutions benefits from its association with the 'natural.' Nature is connoted in a positive register, making Nature-based Solutions normatively or morally good, in comparison to 'unnatural', or human-based, solutions. Thus, when Nature-based Solutions is used as a frame, it carries with it a moral argument around the relative goodness of the natural in comparison to the unnatural. Again, this is evident in the IUCN report:

> The NbS concept, as used in environmental sciences and nature conservation contexts, has emerged within the last decade or so, as international organisations search for ways to work with ecosystems rather than relying on conventional engineering solutions (such as seawalls) – to adapt to and mitigate climate change effects, while improving sustainable livelihoods and protecting natural ecosystems and biodiversity (Cohen-Shacham et al., 2016, p. xii).

Here, the 'conventional engineering solutions' are coded as morally worse than environmental interventions which 'work with ecosystems' to solve the defined problems of climate change and biodiversity loss by mitigating their causes. Working *with* 'nature' rather than 'against' it is built into the frame of Nature-based Solutions (e.g. Seddon et al., 2021 in Welden, 2023). This established moral judgement thus trickles down to the narratives surrounding individual interventions, like beaver reintroduction or regenerative agriculture, as seen in the following quotes:

> *I'm not saying, you know, we can get rid of the downstream flood defences with hard engineering. I think, to an extent we'll always need that. But I think managing our catchments more naturally, and that should probably include beavers, in a lot of places should be part of our management*

> *strategies in the future, you know, so looking at, are there beavers in our catchments (beaver researcher).*
>
> *We can do anything. If it's weed management, if its establishment of a new species on the farm, if we can use an animal and not have to turn a key and start an engine, that's really great, positive. And, you know, the farmer or whoever, doesn't have to sit on a machine bombing up and down a field for four hours wasting his life…[The cattle are] willing partners. They're complicit in the regenerative farming model (regenerative farmer).*

In both instances, the 'unnatural,' human-engineered machinery that would have been traditionally used for these types of environmental interventions—whether it be flood management or agriculture—are judged to be less positive than 'natural' interventions within this Nature-based Solutions frame. In the first quote from the beaver researcher, elements of the nature-based framing come to the fore, highlighting the hybrid nature of some of these interventions. However, '*managing our catchments more naturally,*' with beavers, is made salient as a future goal. In the second quote, the moral judgement appears in the preferencing of an animal—framed as natural (Section 2)—over '*a machine bombing up and down a field*,' an 'unnatural' tractor. As the moral judgement of natural over unnatural becomes a key element of the Nature-based Solutions frame, animals—or nonhumans—are thus enroled as necessary elements of these environmental interventions.

4.a.iv. Suggest Remedies (Solutions):

The final element in the making of a frame is the suggestion of remedies to the problems and causes of those problems identified, that align with the moral judgement carried by the frame (Gamson, 1992 in Entman, 1993). As evidenced by each piece of data above, nonhumans (animals) are inherently woven into the Nature-based Solutions frame. They—as nonhumans rather than individual species—are the suggested remedy to the problems, evident within even the name of the concept, Nature-based Solutions. Framed as the nature (Section 2), even in relation with technologies or humans (Section 3), animals are enroled as fundamental to the Solutions to climate change and biodiversity loss (and their causes) as the morally sound option

of working *with*, rather than against, 'nature.' In both cases of beaver reintroduction and managed grazing in regenerative agriculture, drawing from some of the quotes used above, the animals emerge as the remedies built into the frame of Nature-based Solutions:

> *We're in a biodiversity crisis. With beavers, there's an opportunity to restore a lot of it…we're also a country that is very prone to flooding. And it's likely to get worse with climate change. Beavers are quite a natural approach towards helping with that…(beaver researcher).*
>
> *…we are very supportive of grazing livestock as being part of the climate change solution…(regenerative organisation director).*
>
> *…But I think managing our catchments more naturally, and that should probably include beavers, in a lot of places should be part of our management strategies in the future…(beaver researcher).*
>
> *We can do anything. If it's weed management, if its establishment of a new species on the farm, if we can use an animal and not have to turn a key and start an engine, that's really great, positive…(regenerative farmer).*

As remedies, animals framed as keystone species and producers of nature—if managed correctly and put in relation with the right technologies—are critical to Nature-based Solutions themselves. As made clear from the analysis of this Chapter and from the quotes above, animals are not the full 'solutions' of Nature-based Solutions, but they are posed as the remedy within the framing, what they are and what they do is fundamental to the intervention itself. Beavers *help* with flood mitigation; grazing livestock are *part of* the climate change solution; beavers should be *included* in catchment management; farm animals can be *used* instead of a tractor. What this shows is how nonhuman animals are grouped together, with a focus on their similar keystone capacities rather than their differences and enroled into Nature-based Solutions, not as the full solution itself (nature-based) but as the *infrastructure* of the solution, the being fundamental to the functioning of a NbS, putting to work their material relation with the environment and a replacement for more negatively valanced industrial infrastructure. However, framing animals as 'solutions' to problems is not without consequences. With any framing, it excludes other possibilities, other ways of being for the animals enroled. Further, it

may exclude other ramifications of managing animals in such a way, like the continued emissions from regenerative ruminant grazers (Garnett et al., 2017) or human-beaver conflicts (Auster et al., 2020).

4.b. An Infrastructural Framing

Selected more-than-humans comprise a key element of the broad Nature-based Solutions frame—as providing the 'natural' remedy to human-induced problems. While the next two analytical Chapters explore the spatial and embodied ways in which animals are made to be infrastructure, enmeshed and enfleshed, this section delves into how through Nature-based Solutions, beavers and cattle are framed as infrastructure in the narratives that surround them. As Wakefield (2019) describes in her research on the infrastructuralisation of oysters as coastal protection in New York, animals are not only ordered into being infrastructure, but are narrated into being infrastructure. In this subsection, I trace the infrastructural framing of beavers and cattle, respectively, which builds upon the framings of nature and nature-based to enrol them as the infrastructure of Nature-based Solutions.

4.b.i. Framing Beavers as Infrastructure

Building upon the keystone species/ecosystem engineering frame that characterises beavers as 'natural' agents, the infrastructure frame specifies them as the infrastructure of Nature-based Solutions. This is apparent in the communication of how beavers live, from advocates of beaver reintroduction, to justify the reintroduction of the species within the context of Nature-based Solutions: 'restoring beavers to regenerate landscapes,' as the UK organisation, Beaver Trust's, website reads (Figure 14).

[The image of a beaver on The Beaver Trust homepage originally presented here cannot be made freely available via ORA because of copyright. The image was sourced at https://beavertrust.org/.]

Figure 15: The homepage of the Beaver Trust, an organisation in the UK which manages beavers: their restoration, trapping and relocation, and management, and advocates for their return to Britain through education and policy. Copyright The Beaver Trust.

In this proposition, the beaver is framed as the infrastructure: the subject with material relation to the environment that is organised towards a particular purpose in Nature-based Solutions. The material relation is depicted in the beaver ('nature') amidst the mud, water, and sticks it is known to modulate and manipulate through dam building ('keystone species'), and the human/technological organisation of the beaver and more-than-human relations ('nature-based') is organised under the guise of Nature-based Solutions towards the purpose of regenerating landscapes. This particular narrative demonstrates the enrolment of beavers as Nature-based Solutions infrastructure in the causal, explanatory nature of the rhetoric: restoring beavers regenerates landscapes; the animal is the key to the desired 'solution.' This win-win, co-benefit causal inference made by this frame aligns with Osaka et al.'s (2021) wider framing typology of Nature-based Solutions more broadly, in which the authors found that co-benefits between people and nature is an emergent framing of Nature-based Solutions. Here, the beaver is framed as the infrastructure to unlock those co-benefits, for themselves, the landscapes around them, and humans in these landscapes. By framing beavers as an infrastructural solution

to climate change and biodiversity loss—for regeneration—this narrative acts as an argument for beaver abundance.

This infrastructural frame appears in beaver reintroduction policy documents as well, like in Natural England's Report on beaver reintroduction and licensing, which follows the frame's logic:

> *Beavers may support [nature recovery] through:*
>
> *• Creating and enhancing habitats – through their engineering activities which increase riverine and wetland habitat diversity, thereby increasing biodiversity.*
>
> *• Delivering nature-based solutions – where a more functional ecosystem is potentially able to hold water for longer in the catchment, thereby potentially reducing flood risk, recharging groundwater and neutralising/holding water-based pollutants (Pouget and Gill, 2021, p. 10).*

The policy narrative here frames beavers as infrastructure that 'delivers nature-based solutions:' beavers themselves are not the solution, but the infrastructure through which it is delivered. This frame enrols animals as infrastructure, 'recruited to modify, maintain, or create habitats and act as controls on material flows' (Barua, 2021, p. 14), like water and pollutants.

4.b.ii. Framing Cattle as Infrastructure

Cattle too are framed as the infrastructure of Nature-based Solutions, storied within NbS narratives as bringing about a pastoral 'nature' through their ecosystem engineering, managed and choreographed with technologies and by farmers, and enroled as the infrastructure to bring about environmental solutions. Within this, their 'natural' bodies are enroled in a 'nature-based' system of regenerative agriculture to replace 'unnatural' farming technologies like tractors to provide similar interventions. Returning to a previous quote, one farmer describes the promises of managed grazing of cattle, framing them as natural infrastructure on the farm:

> *We can do anything. If it's weed management, if its establishment of a new species on the farm, if we can use an animal and not have to turn a key and …[The cattle are] willing partners. They're complicit in the regenerative farming model (regenerative farmer).*

Framing cattle against tractors is a key element in the enrolment of animals as Nature-based Solutions infrastructure. Here, the frame draws on the machine in the garden, but goes a step beyond to frame the animals as infrastructure: the modifiers, maintainers, and/or creators of habitats (Barua, 2021). As Mrázek (2002) shares, infrastructure makes subjects and objects—as does this infrastructural framing here. Narratives such as these create animals' subjectivities within farming systems (Holloway, 2007); the cattle are framed as willing, complicit partners—who replace the 'unnatural,' machine (tractor)—to be the infrastructural foundation of regenerative farming, providing benefits to wildlife and farmer alike. An infrastructural framing of animals is significant in that it makes animals in Nature-based Solutions compliant subjects of the intervention—subjecting them to and as the technologies on the farm (Holloway, 2007). This infrastructural frame is thus a political and ethical position taken on by regenerative farmers and organisation directors that presumes a voluntary subject to make claims about the animals' relative welfare and willingness to be subject (Palmer et al., 2023). By enroling animals as infrastructural subjects, their behaviour can be assumed in advance (Wakefield and Braun, 2019), which frames alternative behaviours by an animal subject as working against the production of a morally-good Nature-based Solution.

One key element that emerges in an infrastructural framing of cattle in Nature-based Solutions is a claim of the cost-effectiveness of the animal infrastructure, compared to 'unnatural' alternatives (e.g. Osaka et al., 2021). This is described by a regenerative organisation director:

> *You approach it thinking about your cost structure and trying to work on each cost line and ultimately you realise that grass is free. If you increase your mobbing, you get more grass. And if you give long rest periods, you get*

> *better water filtration, so you get less flooding, you can stay out on grass for longer. So all of these things add up (regenerative organisation director).*

This shows how cattle are framed as a cost-effective infrastructure, producing more 'free' grass, 'natural' pastures. Based on the grazing design[9], he argues, the ruminants can produce 'free' grass for the farm and better water filtration, which then spirals up to further grazing and further productivity of grass. The cattle in this case become the way in which this cost is negated, the infrastructure for growing more grass for the purported carbon sequestration of the Nature-based Solution. This aligns with Nelson and Bigger's (2022) reading of infrastructural nature, considering it an idea which 'shifts attention to the work required to design and manage ecosystems or entire landscapes in such a way that they produce the bundle of services required of them and to invest in their maintenance in the most cost-effective (or even lucrative) way possible' (p. 88)[10]. Framed as the most cost-effective in the indicative quote above, cattle are enroled as infrastructural nature: providing the landscape management and nature-production that comes through a management and organisation of their own bodies by Nature-based Solutions. They are framed as the scaffold through which economic activity takes place, enroled as infrastructural 'nature' that through management and management technologies (nature-based), creates a Nature-based Solution.

5. Conclusion

This Chapter has explored the various ways in which—within the context of Nature-based Solutions—nonhuman animals are framed and how this layered framing works to enrol them as infrastructure. Bringing Goffman's communication framing theory into conversation with more-than-human theory demonstrates how through framing, more-than-human scholars can engage with 'discourse' in a more specific and nuanced way, focusing on the creation of

[9] More in Chapter 5
[10] Drawn out in Chapter 6

arguments, the selection and salience of particular information with the omission of other information, and how more-than-humans are influenced by, and influence, them. My framing analysis, for example, showed how the structurally-dynamic environments that beavers create influence how they then become framed as 'wild nature;' or, how certain novel technologies to monitor, measure, and choreograph cattle on the farm form part of a wider argument for the transition to regenerative farming. Ultimately, by conducting a frame analysis with more-than-texts, with conversations and environments and animals and policy documents, one is able to 'read' the case of animals and/in/as Nature-based Solutions in a different way. Through tracing the framing of the Nature-based Solutions concept itself (following Gamson, 1992), I found that the more-than-human—in my cases, animals—are foundational to the very concept itself: they are written into the very structure of Nature-based Solutions, and this fundamental connection thus justifies my further inquiry.

Through the different layers of framing I traced through this Chapter, beavers and cattle become discursively *enroled* as the infrastructure of Nature-based Solutions. Their presence in different Nature-based Solutions projects is constituted by the ways in which the animals are framed as 'natural' keystone species and/or ecosystem engineers, thus justifying their management by humans and certain technologies that are deemed acceptable in this post-natural space of 'nature-based.' As Nature-based Solutions are themselves framed as requiring a more-than-human remedy to the natural problems of climate change and biodiversity loss, animals that are deemed to be natural—that fit into, or are framed within, the roles of keystone species/ecosystem engineers—are able to be framed and enroled as the infrastructure of Nature-based Solutions. The animals framed in this way are done so for their material relation with the environment—their infrastructural capacity—and this framing as infrastructure enrols them as infrastructure. I purport beavers and cattle are not infrastructure if their lives are not

organised towards particular purposes (following Larkin, 2013 and Berlant, 2016), but communicative framing is one of the ways in which the concept of Nature-based Solutions organises more-than-human lives. Real animals in real projects are enroled as infrastructure through framing; rhetoric has material effects.

Now this Chapter has shown that the more-than-human—including nonhuman animals—is fundamental to the functioning of Nature-based Solutions, enroling them as infrastructure discursively, the following Chapters explore the more material effects. The next Chapter explores the spatialities of the 'nature-based,' how the choreographed relations between beavers, cattle, fences, and humans enmesh animals as the infrastructure of Nature-based Solutions. Then, the final analytical Chapter zooms in even further to individual (and family or herd) animal bodies to illuminate the process of enfleshment: how Nature-based Solutions enflesh beavers and cattle as infrastructure through metabolic, probiotic, and reproductive labour to produce environments. It all begins, though, with the concept of Nature-based Solutions and how animals are enroled into it, necessary for the concept itself.

Chapter 5: Enmeshment

More-than-human relations as choreography

1. Introduction

> *There was a fence around the five-acre, Natural England-approved enclosure, with a skirt of wire netting and a grate through which water could run, but beavers could [should] not. However, the beavers here break out 'all the time,' doing 'beaver things' to enhance riparian biodiversity and water management outside the human-selected space (From field notes, 2021).*
>
> *Standing in a 'mob,' noses just inches away from an electric fence, a herd of Herefords on a National Trust tenancy farm made it known they were ready to leave this pasture for the next, their mooing and rustling making human to human conversation inaudible, if not impossible. These particular cows, and their movements, are key within the emerging practice of regenerative agriculture (From field notes, 2021).*

This Chapter considers the second process through which animals are constituted as infrastructure: *enmeshment*, where animals are enmeshed with different forms of human-created infrastructure through their interactions, uses, and reappropriations of such infrastructures (Barua, 2021). Both the anecdotes opening this chapter animate another way in which nonhuman animals come to be (RQ1)—and come to be known as (RQ2)—Nature-based Solutions (NbS) infrastructures. As NbS are place-specific—only 'solutions' in some places—there are some environments in which these animals' presence and actions would be seen as 'unnatural' or 'problematic.' Thus, NbS require fences to hold the 'solution' in place, enmeshing fence with animal to make infrastructure. However, the process by which this enmeshment happens, the emergent relationships between humans, animals, and technologies in these places, and the significance of such requires further interrogation. Thus, building from Chapter 4, we return to Ballestero's (2015) concept of 'infrastructuralising,' questioning how something is made to be infrastructure, and draw from Star's (1999) foundational tools of infrastructural ethnography, exploring how the creation of infrastructure is both relational and

ecological. I 'lay bare the wires, pipes, and foundations' in an infrastructural inversion (Bowker, 1994 in Hetherington, 2019, p. 7) to understand how enmeshment occurs and what it does to those animals involved. As the primary human-created infrastructures with which beavers and cattle both come into contact with under Nature-based Solutions are fences, or fencing systems, this Chapter considers the different ways animals enmesh/are enmeshed with fences to become infrastructure. With infrastructure defined in this thesis as, material relation to produce, and reproduce, organised practices, the analysis in this Chapter focuses primarily on the former part of the definition, the material relation. How is this material relation (enmeshment) between animals and fences understood, influenced, choreographed into being?

I begin with a discussion of the materiality of the different types of fencing most often used in these different Nature-based Solutions interventions. Acknowledging there are heterogenous ways of holding a Nature-based Solution in place, or making it move, I describe in detail typical fencing arrangements for beaver enclosures—with (semi) permanent fencing designed for beaver containment—and managed grazing—with mobile, often electric fencing that can respond to changes on the farm or changes with the cattle. These different fences are made and choreographed, in material relation to the animals enmeshed with them (Hawkins and Paxton, 2019; Netz, 2004) to produce, and reproduce, the Nature-based Solution.

The Chapter then turns to discuss three ways in which this animal-fence enmeshment materialises as distinct from enclosure, tracing these steps as the start and continuation of an embodied, negotiated more-than-human choreography between animal bodies the fences determining their spatialities and the humans managing these NbS mobilities. First, I discuss how fencing and animals come to know each other through learning (or training via human) each other. This begins with learning containment, but also learning each other's materialities

as a first step in choreography. Second, going beyond fencing as simply an infrastructure for containment—as in most more-than-human studies (e.g. Hawkins and Paxton, 2019; Poerting, 2023)—I discuss the second step in a choreographed encounter, introducing movement and mobilities. This element of choreography is discussed in relation to symbiopolitics (Helmreich, 2009; Lorimer, 2020), in which governance shifts from containment of an animal to a governance (or choreography) of ecosystem relations. However, these symbiopolitics—or animal biopolitics more generally—are not unidirectional from the human/infrastructure to the animal (Asdal et al., 2016). Thus, thirdly, I consider the animal enmeshment with fencing as something which allows for more-than-human emergence within the experimental partnering between human, animal, and fence (Roe and Greenhough, 2014), where the animal agency resists or exceeds the expectations of human design: human and animal bodies both move and move each other to create space (Laban, 1966 in McCormack, 2014). Drawing these three observations together I thereby argue infrastructural enmeshment is not just a call and response from different actors at different times, but a coming together, an attunement (Frischkorn, 2023), and a circulatory negotiation between bodies: a more-than-human choreography.

2. The Materiality of Fences in Nature-based Solutions

In the cases of beaver reintroduction and managed grazing of cattle in regenerative agriculture, the primary technologies that ensure NbS are operating in the intended way, in the intended place, are different forms of fencing. Fencing is used to enclose the animals in the case of beavers, and both enclose and move the animals in the case of cattle. Here, I ground this enmeshment of animals with fences in the materiality of those I encountered. As NbS are place-based (Seddon et al., 2021), particular interventions, including those of the same category in different places, are materially different. Additionally, fences are made themselves in relation to the animals they are designed to contain (Hawkins and Paxton, 2019). Due to the relative

positions of the different animals in Britain (Chapters 1 & 4), each NbS has distinct regulations and norms governing the ways they can, or should, be created, managed, and regenerated. This in turn affects the fencing *of* the animals, the fencing technologies employed, and animal-fence relations.

2.a. Fencing a Beaver Enclosure

As described in Chapter 1, beavers are undergoing a reintroduction of their species to Britain, as Nature-based Solutions. In England, including at most of the sites I visited, DEFRA requires beavers to be reintroduced into Natural England-licensed, fenced enclosures, which are usually under 20 hectares (Figure 15) (Pouget and Gill, 2021; DEFRA, 2021).



Figure 16: Drone image of a licensed beaver enclosure in England, where the enclosure fence clearly delineates the enclosed wetlands from the surrounding pasture. One clear line of fencing is visible. Copyright Alan Puttock, University of Exeter.

Natural England justifies the fencing of beavers in their report on beaver reintroduction and licensing as such:

> Although, outside of zoos and wildlife parks, no other native species is ordinarily kept in enclosures in England, unlike established species, the potential impacts of beavers on their environment can be significant and are not yet fully understood for England. It is therefore accepted that enclosures can be used to aid this understanding. Enclosures should also be considered where beavers may have a localised benefit but their release into the wild would result in unacceptable negative impacts (Pouget and Gill, 2021, p. 19).

Part research—assessing their flood alleviation, restoration, and biodiversity impacts—and part education—teaching publics the values of rewilding—these beaver enclosures have been erected in (now over) 20 sites across England, requiring licensing by Natural England before construction begins (Pouget and Gill, 2021). As one beaver site manager shared, it's important for their enclosure to *'tick all the boxes'* of Natural England, as there are regular compliance checks.

As beavers are highly mobile species (Campbell-Palmer et al., 2016) and fences are permeable by animals (e.g. Poerting, 2023; Roe and Greenhough, 2014), there are often escapes of beavers from these licensed enclosures. 'Despite robust fencing, beavers have escaped from enclosures on multiple occasions and it has been difficult and, in some instances, impossible to trap them,' reads the Natural England report (Pouget and Gill, 2021, p. 20). Thus, with beaver escapees and human-assisted 'beaver bombings' (illegal releases), not all beavers in England are enclosed, and there are established beaver colonies in multiple river catchments (e.g. Crowley et al., 2017). Further, Natural England requires proof of intention for a future wild release of beavers in a given enclosure; the enclosures, and the fencing that does the work of enclosure, thus are known as a temporary solution (Pouget and Gill, 2021). However, removal of the fencing of an enclosure has yet to occur. While this Chapter focuses on the fencing technologies of beaver enclosures, and thus focuses primarily on those places in England, I note that

Scotland and Wales have distinct regulations surrounding beaver reintroduction and whether or not fencing and enclosure is needed, as specified in Chapter 1[1].

Here, I describe the materiality of a 'typical' Natural England-licensed enclosure fence, an amalgamation of the multiple I visited in the course of data collection. Often, the first thing I noticed about an enclosure was the fence; it's the first thing one encounters before entering the beaver-created wetland. It must be tall enough, so that beavers are not (easily) able to climb over it, and made of materials which beavers cannot chew through. While Natural England provides guidelines for fencing an enclosure—and ensures planned enclosures meet their standards for beaver containment—they do not dictate exactly what methods or materials to use. Thus, the Beaver Advisory Committee for England (BACE) provides fencing guidance on their website (2024). For BACE, an enclosure should consist of:

> 7 ft (2.13 m) "cundy" peeled posts set on the outside of the fence opposite to the beavers, sunk 90 cm into the ground and standing 1.2 m above the surface. Three inch (7.6 cm) squared high tensile wire at a height of 1.2 m is strained across the posts. At a height of 90 cm and a 30 cm broad strip of smooth fibre glass or sheet tin is hog ringed to the internal wire. Along the base of the fence a 2 inch (5 cm) weld mesh curtain extends into the enclosure for 90 cm. This curtain extends up the perimeter fence to a height of 30 cm and is hog ringed to the fence. Where straining posts are set on the internal side of the fence these must be protected with 2 inch weld mesh guards. If burrowing is perceived to be an issue then this basic fence can be adapted by extending a 2 inch weld mesh curtain extends down into the ground to a depth of 1.2 m.

Most enclosures I visited had a fence built similarly to the one described by BACE. In Figure 16, one can gauge the immense height of the fence, with the peeled fence posts set outside the squared high tensile wire meshing. In the enclosure where I took this photograph, the site managers opted for a mesh curtain extending into the enclosure, rather than into the ground, and it is clear how far it extends into the enclosure, though it begins to blend with the grass.

[1] With legal protection for beavers since 2019, Scotland does not require beavers to be fenced (Pouget and Gill, 2021), and Wales has not yet started their formalised reintroductions (Wales Beaver Project, n.d.). In Scotland, and in England with the unenclosed beaver populations, beaver colonies are still often carefully regulated and managed, outside pens (Crowley et al., 2017; Ward and Prior, 2020).



Figure 17: An example of a licensed enclosure fence with a curtain of wire mesh in the enclosure to prevent beaver escape through burrowing. Other fences have the curtain as subterranean, if needed, but that requires extra resources. Author photograph.

Walking the fence line, one would eventually come to a place in the fence where the river or stream entered or exited the enclosure. Because burrowing in wet soils is easier for beavers, BACE (2024) recommends setting fences 30 metres from any bank. But, when the stream enters or exits the enclosure, there are material fencing adjustments. As seen in Figure 17, there is special steel grating that covers these places: bars spaced wide enough for some mammals and fish to travel through, but not wide enough for beavers to do so. These are often reinforced

with extra fence posts, and checked by human site managers often as a common place where beavers may dig to escape.



Figure 18: A licensed enclosure fence across a stream entrance or exit to an enclosure, with a reinforced grate over the stream. Author photograph.

Of course, while BACE (2024) recommends most fencing be set back from banks, these banks constantly change in beaver enclosures. As many of the site managers and beaver researchers told me, the hydrology and landscape within the enclosures may look wildly different from one visit to the next, even within a few weeks. An example of this change can be seen in two drone images of the same site, taken a few years apart, with differences in canopy cover and surface water spread (Figure 18). Thus, with this surface water spread, the distance between fence lines and banks when the fences were built at the start of the enclosure (Winter 2020) are going to vary significantly to those distances a few years later (Autumn 2023), as the beavers spread the water with their dams, acting as intended in the enclosure, but disrupting the fences built to contain them.

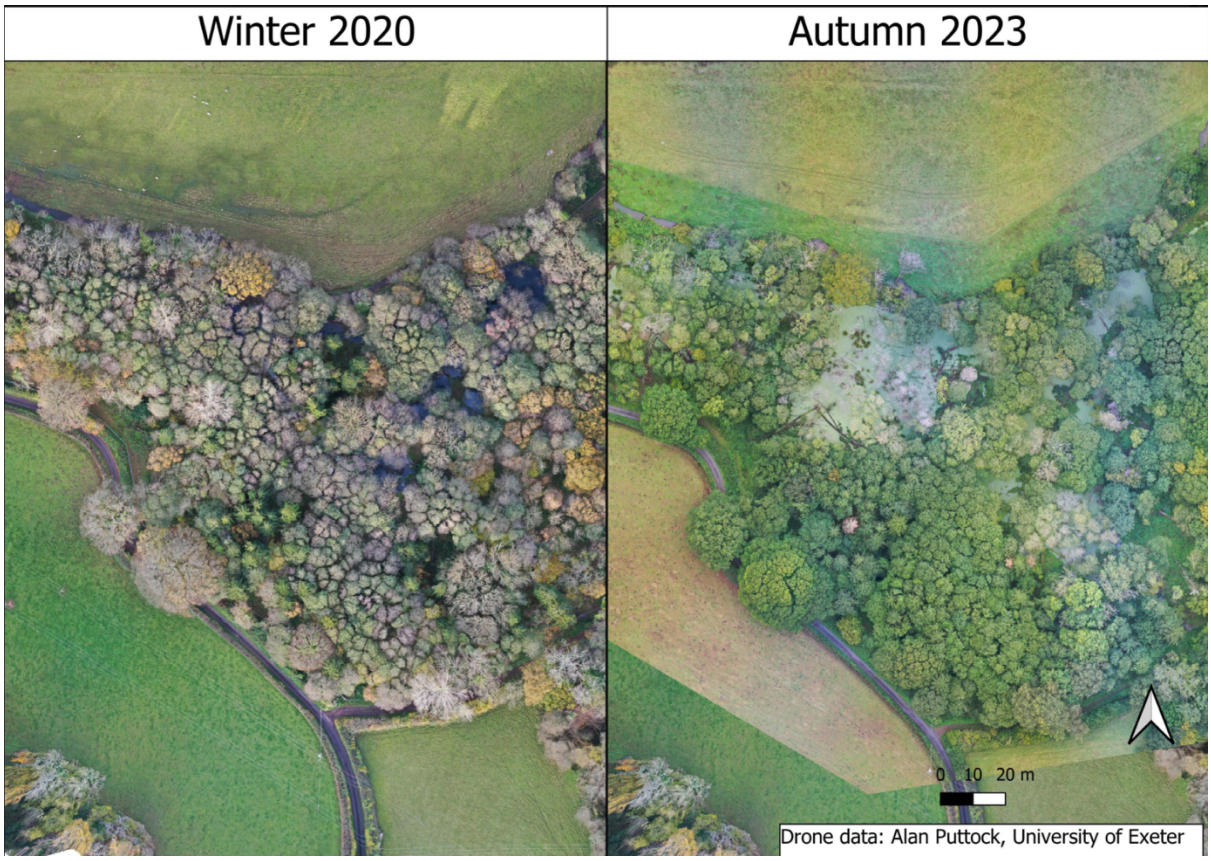


Figure 19: Side by side drone photographic comparison of the same beaver enclosure, a few years apart. Copyright Alan Puttock, University of Exeter.

2.b. Manag(ing) Regenerative Grazing

Fences play a different—yet critical—role in managed grazing on farms using regenerative practices to build soil organic matter, enhance biodiversity, and sequester carbon in grasslands (Swartz 2013; Rodgers and Wolf 2020). As explored in previous Chapters (1 and 4), cattle also hold unique positions in Britain, their bodies, commercialisation, and the fenced land enclosures to hold them having shaped British landscapes (Christophers, 2018; Velten, 2007). However, in this shift towards managed, rotational grazing as a NbS practice, fences once again become important in shaping the landscape, moving cattle from one pasture to the next, within the bounds of a farm. Thus, the fencing needs to often be easily movable, light, and impermanent; electric fencing fits those specifications (Figure 19).



Figure 20: A regeneratively-grazed herd of Hereford cattle behind a single-wire electric fence which delineates the cell's boundaries. Author photograph.

Fences—both adaptable and grounded—play a key role in choreographing the movement of cattle in managed grazing. As one regenerative farmer stated, *'ironically, it was fences that kind of destroyed [the environment]. We're using fences now to try and emulate what was going on before.'* For this farmer, this new use of fences becomes a modern fix; fences enclosed land, causing environmental problems, but now can be utilised within the bounds of certain enclosed lands (farms) to recreate the 'natures' of the past (Chapter 4). As another regenerative farmer shared, they use fencing to *'dictate where and for how long'* the cattle graze.

While I have mentioned electric fencing as common in regenerative agriculture, there are other tools and fences that plan, choreograph, and instigate such grazing movement. Like in the beaver fencing section above, I will describe the materiality of these different fences as I encountered them on the multiple regenerative farms I visited. With electric fencing (the most common in regenerative agriculture in Britain), I noted its use due to its adaptable capacities, constantly set and reset by the farmers to create new 'cells' or fields for the cattle to graze. On most farms, no more than two or three cells would be set at one time, ready for the immediate moves. Electric fencing is preferable for regenerative grazing, as a farmer can respond closely to the weather and the landscape conditions, with one farmer promoting their fencing as *'permanent-temporary'.* As many farmers demonstrated, they could easily adapt some of their fencing technology to respond to the cattle's grazing activities, heavy rainfall or drought events, and landscape features on their farms. To some—especially those with ATVs—the creation and recreation of cells, setting the electric fence lines are made easy (Figure 20).

[The image of an ATV with KiwiTech electric fencing technology originally presented here cannot be made freely available via ORA because of copyright. The image was sourced at https://www.nfuonline.com/updates-and-information/electric-fences-what-are-the-options/.]

Figure 21: An image from the National Farmers Union (NFU) website, depicting the typical installation tools for Kiwitech, a brand of electric fencing.

Once the electric fence is set, in whichever shape decided by the farmer and the constraints of the environment, it can be turned on—through mains or battery (with the possibility of solar) power. Because of their rising popularity, the National Farmers Union (NFU) published an explainer on electric fencing on their website (2023):

> An electric fence is a large open circuit waiting to be closed. An energiser sends a high-voltage pulse of electrical energy through wire, tape or rope at short intervals. The animal (or human if you're unlucky) gets a shock when its electrons complete the circuit travelling from the energiser along the wires and through them to the ground. These electrons then pass through the soil to the earthing system and back up to the energiser. Electric fences run on a high-voltage, low-amperage system, meaning they deliver a pulsing shock that allows the animal to back away unharmed and not be fatally injured.

According to the NFU (2023), over 7,000 volts is enough to contain beef cattle, and after the cattle learn the fences contain voltage, they act as more of a mental block than a physical one, as analysed in Section 3.a. below.

Often intermixed with the electric fencing systems are more traditional, permanent fences, sometimes acting as a constant wall for cells made from electric fencing. Other times, this permanent, or grounded, fencing was living, in the form of hedgerows or silvopasture (Figure 21). Hedgerows, when managed regeneratively, *choreographed* to grow in ways conducive to regenerative farming, provide corridors for wildlife, bird food, insect habitat, pollinator opportunities, connectivity over and between fields, and contribute to biodiversity gain (Jose 2012; Levin, 2022). In relation with the cattle, hedgerows also act as windbreaks or shelter (Jose, 2012) and provide browsing opportunities where cattle can self-medicate on the diversity of fodder. Like with the permanent, traditional fencing, hedgerows will sometimes act as the back wall off which electric fenced cells can be built. Similarly, silvopasture—or the integration of trees with grazing livestock—can act as fences. Figure 21 depicts a newly-planted silvopasture system, each sapling in a white tube, where the grown trees will act as the side walls for strip rows of grazing.



Figure 22: An image of planned cells of silvopasture for managed grazing at a regenerative farm, where each row of white posts contains saplings. These are expected to grow into walls, and cattle will graze about one row per day. Author photograph.

3. Animal Infrastructural Enmeshment as Choreography

The materialities of the fencing described above are made in relation to the animals they are desiged to affect (Hawkins and Paxton, 2019; Netz, 2004). The human beaver site managers and farmers use fencing to move the animals, determining their desired and undesired mobilities (Thompson, 2002), enmeshing the two to govern the ecosystem relations for probiotic performance. Still, the fencing—and animals' enmeshement with it—allows for, and sparks, more-than-human emergence, as I read choreography not as a one-way dictation of movement (Lepecki, 2007), but as a world-producing technology, 'a choreography of worldly arrangement expressive of rather than reductive of difference' (McCormack, 2014, p. 171). This section traces these three assertions through the cases of enclosed beaver reintroductions and regenerative grazing with fences. It reflects on this infrastructural enmeshment as

relational, but not apolitical, as a more-than-human choreography which begins with learning/training one's partner, shifts to moving a partner—or partners—with a body or technological extension of a body, and continues with a response of emergence, making a co-choreographer.

3.a. The Encounter: Training/Learning Containment

An embodied starting point of enmeshment of animals and fencing infrastructure in NbS is learning: an education, a training, an encounter in, for, and with the fencing system. As Netz (2004) shares, animals must *learn* fences through bodily encounter, particularly when engaging with a new (to them) fencing technology. They learn the materialities of the fences, and their limits. Sometimes, human training is required, training the animals how to engage with the fences, and often, how to be contained. These human subjects of choreography are attuning the animals to the fencing and to themselves as trainers, while also responding to the animals' learning of the fence as cattle break out and beavers escape. As I untangle these dynamics of learning to enmesh with infrastructure, I consider whether the force upon bodies fences create is inherently violent, as Netz (2004) contends, or whether there is an appropriation of the fencing for uses *by* the animal, nonviolent and novel (Søraa and Vik, 2021). Further, this force is applied in parallel: 'just as the materiality of technology (the fence) has become an insistent force in the world of animals, so the materiality of animals has become an insistent force in the world of technology' (Thrift, 2005, p. 201). Thus, in this section, I consider the two-way start of enmeshment of animal and fence: the animals not only learn the fence, but the fence also is materially changed by the animal. And, I consider the ways in which this represents the start of a choreography between animals, fences, and humans (trainers), the start of a more-than-human attunement (Frischkorn, 2023).

Not all learning/training is the same for all animals; the species, individuals within the species, and material fencing systems themselves matter for the encounter, this first step in choreography. Thus, I split this section between my two case studies, starting with cattle and electric fencing and hedgerows, then thinking with beavers and enclosures. As will become clear, whether animals find themselves blocked, shocked, or fed comes to matter.

3.a.i. Cattle Trained to Electricity

I begin with the shock, the affective result of coming into contact with 'live' electric fencing, often used in the managed grazing of cattle. For the young, or those animals not yet exposed to electric fencing, learning the force of the technology includes a moment of violence or pain, as they feel the shock and thus learn the fence.

> *Some of these cattle have never witnessed—like never experienced electric fence before, and within a week or so, you know, they soon understand as long as you've got good power down the farm (regenerative farmer).*

Good power—the force of the fence (Netz, 2004)—is defined in the case of electric fencing as enough to teach the animals quickly (within a week or so) what that fence line means. As described in the materiality of electric fencing, this often is above 7,000 volts of energy, enough to affect the animal—mentally—but not enough to cause perceptively physical harm. The fence must be learned as a mental barrier rather than a physical one (NFU, 2023). Indeed, if a cow/bull/heifer/steer pushed on the electric tape, its body would be able to physically snap it. However, the learned shock—especially in the first instance of animal-fence contact—creates that barrier. The farmer's reflection on the cattle encountering the fence for the first time shows how there is an ideal temporality of this stage of enmeshment, timeliness privileged so that the animals can begin their 'work' in the determined places, become the matter moving matter (Larkin, 2013), rather than being the matter moved. Thus, the power asserted by the fence

(through its voltage) is critical in the first week—in the first encounters to encourage a particular kind of continued encounter, a start to enmeshment; the power must be strong at first, then can be reduced once the cattle are trained (NFU, 2023).

To increase the speed of this learning process between electric fence and cattle, farmers sometimes enter the relation as trainers. This usually entails 'training' the cattle to fear the electric shock, the affective sensibility thus enabling easy movement of the cattle from demarcated field to field (Section 3.b.i.). Training, understood in animal geography as a process of attuning to other species (Game, 2001), shaping one another if asymmetrically (Fox et al., 2022), includes technologies (Game, 2001). Describing the way in which they train their animals to respond to electric fences for managed grazing, one farmer shared a story which includes sheep, rather than cattle. However, she noted it is indicative of a way in which ruminant livestock, including cattle, can be trained:

> *Everyone goes, how you keep the sheep inside the electric fences? You've just got to make them really buzz when the lambs are little because the lambs will try their luck, and if they can ping through the fences, then you've had it with them…It's a mean thing we do, but it does work, as we will put a chain on the lamb…don't know if you've ever hit electric fence when holding something metal. It doesn't have to happen much for that to work, you know.*

Here, the training method used increases the force of the fence for the initial encounter, building the aforementioned mental barrier that an electric fence specifically provides. In this anecdote, the force upon bodies exerted by the fence contains violence (Netz, 2004), the fear of the fence critical to its effectiveness. An electric fence without electricity and without the fear trained into an animal is simply a piece of tape. This training method is nuanced, however, in that greater force in the first instance, leads to fewer points of 'violence,' fewer shocks in the long term, as the lamb learns the fence with the training enhancement of the chain on (usually) the first attempt. It is a harm to prevent future harm, the temporality of training shortened to one

instance, in a prevention of continued 'violent' animal-fence enmeshment. It is a choreographed moment by the trainer to guide future engagement—beginning the 'dance' through an affective engagement between animal and fence. As Giraud and Hollin (2016) write, affect can be manipulated; training, in 'enhancing' the affective experience of a shock to encourage particular behaviour from the animal, is a manipulation to encourage containment. In this case, the training is not necessarily one species attuning to another (Game, 2001), but rather the process of attuning a species to a technology, a fencing infrastructure, so that they may become enmeshed.

Through encounter, or enhanced encounter via training, the fence becomes not just a boundary, but a reality-generating device (Hawkins and Paxton, 2019), creating an 'ecology of fear' sought after in regenerative grazing to choreograph the animal-fence enmeshment. The shock of the fence significantly influences the continued animal-fence enmeshment from the first encounter, setting the tone for the choreographed relation. As Hillenbrand et al (2019) argue, an ecology of fear created by the presence of wolves on the premodern grasslands is what prompted free-ranging herbivores to graze intensively while moving from place to place, in ways thought to increase biodiversity and build soil organic matter. One regenerative farmer said:

> *The bull is terrified of [the electric fence]...if he's being really stubborn, you can't move him, you just hold a bit of tape near him, he'll move.*

In learning to be fearful of the electric fence, the bull is transported into a new ecology of fear—not one in which they fear being eaten (by wolves at least), but one in which their fear of the fence's force is what moves them, as the farmer and fence *play* wolf. As Lorimer (2020) notes, the ecology of fear cannot be fully replicated without wolves; thus, the fence and its affect stand in for the predator. The fence itself goes from being something for which animals need

training to something used as a training tool to learn how they are meant to be moved/meant to move in NbS (Section 3.b.). This supports Holloway's (2007) claim that technologies affect what animals are expected to do and be—in their containment, they are both made into subjects *and* subject to the fencing. This act of fencing, creating animal subjects who learn (or are trained) to be contained, is a biopolitical practice (Poerting, 2023), which affects the human-animal relation. The human holds more force, when holding the fence, governing the movement of the cattle, leading the choreography, or in Lepecki's (2007) concept of choreography, regulating the animals' movement. This regulation can occur because of the encounter between animal and fence and the learning/manipulation to be affected. In cattle's embodied encounters with a shock, enmeshment begins to occur between flesh and fence.

3.a.ii. Beavers Learning Enclosure

Given the difference in fencing technologies and difference in animals, beavers reintroduced into beaver enclosures built with high tensile wire and fence posts learn the fencing differently to the cattle. Likewise, the beaver site managers witness this beaver-fence encounter differently, as most beaver activity occurs outside human presence. Beavers learn the fences by pushing against their force—their initial encounter with the fence, the first step of a relational choreography, is often in resistance. They push against a fence's bounds to understand the relation. One beaver site manager reflected upon the ways the beavers she reintroduced to the site would begin their interaction with an enclosure fence, starting with resistance:

> *[Escape would] be easy for them. You're digging the fence into the sorta bank, they [would] sort of dig underneath it.*

Even with the wire mesh curtain and all the protections against escape recommended by Natural England, described in Section 2.a., digging is one way in which the beavers engage with the fence, beginning their choreographed encounter. They learn the bounds in which they are contained by testing them. As Søraa and Vik (2021) shared, in learning fencing technology, animals (goats, in their case) will encounter it, then test its limits, learning new ways to interact with the fence.

With beavers, these tests were often noticed by the beaver site managers around the 'weak' parts in the enclosure. The spots learned to be 'weak' by the beavers were often around the grates allowing water to enter and exit a beaver enclosure, and those were the points at which I was shown the most beaver activity by site managers. The same beaver site manager from above directed me towards signs of beaver activity next to one of the grates across water flow, showing me beaver foot prints and signs of digging (Figure 22). The site was described to me as a point where the beavers identified a potential limit of the fencing system, experimenting by digging next to the grate, leaving an additional pool of water. As the beaver manager assured me, the human team would be monitoring that place to prevent escape, as the beavers—and the human managers as well—learned and negotiated the fencing, learning to *be* in relation to it.



Figure 23: Signs of beaver encounter with the enclosure fence and grate. On the left is the zoomed out picture, depicting digging to the right of the grate and beaver prints. On the right is the image zoomed to better show the prints and result of digging. Author photograph.

As Hawkins and Paxton (2019) write, fencing infrastructure can bring out certain qualities in animals, like the desire to escape the bounds into which they're placed. In this case, the fencing and the humans responding to escape attempts together act as fencing technology to hold the beavers in place, but the beavers' interaction with the humans is mediated through the fencing technology. It is the start and continuation of a mediated choreography, different to that of the cattle in that the block of containment is not so much mental as physical; the continued 'work' by the human beaver site managers monitors and prevents escape. Thus, not only must the beavers in NbS learn the fences, but they too must learn the human. The described beaver learning encounter with the enclosure fence line shapes the beavers' mobilities, their embodied experiences in the world (Hodgetts and Lorimer, 2018). They are encouraged to learn their world is smaller than their ethology tells them, yet their escape-driven encounters with the

fences often continue. Driven by the sound of running water, beavers are often mobile, moving up or downstream to dam further (Campbell-Palmer et al., 2016), but in their encounter with the enclosure fence—and the ensuing enmeshment which has beavers contained to a particular place—changes that.

As beavers and cattle learn/are trained with/by the fences and human intermediaries in different ways, there is a convergence of force (via the fence) and value (via the 'keystone species') in patterns of movement, making 'structure' (Berlant, 2016). The animals, learning to be contained subjects, are not only contained to create stillness, but they are contained in order for their movements to be choreographed/to capture the probiotic choreographies of their environments. Movement emerges in Game's (2001) concept of entraining, as multispecies bodies attune to each other's rhythms. Thus, in the making of animal infrastructure via enmeshment, training extends beyond learning fences, to learning rhythms mediated by and with the fences. Thus, we turn to the second step of animal-infrastructural enmeshment with fences: facilitating probiotic mobilities.

3.b. Facilitating Probiotic Mobilities

Once the fences are learned by the different animals, a more-than-human choreographed engagement begins, as bodies and fences are organised in space to create more-than-human movement and worlds alike (McCormack, 2014). Nature-based Solutions seek to capture the world-making of 'keystone' animals—their choreographies of environmental elements from water to soil—through fencing them in place (beavers) and making them move with fencing (cattle). This next stage of enmeshment demonstrates more-than-human choreography between human, animal, and machine (fence) as an everyday, embodied, and performative 'experimental partnering' which occurs between beings and things (Roe and Greenhough,

2014), in motion. In these NbS projects, we see a managed circulation of both human and animal bodies, made to move or held back for desired or undesired forms of animal mobility, with a human-led attempt for a 'controlled decontrolling of ecological controls' (Lorimer, 2020 p. 107). There is an attempt through this to capture everyday circulation, and the patterns, habits, and norms existent between the farmers, cattle, beaver managers, beavers, and different fencing systems to create infrastructure (Berlant, 2016).

3.b.i Choreographing cattle mobilities

Considering first the choreographed movement of animals' bodies by humans and fences, I turn to the practice of managed grazing, the rationale, movements, and fencing technologies described best by a regenerative farmer as we stood in front of his herd of cattle:

> *With the mob grazing, it's quite a grand description isn't it, trying to say that you're recreating the bison moving across the Great Plains, because we're basically, we're the hunter and they're the prey, and we're pushing them and they're moving [with] the electric fence. We're moving them around the farm in this group and keeping them in a tight group. So again, they're trampling the grass and putting organic matter into the soil and storing carbon, and building soils, healthy soils. So in a way, we're trying to mimic a natural process…It's also forcing them to pick at what you've given them. But they'll pick the nice bits, you see, if I'd just turn them out into the field, they'd go straight back up to the top and graze where they were 10 days ago, because there's some nice fresh shoots up there. But, by giving those fresh shoots the chance to grow, we're growing more grass and feeding them more sustainably longer term. And again, if they were wild and they were moving, they wouldn't go back up where they were 10 days ago. They'd keep on moving.*

This quote is key to understanding the choreography of cattle's movements on a farm using regenerative grazing practices. It nods to the rationale, creating a 'regenerative' ecology of fear on the farm, learned through the cattle's interactions with/training of the (often electric) fence, which moves the grazing animals. With the farmers mapping the grazing route, often adaptable in response to weather and grazing patterns, they use the electric fencing to move the cattle's

bodies to *'mimic a natural process.'* Like Laban's (1966) choreography, the farmers are moving the animals in a way that 'naturally' makes sense. Does it make sense to the cattle though? As described here, the cattle on a farm—considered domesticated, not wild or natural—would choose to move their bodies otherwise, consume otherwise, breaking from the human-determined choreography. However, as the fencing technology holds force (Netz, 2004), the animals are made to move. This enmeshes them with the fence, bringing out the desired qualities of the animal (by the farmer) (Hawkins and Paxton, 2019), to enmesh them with NbS infrastructure for soil health.

This choreography of cattle mobilities—by the fences and farmers combined—can be analysed through Lorimer's (2020) concept of probiotic symbiopolitics. Choreography thus is a way through which entangled relations between more-than-human elements of an ecosystem are governed (Helmreich, 2009). Drawing on the above quote from the regenerative farmer, symbiopolitical governance focuses on the mobilities of the keystone species, the cattle, on the circulations of their bodies (Lorimer, 2020). As another farmer described, her regenerative grazing concentrates on the movements of cattle, choreographing their bodies with the fences the cattle have come to, or been trained to, know:

> *A lot of times we do have to force [the cattle] to do things, to graze certain areas, and they will happily once they're in there….they'll be like 'uhh', if you set stock them, they would just leave it. If you put a[n electric] paddock round it, they eat it.*

Through NbS' enmeshment of animals and fencing infrastructures, animal movements are choreographed, becoming animal mobility, with the intention of capturing desired animals' mobilities that can be 'provoked' (Hawkins and Paxton, 2019) within particular spatial bounds. The cattle mobilities the regenerative farmers seek to capture through this choreography are their consumption (of the right grasses, in the right places), their rumination, their hoof pressure

on the soil, and more, explored in depth in Chapter 6. Choreography is, from the human, a symbiopolitical determining of the animals' 'appropriate movement […] through space' (Thompson, 2002, p. 175). As Thompson (2002) writes, whether that mobility is desired or not will determine an animal's fate and the relative regulation of their body.

However, this determining of where it is appropriate for the animals to move is not only top-down, biopolitical governance from the human to the cattle. Rather, a key element of more-than-human choreography is a multispecies attunement (Frischkorn, 2023), where bodies come together in movement that expresses difference (Lefebvre, 1991 in McCormack, 2014). For example, one regenerative farmer shared the cues he receives from the landscape that determine his next step, his next (choreographed) move:

> *[I take] observational cues, like, when's the right time to move them. Have they been too long, have they not? Is this shape and size of the cell in front of them the correct shape and size of what you're trying to achieve? Because if when you move them out of yesterday's cell, you know, if it didn't look like how you wanted it to, if there wasn't enough trampling, or if they over grazed it…*

Thus, the choreography is a back and forth, done in response by the farmer to the responses of the more-than-human environment: the cattle, the trampling, the grass height. This responsive choreography is made possible by the movable, electric fences. For example, if the ground is too wet, where hooves will pierce the ground and damage the root structure of desired pasture, the farmer will adjust the grazing plan, benefitting the ultimate goals of the NbS in retaining root structure while benefitting cattle's hoof welfare. Thus, human-animal relationships become mediated by the fences, also redefining the farmer's role (Holloway, 2007) from cattle farmer to carbon farmer (e.g. Cusworth et al., 2022). The fencing technology enables the choreography; the choreographed movement makes infrastructure (Berlant, 2016). It is this improvisational element that really defines this stage of infrastructural enmeshment as

choreography—in constant, circulatory response to another's body, movement, and mobility, mediated or bounded by fences.

As Hawkins and Paxton (2019) write, by erecting fencing infrastructure, there is an intention to provoke natural—improvisational—arrangements within the fence boundaries. I argue such a provocation is a bodily move in more-than-human choreography, an invitation for a response, which then prompts another response from the 'natural' arrangements which emerge (more in Section 3.c.). Returning to enmeshment as a symbiopolitical intervention, the choreography of the cattle by the farmers and fences governs the wider environment of the farm, through strategically deploying keystone species (Lorimer, 2020), in motion, but the governance is not limited to the humans. Humans are not the only ones to exert biopower (Asdal et al., 2016; Hinchliffe, 2016); what happens after provocation is a response, but also itself a provocation in the other direction.

3.b.ii. Choreographing Beaver Mobilities

The choreography of beaver mobilities looks significantly different to that of the cattle, but retains the same foundations: chosen movement amongst bodies (Laban, 1966) which makes worlds (McCormack, 2014) and leads to more-than-human attunement (Frischkorn, 2023). The primary difference lies in the fact that beavers are reintroduced to fixed enclosures, learning the fences through encounter and resistance, but not having much bodily contact with the human site managers after their release. However, the contact—the choreography—between human and beaver exists through the fencing, and through the humans' preparations and modifications within the enclosure. Natural England's guidelines for beaver reintroduction not only recommend the height of the fencing, but also dictate what the enclosure must provide ahead of beaver reintroduction: a lodge and a pond (Pouget and Gill, 2021). Thus, in order to

move beavers into the enclosure, the human site managers must prepare for a beaver response. While in an enclosure with one beaver site manager, I was pointed towards the products of these enclosure preparations (Figure 23):

> *You've got the lodge over there, which [the landowner] made himself. Okay, so really great. And he was sort of thinking like a beaver…You put your beavers in there when they first arrive and kind of block them in with wood, shut up for a bit and then they find their way out. And amazingly, they've carried on using it…I think [Natural England] recommends just making [lodges] out of hay bales and a bit of corrugated metal for roof, but because [the landowner] made it so natural, [the beavers] stuck around. And we've got this really cool footage on the trail cameras of them carrying mud. So walking along on their hind legs carrying mud, and sort of putting it back in in the lodge. Like you can see there's lots of branches on the back that they've added as well.*

'Thinking like a beaver,' the landowner made a 'natural' lodge that the beavers have built upon and continued to use after their reintroduction to the space. The choreography here began in the anticipation of beavers, as the landowner built the lodge, specifically attuning to the ways he perceived the beavers think and build and live. While there may be asymmetries, with the humans having agency over placing the beavers in an enclosed space initially, choreography does not work one way. As McCormack (2014) suggests, choreography can be both architectural and facilitate experiments in emergent movement. Choreography, from Roe and Greenhough (2014) is also emergent, an experimental partnering between more-than-human bodies and things, improvised mobilities that respond to each other's lifeworlds (Hodgetts and Lorimer, 2018). Here, the landowner, responding to the beaver's lifeworlds, facilitated an experiment in emergent movement, initiating an improvised response from the beavers, within a fenced space. The movements of the partners participating in worlding, co-created the space (McCormack, 2014). This choreography could be read as a multispecies collaboration, in which living beings come together in mutual respect of each other's differing environmental visions to live (and possibly work) together (Welden, 2023). However, the fact this happens within a

fenced enclosure, with the beavers enmeshed with fencing infrastructure to 'work' within a human-fence bounded space, pushes the limits of multispecies collaboration, as the beavers may respond to humans' alterations, but are held in place to do so.



Figure 24: An image of the beaver lodge (within the orange oval), built through more-than-human choreography between human and beavers. Author photograph.

Like with the cattle held in place with fencing, the choreography within beaver enclosures is symbiopolitical; even without daily contact with the human managers. Instead, their contact is through the provocations, within and by the fencing. After 'redistributing' the beavers (e.g. Lorimer, 2020)—reintroducing them into the prepared enclosure—the choreography of beaver mobilities continues within the fixed enclosure. In erecting such enclosure, and redistributing

beavers, the human choreographers are initiating a symbiopolitical 'controlled decontrolling of ecological controls' (Lorimer, 2020, p. 107). As the beavers are held within the bounds of a fence, their mobilities are decontrolled within controlled bounds—held within that space to produce ecological effects, performing a more-than-human choreography themselves (Section 3.c.). As one beaver researcher shared, within an enclosure, he:

> *learn[s] about what beavers do, especially to the hydrology and the water quality of the streams that beavers build their dams in. But also, what they do to the vegetation, the carbon cycle, […] and the shape of the land.*

By choreographing beaver mobilities—holding them within an enclosed space through enmeshment—NbS and the humans designing and initiating them, initiate the beavers' ecological controls around hydrology, water quality, and more. Thus, the concept of choreography in the case of NbS calls for an expansion of symbiopolitics beyond a relation between living things, to include the organisation of non-living, earthly processes. Choreographed by choreographed animals, the ecological processes include both life and nonlife. This multi-layered choreography with humans, fences, animals, and nonlife enmeshes animal bodies with the fences, the humans ensuring the organisation of (beaver) life and (hydrological) nonlife produces the expected NbS outcomes, thus enmeshed as the infrastructure modulating the NbS itself. Infrastructure is both a thing and the relation between things. 'As things they are present to the senses, yet they are also displaced in the focus on the matter they move around' (Larkin, 2013, p. 329). As the beaver enmeshes with fence and human to make up the NbS infrastructure in relation, they are the visible thing. And yet, as the movements of their bodies move and shift other things—from carbon to hydrology—they become displaced in focus. Animals as infrastructure fade into the background, invisible (Star, 1999), as the benefits or 'solutions' their bodies provide are prioritised.

3.c. More-Than-Human Emergence

In the previous section, a choreography emerged which was driven by the humans and the fences, enmeshing cattle and beavers with fencing so that their 'ecological engineering' can be 'provoked' and ecosystem-altering mobilities can be captured in a place *and* moved around a space. However, in this final section exploring the concept of more-than-human choreography and enmeshment, I focus on Laban's (1966) definition of choreography as *chosen* movement amongst bodies, considering how this infrastructural enmeshment allows for—and encourages—more-than-human emergence. This is key to moving beyond conceptions of animal response to human designs or infrastructures as 'resistance' or 'excess' or 'ferality.' Instead, I argue choreography allows for, and encourages, more-than-human emergence, action, and choice to make things—and worlds—together (Lefebvre, 1991). Frischkorn (2023) considers how the combination of human and more-than-human *chosen* movement is a way to enact agentic capabilities of collaboration, possibly opening space—even if enmeshed with/by fencing—for multispecies collaboration (Welden, 2023). I explore this first through the case of cattle, then through the case of beavers.

3.c.i. Cattle Emergence

Within the regenerative agriculture case, it is important to recognise the heterogeneity of approaches to managed grazing of cattle: from heavily-controlled strip/mob grazing with electric fencing *[I think there seems to be some anecdotal evidence that you can go too far with your mobbing (regenerative organisation director)*] to conservation grazing, or managed grazing, where more-than-human emergence or cattle's 'natural' intuition is encouraged *[the whole situation is geared up to raise them and them raise this land (regenerative farmer)]*. In the latter situation, the cattle's lives are valued in congruence with the way their bodies can choregraph and 'raise the land.' Yes, their movements are choreographed by humans and

fences, which raise them in particular ways, but they are the ones who choreograph and raise the land, creating the world through their chosen movements (Laban, 1966; McCormack, 2014). Their choreography of more-than-human assemblages includes their movement, even within the bounds of fences, among and *for* the ecosystem. This relationship—and enmeshment's encouragement of it—is most visible when the fencing infrastructure holding the cattle in place and making them move is also living: hedgerows and silvopasture.

The same farmer who discussed her regenerative grazing system as one where she raises the cattle, and the cattle raise the land, uses a form of silvopasture where the cattle are (sometimes) integrated with trees. As we walked through the woodland on her farm, she described what the cattle do when there:

> *None of this planted; this is all regen. So as far as I can tell, [the cattle] have a hugely positive impact on woodland if they go through and then leave it to rest. It seems completely natural to me that they're in here, they love it. They cope really well with it, the shade, the scratching, the trees. They love eating trees. So it feels, it feels really good to have them in here.*

In this description of the cattle in/with silvopasture, their interactions with the woodland—the scratching, the browsing—are encouraged by the farmer moving them to that space. There is an experimental partnering in that the farmer encourages a particular behaviour, but allows for improvisation and emergence of cattle's lifeworlds and own choices (Roe and Greenhough, 2014). In improvised choreography, choice—over what to eat, what to crush, what to regenerate—is key. The farmer uses the fences to evoke these 'natural' choices in the cattle, using fences to draw out their 'natural' qualities, as infrastructure can do (Hawkins and Paxton, 2019). Choreographed into being there, the cattle then choreograph the woodland—using their bodies to move and transform more-than-human elements of the space. And, the farmer notes the limits to her knowledge of the more-than-human *('as far as I can tell')*, as the cattle are situated as choreographers of the land in their own right. Even within a bounded space (by trees

and electric fencing), the cattle are those with the decision-making power to affect the more-than-human woodland space. As Frischkorn (2023) writes of more-than-human choreography as an attunement analytic, for humans, it is 'where ideologies of how to place oneself within ecologies are actualized' (p. 22). The choreography of the cattle within the woodland, led the farmer to respect the cattle's place in the land, fostering their emergence through enmeshment.

Enmeshment—and how it fosters emergence—becomes clear when considering the relation between cattle and hedgerows, which demonstrate the variety of relations entangled in an enmeshment with fencing infrastructures. As a regenerative farmer described his cattle's interactions with hedgerows:

> *We give [the cattle] all access to these hedgerows, […] and they get in and they get shade, they get shelter, but they go in and all the things that grow in and around tree lines and hedgerows, things like stinging nettles and brambles, they all get trampled…it's all got feed value, and they'll browse on things in that hedgerow along trees that they'll be getting minerals and things out of them they're not getting in the pasture, things like willow. Willow's really high in cobalt and zinc, it's got some aspirin in it too, they self-medicate.*

While still a technology of enclosure, hedgerows exert a different kind of force on the cattle, less violent and more symbiotic in an emergent relation. Rather than through electric technology, we can read this relation through a symbiogenesis of cow and hedge, in which they interlive and thus form together (Margulis, 1998). Hedgerows act as a living mediation of life's organisation on the farm—not only do they provide structure for life, but they also organise cattle grazing in a way distinct from electric fencing. I watched as the cattle choreographed the hedgerows—by rubbing on them or browsing through them—and the hedgerows choreographed the cattle—by still structuring their mobilities. It is within this co-management where enmeshment becomes clear. The hedgerows make the cattle, not only shaping their

movements as NbS, but shaping their mobilities, what they encounter—and in this case, consume—in their worlds. Likewise, the cattle coppice the hedge, creating space for more growth and regeneration of the plants within it: fostering more-than-human emergence beyond the cattle.

3.c.ii. Beaver Emergence

The cattle's encouraged emergence in silvopasture or amongst hedgerows is beavers' constant: fenced into an area in which they can enact choreography of the hydrology, land, vegetation, and more around them. Through enmeshment with the fences, the beavers redefine what belongs in their worlds, including humans or human interventions. This makes beavers into choreographers of humans too—explicating the multi-actor dance of bodily response. For example, one beaver site manager reflected on the unexpected beaver behaviour and how it called for the manager's response to allow for emergence, even within the bounds of an enclosure fence:

> *We actually made [the beavers] an artificial lodge because we did actually have an issue with them living in a culvert pipe up there. They went under our wire [curtain], you know, we ended up basically having to evict them [from a neighbour's pipe]. I thought, well, they obviously like a pipe. So let's build one [in the enclosure] and they used it. The first pair used it. But of course, when the second pair came, they built this dam here which flooded the lodge, so they can't use it anymore...*

This example synthesises the three angles of more-than-human choreography in this Chapter. In the beavers' encounter with the enclosure fencing, they determined (and found) the limits of the fence's force through testing, digging under the curtain. The human symbiopolitical choreography over the beavers' movements is in their recognition of the beavers' preference for pipes. Thus, holding them in the enclosure—discouraging future escapes—included responding to the beaver emergence by bringing a culvert pipe into the enclosure to encourage the beavers to remain. A second pair of beavers unexpectedly flooded the pipe with their dam

building, rendering that human choreography for the other beavers, useless to this new pair. Choreography is about more-than-human attunement (Frischkorn, 2023), coming to know one another within the remit of Nature-based Solutions, but it is also grounded in different bodies moving with—and in response to—each other to produce worlds (Lefebvre, 1991 in McCormack, 2014), a choreographic movement of oneself and matter, within the remit of an organised practice like NbS, as infrastructure (Larkin, 2013). Instead of resistance of the human-created fence, I read the beaver's escape as expressing a preference for another world. They learned the fence as an infrastructural choreographer, enmeshing with it. Instead of exceeding human design, the enclosures encourage and respond to beaver emergence and beaver choreography—of more-than-human environmental elements *and* of the human site managers. Thus, choreography is an emergent relation between multiple bodies, bodies which within the system of NbS are 'share[sic] space for accomplishing' the sought outcomes (Roe and Greenhough, 2014, p. 52). They are mobilities responding to each other, mediated by the permeable enclosure technology. This permeability, though, is relative, depending on the attractiveness (to the beavers) of the space within the enclosure fence or outside of it. For one pair of beavers, the culvert pipe made an ideal lodge; thus, they left the enclosure. However, when the culvert pipe was brought into the enclosure by the site managers, based on the beavers' expressed preferences, the beavers remained. Choreography is thus a way to view more-than-human encounters from multiple perspectives, happening all at once as different bodies (and infrastructures) come together and affect one another, producing environments, compromising—or collaborating—on the ultimate design, in continuous, circulatory motion.

5. Conclusion

As animals in Nature-based Solutions materially encounter and learn the fences they enmesh with, their bodies are moved in a responsive, rhythmic choreography, which encourages emergent responses and a recognition of more-than-humans as choreographers themselves. Diverging from other literatures on animal fencing and enclosure (or exclusion), this Chapter traces how enmeshment is not the same as enclosure; rather, enmeshment allows for—and fosters—probiotic mobilities and more-than-human choreography. This enmeshment occurs through relations which constitute a 'lifeworld of structure' (p. 393), in which beings are bound to the world in movement, in the patterns, habits, norms, and scenes of use (Berlant, 2016). Movement, amongst other bodies and things in choreographed relation, thus makes and remakes infrastructure. This becoming (infrastructure) together, or becoming otherwise through movement (Colombino and Palladino, 2019), enlists the animals as infrastructure in different ways, depending on the species and depending on the materiality of the fencing. As was shown through the analysis above, and as Hawkins and Paxton (2019) write, the type of fencing brings out different animal qualities and subjectivities, which are 'produced in and through technologies and spaces,' (Holloway, 2007, p. 1041). Thus, animals in NbS, while acting as choreographing agents themselves, do become subject-to infrastructure in their enmeshment with fencing that holds the NbS (animal bodies) in place or makes them move.

I began by situating this Chapter amongst my research questions, answering in part how animals are made to be infrastructure (via enmeshment) (RQ1) and how they come to be known as infrastructure (RQ2). I described the materialities of the different fencing infrastructures, noting how the animals and fences come to be NbS infrastructure in their relation. By considering this animal-fence enmeshment, this Chapter demonstrates how infrastructure is learned/trained, mobile, and emergent, rather than fixed. It considers the spatiality and

temporality of NbS infrastructure, weaving together performance studies and animal geography literatures to provide a novel take on how NbS—or more-than-human relations more broadly—may be performed.

Still, it leaves questions. As McCormack (2008) notes in his theories of choreography, 'the quality of moving bodies contributes to the qualities of the spaces in which these bodies move' (p. 1823). What are the qualities not only drawn out from bodies through choreographed movement, but what are the qualities sought after and reproduced to *enflesh* the infrastructures which sustain Nature-based Solutions? In the next Chapter (6), I draw us closer to these desired bodies—into the guts and limbs and teeth that metabolically labour to (re)produce a given Nature-based Solution.

Chapter 6: Enfleshment

Cycles of metabolic, probiotic, and reproductive labour

1. Introduction

> *Laboring always moves in the same circle, which is prescribed by the biological processes of the living organism and the end of its 'toil and trouble' comes only with the death of the organism -Hannah Arendt (1958, p. 98)*
>
> *The 'blessing or the joy' of labor is the human way to experience the sheer bliss of being alive which we share with all living creatures, and it is ever the only way men, too, can remain and swing contentedly in nature's prescribed cycle. -Hannah Arendt (1958, p. 106)*

Labour is at once unending 'toil and trouble' and something joyful, a cyclical production of the conditions for life (Arendt, 1958). Unlike Marx's humanist conceptualisations of labour, Arendt's labour opens the door for the more-than-human, something which connects all living organisms in the production of life. Thus, in this Chapter where I consider the ways in which animal bodies are *enfleshed* as the infrastructure of Nature-based Solutions, I draw from Arendt's theory of a cyclical, life-producing labour which can speak to the commitments and corporeal impacts of Nature-based Solutions. While Arendt wrote her theory of labour in a vastly different context to that of Nature-based Solutions—namely, post-WWII—I contend that there are lessons to be drawn from her writings on labour (Chapter 2). I do this carefully in this Chapter, not drawing equivalence between our cases, but instead weaving in Arendt's points of departure from Marxist labour theory to explore and expand the ways in which animal labour is conceptualised in the NbS space. Often, NbS include a commitment towards 'regeneration,' regenerating landscapes for human and environmental wellbeing (Cohen-Shacham et al., 2016), while also regenerating animal bodies to do the 'work' of regeneration. Nonhuman labour is thus central to the production of Nature-based Solutions, as regeneration

implies the self-generative production of 'nature' (Wadiwel, 2018; Welden, 2023). By thinking with Arendt, I am able to attend to such bodily regeneration—and reproduction—with a focus on the stakes for the animals themselves.

Speaking to the cyclical, self-generative production of the animal body to labour 'probiotically,' I also draw from, and build upon, theories of metabolism and metabolic labour. While metabolism has broad intellectual histories (Chapter 2), I discuss it in the context of (often bodily) transformation of matter into different forms (Landecker, 2013), with metabolic labour defined in the self-generative production of one's body (Wadiwel, 2018). Drawing this out in the context of the cattle in regenerative agriculture and the beavers reintroduced for ecosystem restoration, I consider the different layers of animal labour occurring to produce—and reproduce—Nature-based Solutions: productive metabolic labour, probiotic labour, and reproductive labour.

This labour lens draws the analysis past *enmeshment* with infrastructure by choreographing bodily mobilities, as discussed in the previous Chapter (5), to an *enfleshment* as infrastructure within and through the bodies of the animals themselves. Barua (2021) uses the term enfleshment to describe the infrastructuralisation of nonhumans 'to modify, maintain or create habitats and act as controls on material flows' (p. 14). This Chapter describes and analyses the different forms of labour that go into such modification, speaking to another process through which animals are made infrastructure in Nature-based Solutions (RQ1) and the impact or significance of this process for animal lives (RQ3).

To tell this story, I begin by providing context on the specific forms of bodily labour that cattle and beavers do, before sharing my model for how NbS are (re)produced via multiple,

intersecting cycles of metabolic, probiotic, and reproductive labour. This brings me to theorise the enfleshment of animals as infrastructure through a (metabolic) labour lens, and I draw out the significance of these connected, cyclical labours for animals' lives and bodies and Nature-based Solutions more broadly.

2. Animals Put-to-Work in Nature-based Solutions

Metabolism, as reviewed in Chapter 2, begins in the body, where life is cyclically sustained through consumption (Landecker, 2013). Thus, in order to understand the ways in which cattle and beavers are 'put to work' in probiotic interventions (Lorimer, 2020) like Nature-based Solutions, more context on the bodily functions behind cattle and beaver 'labour' is necessary. Cattle, managed regeneratively, and beavers, reintroduced into pre-selected places, have been selected as the ideal metabolic/probiotic/reproductive labourers, or 'ecosystem engineers' based on their bodies—internally and externally—and what they (can) do with them. Described below are some of these features, which influence how they (are expected to) labour in the (re)production of Nature-based Solutions.

2.a. Cattle Rumination:

Cattle have been cast as the ideal 'metabolic' labourers in regenerative agriculture in part because of the ways they metabolise what they consume, via *rumination*. Ruminant animals, by definition, have a four-chambered stomach, with the first chamber being the rumen. This is where microbial fermentation of consumed food occurs. Further, they engage in rumination, where they regurgitate 'cud,' chewing, swallowing, and metabolising the food multiple times before it is excreted in the form of wee, muck, or methane gas (FAO, 1994). In recent years, this process has come under investigation, as methane emissions from ruminants have gained notoriety in discussions of climate and environmental change. Geographers have noted how

the rumen may be 'geoengineered' to produce a low-carbon cow (Ormond, 2020) or how the rumen—rather than the individual cow/bull/heifer/steer—becomes the object of governance (Turnbull and Oliver, 2021).

However, the internal processes of rumination is one of the reasons cattle are considered a 'keystone species' on farms adopting regenerative agricultural practices, like rotational grazing. Due to rumination, the nutrients taken in by the animal when grazing become fermented, the ruminants 'inoculat[ing] the soil with beneficial nutrients and microbes, increasing the biodiversity underground and leading to a much more resilient soil profile' (Rodgers and Wolf, 2020, p. 119). These authors go on to claim that the urine and manure from ruminants—grazing in a rotational way—form a 'gut' for the soil itself. Because of this, most farmers practicing regenerative agriculture see ruminants as fundamental to their Nature-based farming system, enlisting them as regenerative workers (Cherry, n.d.).

As reviewed in Chapter 1—and fully explicated below—cattle's labour expands beyond their rumens to their external bodies as they are choreographed into rhythms of rotational grazing. With their hooves, bodies, and movements, they grind the products of their rumination into the soil, for the regenerative goal of increased soil health.

2.b. Beaver Labour

Throughout this thesis, I have focused on beavers' dam building activities, as these are the most impactful actions in terms of their 'ecosystem engineering' landscape modification (Campbell-Palmer et al., 2016; Goldfarb, 2018). As reviewed in Chapter 1, these dams retain and filter water, slowing its flow for natural flood management and increasing biodiversity around the beaver pond. To build these dams, beavers participate in what Barua (2018) terms the body-

work of animals: using their teeth to fell and coppice trees and creating canals along which they transport felled wood. When they fell wood to build their dams, beavers consume the inner bark of the wood, scraping it out with their large front teeth, before weaving the outer bits into their dams (Harper, 1969 in Goldfarb, 2018). They use their hands and teeth to carry mud, which they use as the cement holding the dams together (Goldfarb, 2018; Poliquin, 2015). This work may occur in Natural England-licensed enclosures (Chapter 5) or in 'wild,' unenclosed settings.

3. The Body Work of Regeneration:

Not all labour that goes into the production of Nature-based Solutions is strictly metabolic; however, the different forms of bodily labour I outline in this section are interwoven with a cyclical, metabolic labour that is productive of life through material transformation within/from/of the animal body. In the following subsections, I describe and analyse how cattle in regenerative agriculture are still caught up in self-generative, productive metabolic labour of their own bodies for meat (and other material) production. In this, they produce their own bodies and lives. I then turn to probiotic labour, as the production of conditions for other(s') life, analysing it through metabolism to consider how *both* beavers and cattle are made to labour probiotically in NbS. Finally, I consider the reproductive labour that goes into maintaining the Nature-based Solution through animal (re)production of another's life to continue the productive metabolic and/or probiotic labour (Figure 24).

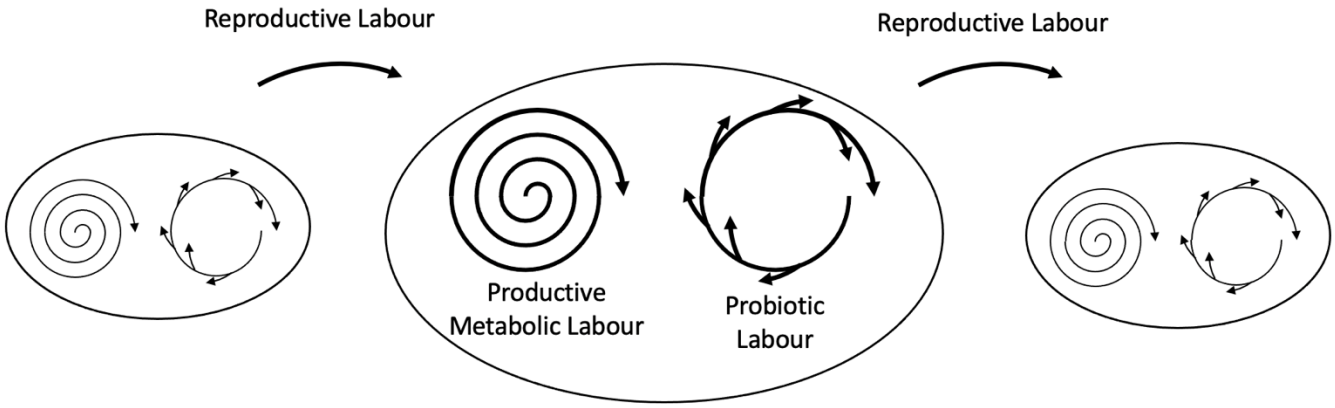
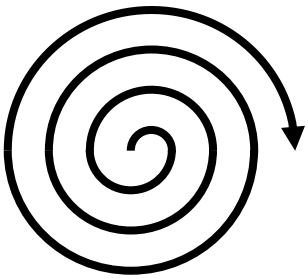


Figure 25: This model demonstrates the linkages between cycles of productive metabolic labour (producing one's body/life), probiotic labour (producing conditions for other life), and reproductive labour (producing another's life) in the layered, cyclical (re)production of Nature-based Solutions. This folding together of labours that create and maintain a Nature-based Solution through material (labour) relations is what enfleshes nonhuman animals as infrastructure. Author figure.

3.a. Productive Metabolic Labour



The traditional conceptualisation of metabolic labour—often based on cases of animals in agricultural production (Beldo, 2017; Wadiwel, 2018) or trees in industrial forestry (Palmer, 2021)—is defined by the production of the body through material transformation, in short, growing. In Figure 24, such metabolic labour is depicted as a spiral, a cyclical growing of one's body through time, ending with the end of the 'toil and trouble' (Arendt, 1958, p. 98), or alternatively, the value-producing moment of death for the animal (Wadiwel, 2018). These metabolic processes are often exploited by capitalism (Beldo, 2017), to become a valued product. Even with regenerative agriculture's environmental ethos, with the cattle framed as

Nature-based Solutions to build soil health on the farm (Chapter 4), a rotationally grazed herd of cattle in regenerative agriculture are often still beef cattle, wrapped up in the production of meat and other products (Cusworth and Garnett, 2023). The various products of—and from—cattle's metabolic labour historically are depicted in Figure 25.

[The illustration depicting different by-products from beef production alongside figures of cattle originally presented here cannot be made freely available via ORA because of copyright. The illustration was sourced at the National Agricultural Institute magazine 1949.]

Figure 26: Illustration of the 'various by-products of cattle' by Armour and Company, printed in the National Agricultural Institute magazine in 1949. Copyright National Agricultural Institute.

However, the fact that certain cattle grew their bodies within 'regenerative' systems differentiated their value from other meat, according to the farmers who reared them. As one regenerative farmer told me:

> *You can't clamp all red meat production in the same category. So you know, people are beginning to try and distinguish out different methods of production.*

Thus, cattle's lives before the moment of death—and what they consume during that life to grow/produce their bodies as meat and by-products of such meat—come to matter in regenerative agriculture. Thus, metabolic labour can produce different value at the end of the cycle, based on the quality of the labour in the middle of the cycle. In this context of regenerative agriculture, life and liveliness of the commodity (e.g. Collard and Dempsey, 2013) come to matter.

In the case of cattle in regenerative agriculture, this value capture during a body's life includes the liveliness of rumen microbes and the consequent fertilisation of soil. As one regenerative farmer shared, while grabbing a fibrous plant in the pasture:

> *Their rumen processes fibrous things like this [grabs plant]. You know, that structure stimulates the rumen, and that's what they break down: the cellulose. And they regurgitate and chew it up and that's what they turn. That's what this is: where four stomachs turn into meat and milk and energy.*

This rumination process, metabolising fibrous plants—transforming matter into a new form (Landecker, 2013), not only produces wee and muck, as many regenerative farmers nodded to, but ultimately produces human-consumable, sellable products: meat and milk and other by-products (Figure 25). To do this, to grow one's body, metabolic labour occurs internally, as cattle consume fibrous plants and ruminate—a metabolic process of consumption for sustenance (Arendt, 1958; Landecker, 2019)—regurgitating, chewing, and fermenting in the rumen, recruiting a 'microbial workforce' (Folkers and Opitz, 2022) as well within their bodies.

Thus, as animals and their rumen microbes metabolically labour within these spaces, their vitalities can be exploited for capitalist production in the products of metabolic labour (Beldo, 2017). Through this metabolic labour, ruminants produce their own bodies for meat, milk, and energy (Wadiwel, 2018); but, within Nature-based Solutions, the products of their bodies extend beyond those characterised by death or food production.

We see this most apparently when cattle are not only viewed as an animal to produce themselves as food, but as an animal to produce environments: biodiversity, carbon sequestration, soil health, and more, by growing themselves, consuming, and ruminating. Another regenerative farmer connected the cattle's metabolic consumption to other valued products made through a particular cow's body:

> *[The cow's] sequestering tonnes of carbon because she's eating grass off. She's encouraging it to grow again, which is drawing carbon into the soil. She's pooping out after, you know, four hours, this amazing pile of compost that comes out the back end. The dung beetles take it all into the soil. The worms take it into the soil. She's nourishing the soil by doing that.*

Here, the metabolic labour performed in the rumen produces something of value for more-than-human beings, for dung beetles and worms and soil. The labour of some—the cow—'suffices for the life of all' (Arendt, 1958, p. 88). The by-products of the metabolic labour of cattle shift from leather and drums and glue (Figure 25) to probiotic, Nature-based Solution benefits: soil health, biodiversity gain, carbon sequestration, according to the farmer. Further, through her metabolism, the cow is labouring as she produces carbon sequestration (Palmer, 2021) through the consumption of grass and the cyclical fertilisation of the soil, helping the grass grow and continuing the sequestration of carbon [remembering this regenerative claim is contested (Garnett et al., 2017)]. This contested argument, connects the material transformations happening in the cattle's rumens to the climate and the material transformations occurring in

the context of the Anthropocene (Turnbull and Oliver, 2021). Another farmer spoke on the carbon, which becomes tied into the metabolic cycle of the production of a cow's body :

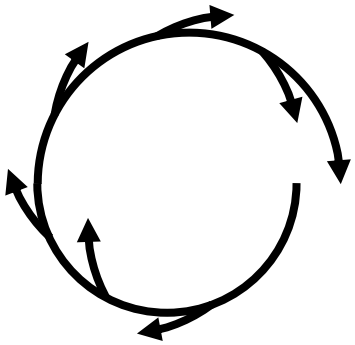
> *There's this whole carbon cycle going on: plants photosynthesize carbon [into] the atmosphere, they turn into sugar in the soil, which soil micro-organisms trade-off for, you know, minerals and as soil nutrients that the plant uses to grow, which makes physical carbon, which is this [grabs grass] which the cows come and eat and turn into meat and milk and they burp a bit of carbon out as methane…that methane breaks down into carbon, hydrogen comes down as rain again.*

As the focus on these animals shifts to their carbon-sequestering abilities and their space within the atmospheric carbon cycle, we see how their metabolic labour, the becoming of the cow herself, connects to the carbon cycle, where interventions in the climate are being realised through internal ruminant bodies (Turnbull and Oliver, 2021). While Turnbull and Oliver's (2021) piece focuses on what they call a 'metabopolitics', or governance of the rumen in industrial agriculture, we see here how metabolic *labour* occurring within the rumen to produce the cow as valued meat is critical to the arguments around the production of Nature-based Solutions in regenerative agriculture. While cattle often are still enrolled in systems of meat production, their value for 'environmental' benefits are still predicated on their liveliness, their ability to perform metabolic labour internally to realise benefits external to themselves. This too becomes a question that regenerative farmers ask themselves:

> *I think, why do we focus on a product? Why are we focusing on beef? We're beef farmers. Why are we focusing on beef, when actually, what we have and what we provide to the public is more than just meat? There's a lot more to it than that.*

In this statement, the primary product of regenerative cattle's labour shifts from meat to probiotic, environmental benefits. The labour shifts from being metabolic, where the animal *must* die for the farmers to realise the value of the self-generation, to being probiotic, where the animal still must grow itself, but in so doing, it produces the conditions for other life, producing what Lorimer (2020) terms, probiotic value.

3.b. Probiotic Labour



While beavers do produce their own bodies, their own lives, growing in 'nature's prescribed cycle' through labour (Arendt, 1958, p. 106), the products of their labour are not (anymore[1]) their bodies themselves, not traditional metabolic labour like in the case of cattle. Instead, their labour within the context of Nature-based Solutions can be classified as probiotic, 'a novel form of ecological animal work, which is configured with a nonhuman division of labour marked by a specialization of animal activity' (Lorimer, 2020, p. 193). Both beavers and cattle are the specialists, the 'ecological engineers,' whose labour produces the conditions for other life. This is depicted as the probiotic labour figure in Figure 24, with the large cycle depicting the life of the ecological engineer, and the offshoots depicting the start of all the lives for whom they create the conditions. As Arendt (1958) notes, the labour of one can supplant the labour of another, to create the conditions for another's life. Within the NbS cases I investigated, beavers and cattle are lauded as the probiotic labourers, producing 'natural,' life-producing cycles, their bodies and their knowledge enlisted to create, uphold, and regenerate the cycles anew.

3.b.i. Beavers and Probiotic Labour

> *It sounds cheesy and cliche, but the missing link there is the beaver, you know, in woodland regeneration. And you're like, wow, that's the species.*

[1] Beavers were historically hunted (not farmed) for first their glands, and then their pelts, driving their initial extinction from Britain.

As this beaver organisation director noted, the beaver as a species is the missing link in the cycle of woodland regeneration: their probiotic labour is key to restoring the cycle which, this participant argued, has been missing in Britain. With (if not through) their bodies, beavers transform material, changing the environments around them through their choreography of hydrology, vegetation, and more (Chapter 5). Their labour is directly tied to their lives in that the beavers' construct their dams: the lynchpin of their probiotic labour, because of their ethological cues to create spaces of deeper water that act as protection of beaver lives from predators. As reviewed in Chapter 1, dams pool deeper water behind them, slowing the flow of streams and creating deeper beaver ponds. Beavers are driven to this life-protecting labour of dam-building by the sound of running water (Lundquist and Dolman, 2016). Thus, while their labour is not to *produce* their bodies, it is to protect them, producing the conditions for other life (cycles) in the meantime.

Beavers' dam building leads to other products of their probiotic labour, transforming material in a metabolic move. They fell trees with their teeth; they drag the wood through canals built with their bodies to their chosen places to build a dam (Figure 26) (Goldfarb, 2018; Gow, 2020). As a beaver site manager and a beaver organisation director reflected, these products of beaver labour are visible as vast material transformations:

> *We can see over time […] the way the canopy is opened up, when they're starting to cut trees down and holding on to water (beaver site manager).*
>
> *[The beavers think] we're just going to build this dam. We're gonna move this water over here. We're going to fell this tree. We're going to create this space. We're going to open the canopy. We're going to create air and light and moisture (beaver organisation director).*

Tree matter is converted into new forms, metabolically, through chewing, dragging, swimming, and constructing a beaver dam. Landecker (2019) describes this metabolism as a 'churning scene of incorporation and excretion' (p. 542) amidst bodies' interaction with other things. The

continuous creation and maintenance of beaver dams, the opening of the canopy, and the holding onto water, are done by beaver bodies, and as witnessed, these environmental transformations are unique to beavers' bodily abilities. Thus, metabolism—the transformation of matter (Landecker, 2019)—is fundamental to the probiotic labour in which these 'ecological engineers' are engaged. Because of the ecosystem-scale metabolic transformations and wide-ranging products of this probiotic labour, beavers' works are associated with Nature-based Solutions. Beavers come to be considered ideal workers—and managers—for the projects (Welden, 2023), where nonhuman labour is divided and valued based on the different species' specialisations (Lorimer, 2020). Further, animals in these 'probiotic' interventions, in which nature is put to work, are made to be ecosystem managers, managing more-than-human elements of an ecosystem assemblage (Lorimer, 2020), creating the conditions for other life. As a beaver site manager reflected, regenerating more life is made possible with beavers building dams:

> *[The beavers] were able to build their dams, and then they held the water on the land. And then that's one of the things about this is that we get this very, very good regeneration.*

This management work extends outside beaver bodies—and their lives' own prescribed cycles of dam building—to other things and beings, including water and the regeneration of other life, other life cycles. A dam, as seen in Figure 26, and the other probiotic labour done by the beavers, creates the offshoots on the beaver's life cycle, making other life possible.



Figure 27: A beaver dam, holding back the water on the left to create a deeper pond for beaver protection. The image also depicts the complexity of a beaver dam's structure and its contents, including soft mud and woven, hard branches, produced through beaver probiotic labour. Author photograph.

3.b.ii. Cattle and Probiotic Labour

> *The whole cycle of eating grass and pooping and burping, it's just all there and you can just see it all happening (regenerative farmer and organisation director).*

Beyond the cattle's consumption of grass and rumination to produce their bodies for beef in a traditional metabolic labour sense, they are also labouring for life probioticially, producing the conditions for other life: other cycles springing from the cattle's cycle of rumination. A new probiotic cycle, with offshoots signifying the creation of the conditions for other lives, is added to the spiral of growing one's body in the case of cattle in regenerative agriculture. Again, metabolism also exists outside of food consumption (Landecker, 2019) and is transformed by

bodily labour that is not just in the rumen, but through the limbs. While the cattle are chosen as labourers for their superior capacities for metabolic work (Palmer, 2021), they also are enlisted as managers of other life (Lorimer, 2020), connecting the self-generative metabolic labour to probiotic labour where their specialised labour can spark the life, and labour for life (Arendt, 1958), of others within the Nature-based Solution. For example, one regenerative farmer discussed his animals' bodily labour to produce the benefits of a regeneratively grazed system:

> *This area represents eight days-worth of grazing ... And they started here, you can see the line, and they've grazed. And if you look here, we have this folded mat of material and dung, which hasn't been utilised that's just going to feed the life of the soil, the microbes, that carbon, you know, it's all going to grow in and it's going to regenerate these soils.*

Cattle engage in this probiotic body-work, *'by hoof and tooth'* (regenerative farmer), trampling their feces and dead organic matter into soils and ultimately regenerating life processes through their bodily interventions in and above the soil. The by-products of cattle's rumination—as a part of the metabolic labour to produce themselves—become the food for the life of the soil, the microbes. This demonstrates the connection between metabolic and probiotic labour, the latter connecting one life to another. Above the soil, the cattle's trampling of the grasses transform matter, creating a matt of folded grass and dung that retains water in the soil and protects it, adding to its regeneration.

Connecting to how this labour is choreographed with/by the fences and the patterns of movement, one farmer discussed how their grazing plan achieves their Nature-based Solutions goals:

> *What [the cattle are] doing is trampling, cause you've got them in a smaller area so the more intense trampling period and then a longer rest time so that's all helping the trampling is really good for the soil health, getting this*

> *down into the into the soil to feed the microbes and microorganisms there and then yes yeah it's also feeding off each other so the more diversity you've got above ground, the more diversity you've got below ground.*

With this kind of rotational grazing, the cattle mobilities become choreographed into the places and spaces and rhythms (Chapter 5) that enable and encourage probiotic labour. Analysed through Lorimer's (2020) probiotic lens, the bodily labour of the cattle through their trampling—in the right places—is a specialisation. Their bodies are dedicated to particular tasks: eating, ruminating, weeing/mucking, and trampling, which in turn spark life in the soil in the form of microbes. These microbes are then 'put to work,' feeding off each other and building the soil structure through their own bodies. Metabolism, if not metabolic labour, is at the core, as cattle and microbes feed from the ground and off each other, the cattle labouring to create the conditions of life for the microbes.

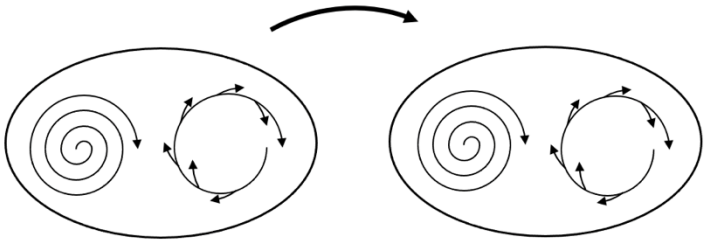
Recognising how metabolism is woven into probiotic labour addresses some concerns about how labour may alienate nonhumans from themselves and their 'species-being,' their ensemble of social (and material) relations (Fair and McMullen, 2023). I draw this out through one regenerative farmer's argument for the necessity of cattle in regeneration:

> *The cattle are necessary in the regeneration of the meadow pastures…there's something about their hooves, exerting a pressure and they're dunging and the way that when they move, they turn [the soil] with that hoof.*

Here, the cattle's hooves are particularly specialised for this probiotic labour of meadow pasture regeneration. As they labour in socio-material relation to the pasture, it is their species-being that is being captured in the production of probiotic labour. Unlike the cattle under capitalist industrial production, where the cattle's relational behaviours of foraging, mating, and rearing are suppressed (Stuart et al., 2013 in Fair and McMullen, 2023), species-being and the labourer are reconnected, and utilised to do the probiotic labour itself. The specialised way

in which the cattle turn the soil with their hooves, browsing and dunging in the regeneration of a meadow speaks to Fair and McMullen's (2023) assertion that a recognition of nonhuman species-being 'demand[s] space for nonhumans to engage in their own world-making practices and produce their own use values in their species interest' (p. 197). The connection between probiotic labour and metabolism, read through an Arendtian labour lens, demonstrates how in producing one's own life through their material relations, the 'ecological engineers' in Nature-based Solutions too produce worlds, for themselves and others.

3.c. Reproductive Labour



To ensure the cycles of metabolic (for cattle) and probiotic (for cattle and beavers) labour by nonhumans continues within NbS projects, with few disruptions or easy replacements for disruptors, there is another cycle in which the initial cycles are nested: the cycle of reproductive labour. Reproductive labour too is tied to metabolism; metabolism is intergenerational (Landecker, 2013). As Prouse (2021) writes in her work on social reproductive metabolisms of human milk banking, 'labouring and metabolism are also fundamentally about reproducing human life' (p. 106). But, reproductive labour is not limited to the human (Gillespie, 2014; Parreñas, 2018). As Collard (2014) shares, the labour of lively commodities is reproductive daily, nodding to the cycles of metabolic and probiotic labour, and reproductive over a lifetime, as animals breed and produce new labourers. In the context of Nature-based Solutions, or in interventions where the ecosystem is designed to be 'regenerative,' reproduction of the

labourers to conduct such probiotic labour becomes inherent within the design. However, given the contexts of the different interventions, one situated within economies of agriculture and one situated within economies of ecological restoration, the reproductive labour which occurs to regenerate preferred environments is contextually and organisationally distinct.

3.c.i. Beavers Reproducing

Extending beyond the regeneration of their own bodies to continue the labour of regenerating the ecosystem, beavers are *selected* and *expected* to reproduce new life to continue the metabolic labour cycle in new places. One beaver researcher reflected on the selection process within a particular enclosure:

> *So when [the beaver pair] were felling one of the trees on the other side of this bank… [the male beaver] cut partly the tree down and then it back sailed and hit him. So he ended up having an exploded lung and died from that. But what happened is that [the female] was then left on her own. So she was then moved up here, then the kits who lost their mum were then moved into here…it needed a proper pair of beavers to actually dam that system … So she was moved down here and has a new male and his son come in here. So they're now all together.*

Currently in a Natural England-licensed enclosure, beavers are reintroduced in pairs, selected to be compatible breeding partners. As beavers operate in family units, first as reproductive pairs, with kits dispersing (Campbell-Palmer et al., 2016), there is an expectation that the pair—via reproductive labour—produces kits to continue their labour regenerating the ecosystem, moving up or downstream to continue the work (in the context outside a Natural England enclosure). In this case, the male beaver died before the reproductive labour of the system to produce Nature-based Solutions could occur. As the researcher reflected, *'it needed a proper pair of beavers to actually dam that system.'* The (re)production of the Nature-based Solution required more beavers: a breeding pair that could then labour to reproduce more damming beavers. Thus, more beavers, including another male to pair with the female, were placed

within the enclosure. While less organised than the animal husbandry I will explore in the case of cattle, there is still human intervention within this metabolism (Landecker, 2013; Parreñas, 2018), as beaver pairs are selected in particular for their compatibility. And, if the beavers are not observed as being compatible, one of them will be 'relocated' out of the enclosure, showing the consequences for breaking the reproductive labour cycle in this case.

The expectation, the hope, is that a reintroduced beaver pair will breed to regenerate both their probiotically labouring bodies and the life of the ecosystem. As one regenerative farmer with beavers reflected:

> *[The beavers are] eating willow and regenerating, coppicing the willow and building. It's a slow start. It will take time. But as we get to a point of deregulation, they will migrate down the tributaries and they'll become more established…and the hope is that they would breed. And regenerate.*

As this participant shared, the beavers are both regenerating the willow and *hopefully* regenerating themselves through breeding, even after the enclosure fences are removed. As NbS are designed to be regenerative of the nonhuman labourers tasked with the production of the project, this cycle is built into their design, and compliance is a condition for continued life and labour in that space. This aligns with Parreñas' (2018) analysis of orangutan conservation in which there was 'forced copulation' to meet the project's conservation aims: 'the survival of a few species is meant to stand in for the propagation of the entire species (p. 99). Like the orangutans, beavers within and outside these enclosures are conducting the reproductive labour to repopulate their species in Britain; however, they are placed into these conditions for copulation not only to do the reproductive labour for the security of their population, but to do the reproductive labour for the maintenance and continuation of the Nature-based Solution. They are enfleshed as the maintenance infrastructure of NbS, the 'fleshy, messy, and

indeterminate stuff of everyday life' that is the structural backbone of economic (or probiotic) production (Katz, 2001, p. 711).

3.c.ii. Cattle Reproducing

In a different context to beavers, cattle breeding is entrenched in the history of Britain (Velten, 2007). Given the context and histories of agriculture within Britain, one can see that these life- and nature-producing projects are still situated within traditional animal husbandry practices[2]. In this case, however, regenerative farmers are breeding—controlled reproductive labour—for the ideal 'regenerative cow:'

> *What we're trying to do is drop that frame size. So we don't want animals with these big long legs and these big heavy frames because [the] energy they need to breed that calf's much higher. And the best animals that're converting grass into energy are the little short, squat, short legs, big fat, feral bellied things.' (Regenerative farmer)*

A paradox, controlled breeding for a 'natural' body (Holloway, 2007) to produce 'nature' in NbS, 'regenerative' reproduction in this sense aims to produce the 'best animal' bodies for ecological labour on the farm. Reproductive labour, here, is organised, focused on regenerating the ideal cow to continue the probiotic cycles of labour that produce particular environmental outcomes. There is a focus on the body: which body type is best suited to both the metabolic and probiotic labour cycles discussed above. This ties in with Beldo's (2017) thinking around how agricultural animals are put to work to exceed human inputs, producing surplus value through metabolic labour. In breeding and instigating a second-level cycle of reproductive metabolic labour, there is a surplus value of new life that is produced, new labourers to continue the work (e.g. Federici, 1998; Katz, 2001), demonstrating how animals too fall under the economies critiqued by seminal feminist writings on reproductive labour. This shows a clear

[2] This runs contrary to Lorimer's (2020) analysis of the backbreeding of Heck cattle for rewilding. It is a hybrid of breeding for ecological, metabolic labour and breeding to produce agricultural products.

human intervention in nonhuman metabolism (Landecker, 2013), whereby ideal qualities of labourers are selected—by humans—to do undergo reproductive labour to not only sustain conditions of the animal's life but reproduce new life to start new metabolic cycles. As one regenerative farmer reflects, their farm is breeding specifically for the landscape, to increase the production of probiotic labour:

> *We're also working with the Ruby Devon cattle, and they are an at risk, recognized breed on the at risk register. So we were doing a bit to keep that geographic genetic gene pool going. We're trying to be progressive in our breeding. and, trying to, yeah, breed the right animal for this geographic landscape.*

Breeding the right animal for the landscape, many regenerative farmers aim to reproduce cattle that are suited to conduct the probiotic labour described in the previous Section. This also ties in with the discussion in Chapter 4, in which there is an ecological baselining to future-pasts (Cusworth et al., 2022). There is a coordination of reproductive labour to reach towards the 'naturalised' breeds of the past to (re)produce Nature-based Solutions for the future, creating future animals for the 'natural,' probiotic work. The selection of breed, then, goes beyond the reproduction of body parts to produce from metabolic and probiotic labour—dropping the frame size for soil impact—and reaches into the past to consider a '*progressive'* gene pool, which can reproduce progressively the renaturalised animals for the renaturalised places. As with tree species selection in forestry regeneration, cattle breeds are chosen to reproduce due to their superior capacities for metabolic work, transforming matter [probioitically] into different forms (Palmer, 2021). In this, the different cycles of metabolic labour, probiotic labour, and reproductive labour entangle in a wider cyclical system (Figure 24).

Further, not only is reproductive labour all-consuming of the body, with some level of suffering involved (Wadiwel, 2018), but if the reproductive cycle is broken, there are potentially deathly consequences for the animal who does so. If the cow is not a consistent producer of 'healthy',

regenerative life, of an ideal design, then that animal's value for reproduction declines (Gillespie, 2013) and value for capital (via the abattoir) relatively increases. This is seen in one regenerative farmer's reflection on a cow she plans to remove from reproductive labour production:

> *So, ['Mooo,' from a lone cow we were passing] aww poor girl are you mad? [She walks up to cow and pats it] That cow had a caesarean, so yeah, we look for smaller cattle. This one, we won't breed from again. She's only had two calves, the second one died.*

With the cow not re-producing as expected, losing a calf and costing the farmer additional capital for veterinary labour, she is removed from the cycle of reproductive labour. This influences the farmer to look elsewhere, seeking out smaller cattle whose bodies can labour to reproduce new calves to continue the regenerative cycles, for their own lives, the lives of others on the farm (soil, worms, grass), and for the lives of future generations.

3.d. Interconnected Cycles of Labour

While I delineated the cycles of metabolic, probiotic, and reproductive labour that are performed by animal labourers in Nature-based Solutions, they are woven together in a cyclical (re)production of Nature-based Solutions (Figure 24). The cattle metabolically produce their bodies from within, still entangled in the production of their bodies for consumable food products. While within the self-generative spiral of their own growth, they are also producing the conditions for other life, ripping up grasses with their teeth, ruminating alongside microbes, chewing and rechewing their cud, and excreting this matter as fermented nutrients into the soil. With their hooves, they till their muck and wee into the soil creating a mat of grass, regenerating the soil organic matter to grow more grass which they will then eat, connecting self-production through consumption [labour for life (Arendt, 1958)] with the probiotic labour to create the conditions for grass, microbes, dung beetles, and more. In order for this regenerative

agricultural production to be maintained, the cattle are made to labour reproductively, producing new workers to continue the connected cycles.

While not (currently) enrolled in agricultural systems in which their bodies may become the product[3], beavers labour probiotically: their own growth and lives predicated on the conditions of life they create for other species. As a surplus for the production of the conditions for their own lives (Beldo, 2017), they produce conditions of life for other ecosystem elements. In order for the Nature-based Solutions they become to be maintained and sustained, the beavers are made to labour reproductively, selected to mate in particular pairs and expected to produce kits that disperse and continue the probiotic labour cycle elsewhere.

In both cases, through a choreographed, (sym)biopolitical management, nonhumans in NbS affect the flows of things through their bodies—internally or externally—and transform matter around them and through themselves. The interconnection of these (for life) cycles—and the human choreography (Chapter 5) of them—holds some significance for the animal labourers. This probiotic labour is significant for these species considered 'keystone,' as it is their ability to labour in such ways that enfleshes them into these NbS projects. The justification for their use, or reintroduction, in such spaces is due to the way that they labour (Welden, 2023) in such cycles, self-generating and self-sustaining, their superior capacities for metabolic work justifying their continued enrolment/enmeshment/enfleshment in such projects (Palmer, 2021).

[3] Historically, beavers were hunted for their fur in the production of hats, though they were not farmed (Poloquin, 2015).

On a smaller scale, the interconnected cycles of labour also affect the expectations humans have of what the animals *should* do: how they should labour and what they should produce. If labour is cyclical, then certain cycles may be anticipated.

> *[The cows will] come through all of this, and they'll crush all of that. I'm certain of it. they'll probably knock over a few of the dead ash as well…Get that laying down. The boys have got a lot of work to do in here. (Regenerative farmer)*

There is a presumed certainty to the ways in which nonhumans will labour in these spaces, doing ecological, 'natural' jobs. As spaces are planned for Nature-based Solutions projects, the planning assumes particular outputs, as the nonhumans labour in these cycles, transforming environments from one shape into another, through consumption, through material alterations, through management of others, and through reproduction.

> *The beaver is always talked about as the architect […] He's gonna be here, and he's gonna build the biodiversity…We're gonna see the insect life go up. We're gonna see filtration in heavy rainfall events. And then the birds will come. (Regenerative farmer with beavers)*

As this human participant showed me around the beaver enclosure on his farm, in which three beavers had recently been released, he spoke of the ways in which the landscape would be transformed through beaver labour. This cycle allows humans to presume what kind of work will be done in advance (Wakefield and Braun, 2019).

However, given the nonhumans enrolled in these projects are enrolled *because of* their liveliness, there must also be space allowed for these cycles of labour to be disrupted by their liveliness/agencies, to be affected by the more-than-human choreography occurring beyond their mobilities (Chapter 5). The acknowledgement of the choreography of labour, rather than its delegation—where one can labour for the life of another (Arendt, 1958)—requires the recognition of multispecies connection under the rationale of multispecies collaboration (e.g.

Welden, 2023) (Chapter 7). Without this, presumed 'resistance' to the assumed, layered metabolic cycles can come with deathly consequences for the animals (Holloway, 2007), for 'if nonhumans do not work as desired, their conservation [may be] left without rationale; their lives valued for use depend upon them being good labourers' (Welden, 2023, p. 7).

4. Metabolic Labour Making Animal Infrastructure

> *I just think that a landscape without any large animal impact is not really working. (Regenerative farmer and Beaver organisation director)*
>
> *If you've got beavers here as well, they're probably one of the most influencing benefits that you can have in the landscape. (Beaver enclosure manager)*

Seen as key(stone) to producing the 'landscape' of Britain—producing a landscape which 'works'—cattle and beavers are lauded for their life-producing, landscape-producing abilities, able to transform themselves and the materials around them in material relation. Thus, to capture such material relation, animal bodies are being *enfleshed* as infrastructure to (re)produce the organised practice of Nature-based Solutions, capturing the layered cycles of metabolic, probiotic, and reproductive labour. As Barua (2021) discusses in his review of nonhuman infrastructures, 'corporeality and substrate meld or the habitat and habitats of living beings become synonymous with infrastructural environments (p. 1467)'. In the case of NbS, however, I must go one step further to think about how the corporeality of the animal bodies—not just habitats—become synonymous with infrastructure to uphold environments and make landscapes 'work'. And, I think about how this is done through these regenerative cycles of metabolic labour.

To begin, I want to review the fundamental relations between metabolism, labour, and infrastructure, as they've been discussed in this Chapter. First, metabolism is the conversion of

matter into different forms (Landecker, 2013). Infrastructure enables the movement of such matter (Larkin, 2013), is the architecture for the circulation (Swyngedouw, 2004), and thus creates the conditions for metabolism to occur. So too does metabolism provide the justification for infrastructure's existence. Labour, then, is entangled between the two, producing the conditions necessary for life, moving in the cycle prescribed by metabolism, and regenerating the life process (Arendt, 1958), metabolically making infrastructure (Barua, 2021). So, while the previous section described how animals are labouring within systems of NbS, in this section I seek to bring the infrastructural element to the fore.

To start, I take the case of cattle in 'nature-based,' 'regenerative' farming systems. I witnessed the animals' layered cycles of labour: from their rumens to their hooves to their controlled breeding for the ideal labourer. They were sometimes cast as the 'tools' for carbon sequestration or partners in biodiversity gardening *['I wouldn't say tool. I would say assistants, you know, they're my little gardening assistants' (regenerative farmer)],* but in all cases, farmers agreed that the life-producing, landscape change that they were targeting could not be done without the cattle's body-work. In regenerative farming in particular, these cycles are coopted, entangling with human labour (Battistoni, 2017; Beldo, 2017; Wadiwel, 2018) as the farmers move the herd from pasture to pasture. This system though, both requires and builds an infrastructure to circulate ecological matter to 'build' landscapes. These cycles—and the ecological labour their layering constitutes—become the infrastructures to circulate and transform matter, for life; they become the infrastructure of NbS. And, as these cycles are performed by the nonhuman animal bodies, unable to be (re)produced by human or machine (Beldo, 2017), it is the labour that *enfleshes* animals as infrastructure.

This too occurs in the beaver spaces, though their embodied cycles of labour have slightly less embodied human coordination than that of cattle. While many of their lives and labours are held-in-place by Natural England-approved enclosures, their layered cycles of labour involve less direct human involvement, more in line with Lorimer's (2020) 'controlled decontrolling of ecological controls' (p. 107). Barua (2021) considers those animals enrolled in such activities, namely beavers, to be 'ecological infrastructure.' Further, through this study, I have shown that through the layered cycles of labour, those animals enrolled in NbS projects are enfleshed as 'provisioning infrastructures,' or those which provide ecosystem services through metabolic labour (Barua, 2021), even if it is not metabolic in the traditional, meat-producing sense. This signals a need for the expansion of metabolic labour beyond infrastructure, to include the animals who too produce themselves, for the labour they are made to do. However, these animals go one step further. Rather than just providing 'services' to ecosystems, they are building ecosystems with and through their bodies. Thus, a combination and expansion of Barua's (2021) modes of infrastructure is necessary to capture the animal enfleshment with infrastructure in NbS projects. As it requires and enfleshes distinctly animal bodies in the context of this study, I term it animal infrastructure.

One of the dangers and drivers for infrastructuralising animals through their labour—and putting in place NbS more broadly—is 'reorganising work and fueling the creeping neoliberalisation of those infrastructures that provide staples and public goods' (Barua, 2021, p. 14). Outsourcing labour to 'low-wage labourers' like beavers (Woelfle-Erskine, 2015) to produce, and reproduce, landscapes naturalises the need for work to be done by nonhumans (Lorimer, 2020). For example, one farmer argues how the cattle produce 'free' grass for the farm and better water filtration: '*ultimately you realise that grass is free. If you increase your mobbing, you get more grass*.' This then spirals up to further grazing and further production

of grass. Inherent in animal infrastructural design, labour is built into the production of these ecosystem services. By organizing nonhuman labour to constitute infrastructures of NbS, there is an outsourcing of 'free' labour, for life.

This life is multi-layered. First, you have the life of the animal enfleshed through labour as the infrastructure. Their life, or lives in the case of a herd of grazing cattle, produced through cycles of metabolic, probiotic, and reproductive labour, is and are necessary for the functioning of the infrastructure, for the circulation of ecological matter to produce—and reproduce—a Nature-based Solution. To what end? Their lives as animal infrastructures produce the conditions for more-than-human life, produce 'landscapes' that go on to circulate, or 'work' themselves. It is these labour capabilities which make particular animals eligible to be infrastructuralised as animal infrastructure in NbS. The product of beavers' labour—namely dams—create the conditions for not only their lives, but for other more-than-human and human life as well. The product of cattle's labour produces their bodies and produces soil organic matter, making agricultural space livable for on-farm biodiversity. Thus, in animal infrastructures, 'the labour of some suffices for the life of all' (Arendt, 1958, p.88). This is inherent within their design.

However, must this practice of making animal infrastructure be instrumentalising or exploitative? Barua (2021) argues that while more-than-human infrastructures may be put to capitalist ends, 'there is nothing inherently capitalist or neoliberal about more-than-human infrastructures: they are amenable to capture but the latter does not always have to be the default position' (p. 1482). Thus, we can see how different animal infrastructures in NbS may resist capture by capital while still producing the conditions for more-than-human life, in common. This will be drawn out in the following Chapter.

5. Conclusion:

As this Chapter showed, animals are not only becoming infrastructure through their discursive *enrolment* framing them as Nature-based Solutions (Chapter 4), nor through their mobile *enmeshments* with human infrastructure (Chapter 5); rather, through nested cycles of labour—metabolic, probiotic, and reproductive—to produce a multiplicity of life, animals are *enfleshed* as infrastructure, within and outside their bodies, in intergenerational ways to continue the production of 'nature' in NbS. I explored this through my cases, focusing on the specific acts of metabolic labour targeted by *enfleshment*. Through these cases, I explored the 'body-work' (Barua, 2018) of regeneration, laying out my layered model of productive metabolic labour, probiotic labour, and reproductive labour, which circulate, enfleshing animals as infrastructure.

By carefully unraveling the forms of more-than-human labour that go into producing and reproducing Nature-based Solutions, the relations between metabolic, probiotic, and reproductive labour are made clear. By viewing nonhuman labour through this case, we are able to see how the cycles are nested within each other, one justifying the next: the metabolic labour that self-produces the animal body, and probiotic labour that produces the environment, justifying reproduction to 'continue the work' that both constitutes and produces a particular Nature-based Solution. The temporality of Nature-based Solutions extends beyond a singular animal life. Importantly, the preceding analysis demonstrates how probiotic, ecological labour in the context of NbS necessarily includes these nested cycles. In Barua's (2019) review of the dimensions of animal work, metabolic and ecological labour are distinct from each other: 'In contrast to highly orchestrated work and intensively metabolised labours of farm and industrial animals, ecological labour is largely contingent upon an organism's quotidian rhythms and ethological propensities' (p. 655). What this analysis does, however, is demonstrates how

within Nature-based Solutions—or other 'probiotic' interventions (Lorimer, 2020)—these forms of animal labour are connected in a wider cycle.

Probiotic labour in this instance is constituted by ecosocial reproduction (Battistoni, 2017) to reproduce and regenerate ecosystems (Barua, 2019), and the choreography of such reproduction is for the continued metabolic labour that makes animal bodies and probiotic labour that makes ecologies alike. The case of NbS demonstrates one of the ties between metabolic and probiotic labour is reproductive labour—sometimes a sexualised violence of a body to produce other bodies for meat production, as in the case of cattle (Coulter, 2016; Gillespie, 2013), and sometimes as a human-nonhuman assemblage of work (Kosek, 2010) that may take different forms in reproducing livable landscapes as in the case of (many) beavers (Welden, 2023). Because NbS is so place-based, however, there are multiple iterations of metabolic, probiotic, and reproductive labour occurring, with different consequences for the animal bodies *enfleshed* as the infrastructure making the conditions for more-than-human life. These differences and possible futures require further exploration and thus will be considered in depth in the following Chapter.

Chapter 7: Conclusion

The futures for animals enroled, enmeshed, and enfleshed as infrastructure

1. Scaling up from the scaled down

Over the past six Chapters, this thesis has demonstrated the importance of studying 'scaled down' Nature-based Solutions, scaling down from narrative framings that place animals in NbS (Chapter 4), to the assembled and choreographed relations that make up a given NbS (Chapter 5), to the intimate metabolic bodily labours that (re)produce life of/for a NbS (Chapter 6). In this concluding discussion, I begin to scale back up, bringing the lessons learned from the scaled down to the reality of the rapid scaling up of NbS interventions (e.g. Cohen-Shacham et al., 2019; Seddon et al., 2022), and considering what this may mean for the futures of the animals enroled, enmeshed, and enfleshed as infrastructure.

In Chapter 1, I set out the three Research Questions which guided this thesis:

1. How are nonhuman animals made to be infrastructure—enroled, enmeshed, and enfleshed—within the context of Nature-based Solutions? (RQ1)
2. How does 'animal infrastructure' come to be known by the animals and humans involved in particular Nature-based Solutions projects? (RQ2)
3. What is the significance of the infrastructuralisation of nonhuman animals, for both the animals and humans involved? (RQ3)

Over the three analytical Chapters, I analysed *how* animals are infrastructuralised in and through the organised practice of Nature-based Solutions, storied and choreographed into material relation with the environment to produce and reproduce the Nature-based Solution intervention. In exploring the dimensions of that question, the expanded typology of enrolment, enmeshment, and enfleshment was developed, detailing three processes by which animal

bodies are made to be infrastructure and leading to theoretical contributions to more-than-human research, outlined below. Exploration of the second, epistemological question appeared primarily in Chapter 5, where I developed choreography as a novel mode of more-than-human knowing and relation. Finally, answers to the third question on the significance of infrastructuralisation for animal bodies exist throughout the analytical Chapters, as I draw out what each of the forms of infrastructuralisation means for animal bodies and subjectivities. However, I expand the discussion in this Chapter, ruminating on the significance of the 'scaling up' of Nature-based Solutions and the consequent infrastructuralisation of animals for the *different* species in *different* NbS contexts, measuring the impact of/on these animals' lives through the criteria of multispecies collaboration (Welden, 2023).

I developed multispecies collaboration for this purpose: to consider, carefully, the ways in which humans and animals become 'capable, with each other' in troubling times, to use Donna Haraway's (2016, p. 1) terms. Writing specifically in the context of Nature-based Solutions, I write, 'multispecies collaboration is grounded in interspecies solidarity, constituted by multispecies community, and defined by *consensual work*, *respectful relations*, and *shared purpose*[1], opening imaginative possibilities for both working *with* and living *with* nature' (Welden, 2023, p. 12). Expanding Coulter's (2016) interspecies solidarity and humane jobs to include animals outside domestication, my framework of multispecies collaboration provides criteria off which to judge the significance of projects—like Nature-based Solutions—on both wild and domesticated animals' lives:

> First, by meaningfully acknowledging and responding to the 'wild' animal agencies, […] one may confirm suitability for, and interest in, the 'job'. As collaboration requires meeting one's own concerns as much as it does meeting one's collaborator's (Killmann & Thomas, 1977), interest and suitability are prerequisites for entering into a multispecies collaboration. In addition, 'wild' animal consent can be gained (Yandaara with Gumbaynggirr Country et al., 2021): consent to collaborate with more-than-

[1] Added italics for emphasis

> humans requires acknowledging their sovereignty by respecting boundaries and limits and 'follow[ing] processes of meaningful engagement, consultation, and sharing' (p. 710). Multispecies collaborations require animals be allowed to refuse the collaboration—walking (or swimming) away—even more possible for those animals considered 'wild' than 'domesticated'. Beyond their consensual presence, listening to and learning from the knowledge of nonhuman collaborators is necessary for a successful multispecies collaboration or humane job (Welden, 2023, p. 12).

Thus, in this Chapter, I use these measures (consensual work, respectful relations, and shared purpose) to evaluate the cases I have presented in this thesis. This helps me to draw out the significance for the animals enroled, enmeshed, and enfleshed and/in/as the infrastructure of Nature-based Solutions (RQ3). Against this framework, I ponder whether or not infrastructuralisation can be an affirmative—rather than instrumental (e.g. Giraud and Hollin, 2016)—form of more-than-human relation in the Anthropocene.

1.a. Measuring Infrastructure as a More-Than-Human Analytic

In the process of scaling down, the infrastructuralisation of beavers and cattle was made apparent, with Nature-based Solutions as the organising principle that creates and maintains the material relation between animal bodies and their environs, which produce and reproduce the NbS. While this infrastructural approach emerged from the data inductively, as I witnessed beavers and cattle made to enter into such relations (Chapter 3), I recognise its deductive origins, as infrastructural approaches in more-than-human research are developing as generative lenses, infrastructural analytics (Bowker, 1994) through which to look at Anthropocene-era environmental governance (e.g. Barua, 2021; Hetherington, 2019; Wakefield, 2019). As Hetherington (2019) writes, 'infrastructure itself was always also an interpretive tactic' (p. 6).

Infrastructure suits more-than-human geography well as a lens through which to approach Nature-based Solutions, by inverting the infrastructure to bring the invisible more-than-human

elements from the background to the foreground (Bowker, 1994; Star, 1999). Aligning with more-than-human geography, and its critical partners political ecology and biopolitics, infrastructure highlights assembled relationality—as infrastructure is made in relation (Berlant, 2016) and made real in relation to organised practices (Star, 1999). It also highlights the (governed) movement and rhythms of daily life (Berlant, 2016; Larkin, 2013) and the power, or political rationalities, that underlie a project (Larkin, 2013). These more-than-human, infrastructural criteria were thus aligned with the framework through which I approached my cases. Through this thesis, I have untangled the relations—material and discursive—that make up Nature-based Solutions, illuminating how the more-than-human makes up NbS through a capture of particular species' material relation with other more-than-human elements of the assemblage. These movements and rhythms of the animal choreograph their relations with others, choreographing their environments, while being choreographed themselves in an improvisational mode of bodily affect to create and harness NbS.

An infrastructural approach is thus a collective way to address many of the questions and commitments held by more-than-human geographers: relationality, governance, and power. Which relations make up a material and discursive environmental governance project? Whose mobilities and whose bodies are enrolled into its making? How is power exerted, who holds it, and how entrenched is it? My use of infrastructure in this thesis inserts power back into theories of assemblage, considering the ways in which key actors in the relational assemblage are organised to produce or reproduce the system in which they are enroled/enmeshed/enfleshed.

1.b. Infrastructure and Animal Lives

As certain animals are infrastructuralised through NbS, there are implications for their lives. Their enrolment as infrastructure shapes how animals—and the boundaries of what their lives

should be—are imagined: as nature, evoking a wild or rural past; as nature-based, 'naturalised' to be in relation with humans and technologies; and as Nature-based Solutions, framed to be the desired 'solutions' to anthropogenic problems. This framing 'opens up' (Stirling, 2008) certain visions for animal lives, and their relations to humans, while 'closing down' (ibid.) others outside of instrumentalisation; however, these futures are further interrogated and explored in Section 2 of this Chapter. Their enmeshment as infrastructure shapes animals' mobilities, as they come into contact with the human-made fencing infrastructure of NbS that holds them in place and/or makes them move. Through more-than-human practices of choreography, their everyday lives are negotiated between the animals, the humans, and the technologies with which they become enmeshed. Finally, their enfleshment as infrastructure impacts how animals' bodies are valued: as productive metabolic labourers—producing their own lives (Wadiwel, 2018)—probiotic labourers—producing the conditions for others' lives (Lorimer, 2020)—and reproductive metabolic labourers—reproducing their bodies and new life in the process of continuing this environmental labour (Collard and Dempsey, 2013). If their value is contingent upon their labour, which enfleshes them as the key infrastructure of the NbS, their lives become contingent on being good labourers in some cases (Welden, 2023).

However, by using my concept of multispecies collaborations, I can attempt to determine whether the enrolment, enmeshment, and enfleshment of animals is exploitative, instrumentalising life (e.g. Giraud and Hollin, 2016) through infrastructuralisation, reducing animals to mere tools for the production of NbS, or whether there are affirmative pathways under interspecies solidarity (Coulter, 2016) for these inherently multispecies projects. As I will trace in the following section, this comes down to the species, the individual animals, the contexts, the human managers, and the heterogeneous relations of NbS I witnessed in different places. Are the animals and humans involved in NbS projects choreographing (with) each other

in a relation of working *and* living together, or is there limited room for animal agency, refusal to work, and shared benefits as animals are infrastructuralised? Viewing similar cases from an infrastructural perspective, thus, demonstrates how the infrastructuralisation occurs under the premise of NbS, as discussed in Section 2.

While considering the ways infrastructure *may* be an affirmative multispecies collaboration for *some* animals, I want to be clear that animals and/in/as infrastructure is not the only possible future. While critiques of such infrastructural approaches surround the ubiquity and conceptual unruliness of infrastructure (Larkin, 2013), this thesis shows that not everything is infrastructural. As Star (1999) makes clear, infrastructure is only made real in relation to organised practices; thus, without the organised practice of NbS—or its related subprojects: regenerative agriculture, beaver restoration, natural flood management, etc.—the animals discussed in this thesis would not be infrastructuralised. Their stories, their movements, their bodies may still exist in relation to the environmental or political assemblages around them, but they are not made infrastructure unless organised around and through the particular structures of NbS. Alternatives to infrastructuralisation do exist.

In the rest of this Concluding Chapter, I begin by exploring some of these possible futures, first for beavers and then for cattle in Britain. Still drawing from fieldwork data, I discuss these different possibilities from the ground up, following a 'scaled up' trajectory of NbS, and addressing my third research question around the significance of infrastructuralisation for animals' lives. Through this comparison, I illuminate the ways in which NbS and infrastructure operate differently for different species: with beaver *enrichment* as/through infrastructure and cattle *entrapment* as/through infrastructure. I then return to this thesis' analytical Chapters, drawing out the key contributions from each Chapter and considering areas for future

research—with and without an infrastructural approach. Finally, I conclude the thesis by redefining Nature-based Solutions with the more-than-human infrastructure at the centre, ruminating on what it would mean for the animals involved if their foundational contribution to the production and reproduction of NbS were to be recognised at an upscaled level.

2. Futures for Animals Enroled, Enmeshed, Enfleshed

Now that I have shown *how* animals become infrastructure in/and/of Nature-based Solutions (RQ1), and considered the ways in which they are *known* as infrastructure (RQ2), I ruminate on the significance of this for beavers' and cattle's futures—considering both the impacts and alternatives of infrastructuralisation. I use multispecies collaboration as an analytic and a measure off which to gauge the relative affirmative or instrumentalising nature of particular NbS interventions, with particular animals. I thus consider the two cases separately, for while beaver and cattle lives become entangled through Nature-based Solutions, their differences—and the different ways in which they are infrastructuralised—mean the prospects for their futures under, or beyond, Nature-based Solutions diverge.

2.a. Beaver Enrichment

As illuminated in the preceding Chapters, the current regulatory structure for beaver reintroductions in England is into fenced enclosures licensed by Natural England (Pouget and Gill, 2021). In Scotland, there are both wild and enclosed releases (Jones and Campbell-Palmer, 2014), and in Wales, planned releases have not yet started, though beavers have appeared in Pembrokeshire (Halliday, 2023). Thus, as of now, there are two pathways through which beavers are reintroduced as Nature-based Solutions in Britain: enclosed releases and wild releases. I measure these current prospects against multispecies collaboration, considering whether or not beavers and humans in the different pathways are participating in consensual work, with respectful relations and a shared purpose. I return to the data, contemplating what

futures are imagined, negotiated, and preferred by the different human participants, often in response to the choreography of the beavers, the shifting policy environments, and the scientific research. I then consider how the infrastructuralisation of beavers enables or disables those futures, with the possibility of *enrichment* through infrastructuralisation: for beavers, for humans, and for environments.

The current pressing question in English beaver reintroduction is whether the enclosure walls must stay up or whether they can be removed, allowing beavers the (relative) autonomy to move into river catchments. As noted in Chapter 1, while DEFRA's (2021) consultation concluded that *managed* wild releases of beavers should be allowed due to the benefits beavers bring to the British landscape, the current government has made no effort to change the current policy on enclosed releases (Horton, 2024). This uncertainty was a prominent theme in my go-alongs, sparking conversations of different imagined and preferred futures for beavers in Britain. For example, while walking through a beaver enclosure with one of the site managers and two beaver researchers conducting research on the site, we discussed the future, mainly of the fences, thus intricately *enmeshed* with the future of the beavers:

> *Site manager: [We site managers are] looking towards catchment wide release, as soon as possible, sort of dependent on PhDs and monitoring.*
>
> *Researcher 1 (PhD candidate): I'm holding it up a bit, aren't I?*
>
> *Researcher 2: It's also national strategy, isn't it? We're all in this grey area at the moment … where there's been the public consultation, they've promised us results … the suggestion is that there will be further wild releases, but no one knows under what conditions that will be. So that's the big pain, for not so much us as scientists, but for you guys [referring to the site manager], so you don't know what the rules are gonna be next month.*
>
> *Site manager: We've got a bit of an idea just from what information they put out with the consultation, obviously, with feedback from that, like it will change. So it's hard to be completely prepared for applying for a catchment-wide release license. I know our site's probably favourable because we own our river catchment, the entire catchment. So we don't have as many*

> *stakeholders and sort of other people involved to kind of have permission to do it. Basically, what we say, goes…I think we were probably in a fairly fortunate position that most people are quite keen on [the beavers].*

This conversation highlights the different dimensions of uncertainty around beavers' futures as Nature-based Solutions in England. Whether they will be enclosed or not depends upon a policy decision being made from the positive DEFRA (2021) consultation results; and once that decision is made, it depends upon the place-based context (land ownership, stakeholders, rural or urban environment, etc.) *and* whether ongoing beaver research must be completed in a controlled, enclosed environment. As Researcher 2 notes, the uncertainty for scientists is one thing, but the uncertainty for the site managers leaves them in a place of constant anticipation and changing plans. These are changing plans that affect the beavers, yet in this conversation, are more dependent upon human 'stakeholders,' land ownership, and PhD research—the humans situated in place relative to beavers in the British environmental political order (Crowley et al., 2017).

To measure the case of the continued enclosure of beavers against the criteria for an affirmative, multispecies collaboration does not depict a future of affirmative multispecies relations, under interspecies solidarity. Rather, as the beavers are made to be infrastructure and enmeshed with the enclosure fences—even if enmeshment is a more entangled analytic than enclosure (Chapter 5)—the context limits the capacities for consensual work from the beavers. Rather, by attempting to hold the beavers in place with fencing infrastructures, their infrastructuralisation removes the wild animal ability to refuse work by physically leaving the place where an invitation to 'collaborate' was issued (Yandaara with Gumbaynggirr Country et al., 2021). Enclosures cast the beavers as liminal species between wild and domestic, as their ability to leave an encounter, removing themselves from the work, is refused itself. Instead, beavers in enclosures align more closely with Giraud and Hollin's (2016) concept of 'affective

tinkering' with another species, where what I term 'choreography' (Chapter 5) is relatively directed by the humans, and the animal qualities (e.g. dam building, propensity to escape the enclosure, etc.) are tinkered with, encouraged in some cases and discouraged in others, to mould species into being the instruments, the infrastructure, of an experiment.

In the case of wild releases, or the removal of enclosures, a different future can be imagined. To anticipate the impact on the beavers themselves if the enclosures were removed, I turn to Scotland for examples of what beaver lives may entail in Britain as a whole, beyond enclosures. As an organisation director and beaver restorationist shared with me:

> *So obviously, in Scotland, we've got like, the most wild living beaver populations, and probably in real conflict areas. So prime agricultural land. I've got various [work] contracts all over the place, but day to day is trapping and relocation, relocating animals and mitigation.*

Without the enclosures, human-wildlife conflict mitigation becomes a key element of beaver reintroduction in Britain, where beavers' mobilities are still managed, but through trapping and relocation instead of holding them in place. Ward and Prior (2020) analyse the Scottish beaver example through the lens of biopolitics, noting the different forms of autonomy beavers have in or outside enclosures. Within enclosures, they are allowed autonomy only within the boundaries of the site, secured natural containment. However, in wild releases, their autonomy is still managed in some ways—through practices of trapping and relocation as noted by the organisation director—'allowed for' in some landscapes, but not in others (Ward and Prior, 2020, p. 31). Still, in the wild releases in Scotland, Ward and Prior (2020) note that the beavers had more agency and thus were able to guide legislation to secure their own species, unlike those managed in enclosures. As one beaver researcher argued:

> *The average person, even the most negative people, once they see what beavers do, they're not really going to have a problem.*

This speaks to Ward and Prior's (2020) points: if the beavers have the autonomy to demonstrate their 'Nature-based Solutions' benefits outside enclosures, where people can interact with them without (much) conflict, they can influence perceptions and human-beaver 'renewed' coexistence (Auster et al., 2022b) and foster an experimental approach to co-inhabiting with beavers (Crowley et al., 2017).

With beavers outside enclosures, then, there is the possibility for a shift in more-than-human political order (Crowley et al., 2017). In the Devon case studied by Crowley et al. (2017), the state moving to capture 'wild' beavers led to a response from the human community around the river, in which the locals 'made political and material moves to protect beavers on the grounds that they "belonged here:" as community members, wild lives, and British/European natives' (p. 1847). Once multispecies community (van Dooren, 2019) is established with beavers and/in/as Nature-based Solutions, with humans and beavers *living with* each other, the possibilities for multispecies collaboration is opened up (Welden, 2023). Thus, these unenclosed futures for beavers in Britain are possible—and possibly affirmative—if the beavers are given space, according to one researcher:

> *Beavers will have most impact, where they can reconnect the channels and floodplains, you have space across the landscape, and in those landscapes, it seems that they will provide significant downstream natural flood management benefits along with a whole host of other benefits. So that's the kind of key thing for me, it's that kind of more, looking at the landscape and how it all fits together. And seeing beavers could have these fantastic impacts in certain places, if they're given space.*

In this imagined future for beavers in Britain, the beavers have the autonomy to reconnect hydrological landscapes, *providing* benefits associated with Nature-based Solutions. These benefits are shared amongst humans, beavers, and environments, as in the case of humane jobs in multispecies collaboration. Further, they have the autonomy and space, as noted by the

researcher, to determine *where* to be and *where* to dam, denoting consensual work. In this case, there is also a respect for beavers' work and decision-making on/for the landscape, even if the decisions are different to those made by humans. All of these elements make possible the affirmative potential of multispecies collaboration for beaver reintroduction in Britain (Welden, 2023). This does not mean there will be an absence of conflict. The researcher qualifies this future in anticipation of such conflict, noting that these *'fantastic impacts'* can be realised in certain places, with space given for the beavers to live. Imagined is thus a bounded ideal, where beavers are unenclosed by material fences, asserting their own political power and shifting the political order through government-multispecies community negotiations (Crowley et al., 2017; Ward and Prior, 2020). In this future, the beavers are still acting as Nature-based Solutions to provide environmental benefits to the multispecies community (Welden, 2023), but only in certain (at least partially human-determined) places, where there is space for their beaver-led landscape orderings, their choreographies. This does not negate a multispecies collaboration, but it does bound it in this context.

In this particular future, the beavers remain enroled, enmeshed (perhaps not with enclosure fences, but with coexistence technologies like flow control devices or BDAs), and enfleshed as Nature-based Solutions infrastructure, their existences—even outside of enclosures—choreographed amongst themselves, the humans living with them, and the government policies dictating their handling. Their lives and mobilities are tied to their behaviour as the infrastructure of NbS, in material relation with their environment to produce certain (albeit shared) benefits and practices. Beavers' enrichment of the environments—their being as infrastructure—is what may lead to their release from enclosures and the subsequent increase in their own autonomies (Ward and Prior, 2020), an enrichment of their own lives. Their infrastructuralisation as NbS *can* thus be a stepping stone to working with and living with more-

than-human others in multispecies communities, an argument for their (renewed) existence in the landscape that then opens up possibilities for increased beaver agency. Multispecies collaboration (Welden, 2023) in the (re)production of Nature-based Solutions is a form of choreography, where humans and beavers doing environmental work *together,* negotiating differences, and reacting to each other's bodies and intentions, may include the infrastructuralisation of beavers. But, it may also lead to their release from being infrastructure altogether—their existence no longer justified by their ability to collaborate for imagined future benefits.

What would it look like for this release to occur, for beavers not to be infrastructure, consensually exiting their multispecies collaborations? For this, we can turn to examples of beavers in Britain who are not infrastructuralised, not organised by the practices of NbS to choreograph their material relation to the environment:

> *I think people are under estimating [beavers' mobilities] and it's like, there's still so much habitat in the whole of Britain, and so they're spreading like rapidly … Beavers are so mobile, and they're so adaptive. [People say], oh, they must have trees and must have this really strict criteria for release. And like most of the beavers in Scotland are living in the smallest agricultural ditches. There're no trees around, there's very little water, but they are just absolutely fine. And they're big, healthy, robust animals (beaver organisation director).*

Beavers—as with any animals in some infrastructural entanglement—can behave unexpectedly (Wakefield and Braun, 2019). They can survive—and thrive—in places that are not carefully curated by humans for beaver reintroduction. As the organisation director noted, they are adaptable beings, who also do not always behave as predicted. In the agricultural ditches, with little trees and water, they live, and not as infrastructure. This example depicts beavers living outside of infrastructuralisation. They are not enroled as infrastructure through stories of their abilities; they are not enmeshed as infrastructure through their relations with humans and fences

choreographing their lives; and they are not enfleshed as infrastructure through the capture of ideal cycles of metabolic, probiotic, and (re)productive labour. Their bodies are not enroled/enmeshed/enfleshed in material relation with their environment to make Nature-based Solutions. The beavers in the agricultural ditch may not be solutions, but they are not problems either; they are just beavers living in Britain.

And thus, we can see multiple futures for beavers in Britain: a maintenance of the status quo, where many beavers remain instrumentalised as NbS infrastructure in enclosures; a removal of enclosures which leads to choreographed multispecies collaborations, where beavers remain as the infrastructure of NbS; and a removal of enclosures in which beavers can live without a requirement or expectation for them to make or be NbS. In reality, the future of beavers in Britain is likely to be a combination of all three—where some current enclosures remain for research and control, where wild releases are approved with beaver autonomy increased but still managed to produce NbS benefits, and where some beavers do their own thing, behaving unexpectedly and not damming (as long as it does not cause conflict). Even with these caveats, it is clear that beaver infrastructuralisation as NbS can act as a stepping stone to beaver *enrichment*: to their liberation from enclosures, to affirmative multispecies collaborations, and beaver autonomy. I am not arguing for infrastructuralisation as the ideal, just, nor only route for the enrichment of beaver lives; however, in this troubled, turbid Anthropocene, these unexpected collaborations amongst companion species and technologies and infrastructures are 'important to embrace' (Haraway, 2016, p. 3), and may provide unexpected pathways to life, together.

2.b. Cattle Entrapment

The futures for cattle, even under infrastructuralisation and/in/as Nature-based Solutions, look different to those for beavers. While beavers are centred within their Nature-based Solutions,

cattle are often sidelined as a part of agricultural production. In some ways, there are more dimensions, as regenerative farmers can make decisions for their own herds, on their own lands, outside of strict regulation or licensing. According to many of the farmers with whom I spoke, in the ideal case for regenerative agriculture as a Nature-based Solution, the future regulations out of ELMS and SFI would incentivise more farmers to transition to regenerative farming practices *and* pay current regenerative farmers for the transitions they have already made. However, regulations that make a meaningful impact and provide payment for past work do not seem likely. And again, those regulations are focused on the whole farm, the whole herd, rather than the individual cow/bull/steer/heifer[2]. In this section, I *ruminate* on the different futures for regenerative farming—centred on the cattle that are so key to this agricultural practice. I also measure this against my concept of multispecies collaboration, asking whether this is a possible affirmative pathway for them or whether they are instrumentalised to both produce themselves for meat and produce desired natures on the farm (Chapter 6), *entrapped* as the infrastructure of Nature-based Solutions in regenerative agriculture.

In its combination of agricultural production with environmental benefits, regenerative agriculture—integrating livestock through rotational grazing—purports to manage their cattle in a *better* way, compared to industrial agriculture (Cusworth and Garnett, 2023). 'Better' is quite an expansive term, its multitude of meanings encompassed by one regenerative farmer:

> *Basically what I want to prove is by [grazing livestock] in a careful manner, I can produce world-class meat. I can have really healthy, incredibly happy [animals]…The other one is carbon sequestration and storing that carbon, biodiversity increase, and holding water (regenerative farmer).*

Doing agriculture 'better' for this farmer, shows a layering of different lived realities for the livestock involved in this system. From the animal management, the farmer seeks to prove his

[2] Even in their etymology, cattle are either grouped together as a herd or distinguished based on their reproductive capacities and histories (Velten, 2007).

creation of *better* meat, *better* animal health and happiness, and *better* probiotic management of his farm, with 'solutions' aligned with Nature-based Solutions to climate change and biodiversity loss. While the cattle's lives are still wrapped up in (better) meat production, enfleshing them in life and death as infrastructure, this farmer claims their lives and their choreographies of/with the more-than-human elements of the farm make for a *better* farming system. Through this vision of regenerative agriculture, the cattle's subjectivities are produced through the 'spaces involved in the ways specific farm animals are "kept"' (Holloway, 2007, p. 1041). They become subject-to regenerative agriculture, cast as the happy, healthy choreographers whose lives end in the value-producing moment of death (Wadiwel, 2018). Reading this through the lens of multispecies collaborations, there are some shared benefits from the 'work' of grazing, that is done as an enmeshed infrastructural relation between farmers and fences and herds, where the cattle have some agency over the farm in a more-than-human choreography (Chapter 5). As I write, multispecies collaboration 'promotes experimental ways of thinking and working together' (Welden, 2023, p. 12), where an experimental partnering (Roe and Greenhough, 2014) went into producing the probiotic management of regenerative farms: the cattle's sensibilities respected, within the bounds of the electric fences. However, these bounds may prevent the realisation of multispecies collaborations here, as there are fewer opportunities for the cattle to not consent to the work.

Some farmers push back on this assertion, claiming the cattle do indeed consent to living and working together within regenerative agriculture. One regenerative farmer, who appeared in Chapter 4, reflected on his cattle's 'willingness' to participate in his grazing system:

> *We can do anything. If it's weed management, if its establishment of a new species on the farm, if we can use an animal and not have to turn a key and start an engine, that's really great, positive. And, you know, the farmer or whoever, doesn't have to sit on a machine bombing up and down a field for*

> *four hours wasting his life…[The cattle are] willing partners. They're complicit in the regenerative farming model.*

Here, the farmer imagines the cattle to be consensual, willing partners keen to move from one pasture to the next for fresh grass and in the process, do the metabolic, probiotic, and reproductive labour (Chapter 6) required for this kind of agriculture. There is a presumption of cattle willingness, consent to labour in this way to produce their own lives and, as a by-product, produce the conditions for other life on the farm (Arendt, 1958). In a domesticated setting, Coulter (2019) claims consent for humane jobs can be gauged by listening to the animal—engaging in respectful relations (Welden, 2023)—which looks different to consent with a wild animal, where the animal is able to walk away from the site of multispecies engagement. So, we see an opening for multispecies collaborations to be present on a regenerative farm; however, they appear limited and bounded by the ultimate death of the animal for beef production, compared to the (managed) autonomy that beavers may hope to achieve.

Other scholars may consider this infrastructuralisation of cattle as instrumental, not consensual, with the cattle's lives tinkered with to push their 'willing' participation in this model of farming (Giraud and Hollin, 2016). As Giraud and Hollin (2016) posit, while there is room for animals to *comply* within the system, following the tinkering nudges that respond to their animal affect, in the end there is no room for animals to object. On the contrary, I found the cattle could object to being infrastructure, breaking the electric fencing or refusing to graze, but this would lead to their removal from the system altogether, to their deaths:

> *These are 2020 sires of [one bull] who's now gone [to the abattoir] and Karate Kid who is now also gone because he had a bad attitude and smashed through our old fence (regenerative farmer).*

Thus, infrastructuralisation for cattle in regenerative agriculture is constitutive of their lives; the choice to object to their enmeshment is there, but it has significant consequences. Through

this limited capacity to exist outside infrastructuralisation, I argue that cattle in regenerative agriculture are *entrapped* as the infrastructure of Nature-based Solutions.

In one variation of regenerative agriculture—or a practice which uses regenerative grazing for purposes that *can* exist outside of meat production—conservation grazing provides another possible future for cattle in Britain. As noted by a regenerative organisation director, conservation grazing is emerging as an affiliated way to keep cattle, sometimes outside of beef production, while using regenerative grazing practices, though it is not without its tensions:

> *When it comes to the grazing management, this is a hot topic because the regenerative movement is very keen on mob grazing. And we have lots of farmers who are very keen on mob grazing…But then we also, I would say, have a big cohort of what you'd call conservation grazers for whom either biodiversity is the thing and it's not about […] carbon, for example. Because there does seem to be more and more evidence that mobbing increases kind of water storage and carbon sequestration. But if you're really focusing on biodiversity, or you're grazing a patch of land that needs kind of one cut a year and otherwise is managed for wildflower meadows or, you know, whatever the management practice is, you have a kind of inherent friction there. And I think there are people who are doing the mobbing who feel a bit shackled, unfairly shackled, to the conservation grazers who perhaps, you know, they might think it's kind of a bit idealistic.*

Conservation grazing, using livestock as a grazing tool to manage a site for wildlife and biodiversity, sometimes includes the slaughter of the livestock, but the production of meat is not central to the practice (Payne, 2020). However, the cattle within this practice are still enroled, enmeshed, and enfleshed as the infrastructure of Nature-based Solutions, as without their metabolic production of beef, the animals are more explicitly linked with the probiotic (re)production of biodiversity through their mobilities and metabolisms. Tensions exist, though, between these two methods of regeneratively grazing cattle, as the organisation director notes, with the farmers who mob graze in the production of beef considering the conservation grazers '*a bit idealistic*.' This tension, this frustration of being held to the ideal outside of beef production, highlights how farmers exist within a governance system in Britain

which influences their on-farm decision-making, their relative abilities to transform their systems in one way or another, and their relations with their cattle. Across Britain, 72% of UK land is used for agriculture, around 43.34 million acres, and only around 77,279 acres of farmland is (self-identified) under regenerative production (Regenerative Farmers of the UK, n.d.). Thus, most farmers using regenerative practices are doing their best to manage their cattle in a *better* way (e.g. Cusworth and Garnett, 2023), working to transform their farms from the antibiotic modes of land governance with chemicals and industrial production (Lorimer, 2020) to probiotic modes, where farmers attempt to 'use the food system to close the rift between the human and natural, and to achieve a mutually symbiotic state of flourishing' (Cusworth and Garnett, 2023, p. 1). Within the current system, including the infrastructuralisation of cattle *and* the capture of their value through beef production, regenerative farmers are transforming their lands with the cattle, through the cattle's enrolment, enmeshment, and enfleshment as infrastructure to provide the biodiversity and/or climate benefits.

Though the *better* futures for cattle remain entrenched/entrapped within regenerative agriculture, that does not stop some farmers from imagining something otherwise, where cattle exist outside their infrastructuralisation in something closer to—or even beyond—multispecies collaboration. As one regenerative farmer shared with me:

> *Sometimes when I'm like, in my most wild, I'm like, why are we doing this? I just want [the cattle] to be free. But then I'd be like, you've got to rip out the hedges, you've got to restore the moorland, you've got to get rid of the boundary fence and have them be able to go to all our neighbours' places if the wind's in the wrong direction. It's just not, it's not what the land is like, so it's a give and take kind of situation. And I do think as well, that the amount of people that we have that want to come here, there is something really important in being connected to the landscape and to animals. And you learn a lot from it, and people get a huge amount from it. And I think, why do we focus on a product? Why are we focusing on beef? We're beef farmers. Why are we focusing on beef, when actually, what we have and what we provide to the public is more than just meat? There's a lot more to it than that.*

Speaking to wildness, to an un-enmeshment from fences, to a human-landscape connection through animals, to a system of production of the probiotic, rather than the metabolic, this farmer imagines an unlikely future, yes, but a speculative fabulation (Haraway, 2016) which leads her to consider the variety of ways in which the cattle may be, may live, with and among others, in the British landscape. As Haraway (2016) notes, these speculative fabulations can lead us to 'follow a thread in the dark…where who lives and who dies and how might become clearer for the cultivating of multispecies justice' (p. 3). While I have shown that the cattle approached in this thesis are entrapped as the infrastructures of Nature-based Solutions in the *better* (than industrial) regenerative agriculture—where the *better* (than industrial) outcomes for their futures appear to be in the upscaling of their instrumentalised infrastructuralisation—the speculative fabulation future of a multispecies, more-than-human world is not to be dismissed. As we have shown in past work (Cusworth et al., 2023), regenerative farmers learn their agro-ethical responsibilities to more-than-human actors on and off their bounded farms through their practice of regenerative farming. While the cattle's futures—for now—remain entrapped as infrastructure within a meat-producing system, the regenerative farmers may imagine an even *better* system of multispecies community.

3. Key Contributions and Areas for Further Research

Beyond an expansion of Barua's (2021) typology of nonhumans and infrastructure, and the inclusion of animal and more-than-human geographies in the critical social science around Nature-based Solutions, this thesis has made some key contributions in each of the analytical Chapters. Below, I outline the theoretical contributions I make in each Chapter to the field of More-Than-Human Geography. I then turn to some areas for future research, as this thesis has—as expected—opened up more conceptual questions.

3.a. Enrolment's Development of Framing of/for the More-Than-Human

When more-than-human geographers reflect on the way discourses affect the more-than-human, they will often say that an animal, for example, was 'framed' as a producer, or 'framed' as a pest, or 'framed' as a problem. However, few of these studies engage in the rich literature on framing from communication studies. Thus, drawing on my background in this field, I use Chapter 4 to bring framing theory (Entman, 1993; Goffman, 1974; Lakoff, 2010; etc.) into more-than-human geography. In doing this, I drew out how beavers and cattle come to be framed first as 'Nature' in different ways, wild and pastoral, respectively. Then, I analysed how beavers and cattle are framed as 'Nature-based,' with beavers framed as rambunctious gardeners of the 'post-wild' and cattle framed as the 'natural' machine in the garden in the 'post-pastoral.' I finish with tracing the process through which beavers and cattle are framed as 'Nature-based Solutions,' aligning with the four steps of framing: problem definition, causal diagnosis, moral judgement, and remedy (solution) suggestion, from Entman (1993), demonstrating how through this framing, the animals become *enroled* as infrastructure.

The impacts of engaging with framing in this way became clear in this Chapter, as cattle—for example—are in part entrapped as infrastructure due to their initial framing as 'pastoral nature.' Thus, within Nature-based Solutions, they become bound within agricultural production, as production of cattle bodies is connected to the 'nature' they are framed to evoke. This connection is significant for MTH geography, as framing allows geographers to trace how material futures are tied to framings, demonstrating a cognitive resonance between the frame and what people want to do (e.g. Lakoff, 2004). Thus, there is a generative potential of framing theory for MTH geography. I also demonstrated in Chapter 4 how the MTH too influence and create frames, making worlds and thus calling MTH geographers to pay attention to these MTH elements of communication.

3.b. Enmeshment's Exploration of a More-Than-Human Choreography

While more-than-human and animal geographers often discuss the ways in which nonhumans relate to humans (or human design) in terms of resistance, objection, or excess, I challenge this with my development of more-than-human choreography as a mode of multispecies relation. Drawing on theory from performance studies and McCormack's (2008; 2014) reading of it, I develop choreography as a mode of world making and more-than-human relation/attunement (e.g. Frischkorn, 2023), which can address in an affective mode, the way that humans, animals, fences, and more come to relate, and react to, and affect one another. Beyond a call and response, or even a tinkering (Giraud and Hollin, 2016), choreography picks up on the rhythmic, improvisational, and experimental ways in which humans and nonhumans come to interact with and choreograph each other. It is attentive to bodily change, from multiple bodily perspectives at once. This can have wide impact on future MTH geography around more-than-human, assembled relation, providing an analytic of bodily relation with which to think through power from multiple angles.

Additionally, the concept of enmeshment works well as a way to think through and conceptualise the more-than-human choreography occurring in my cases. In contrast to enclosure, the dominant context in which animals and fencing are discussed, enmeshment acts as a more entangled lens through which to view the cases and the different fences within which beavers and cattle are enmeshed. This entangled lens, where animals can reappropriate or interact with fences in ways outside of force from the fence and a resistant response, allowed me to think about this interaction—and all of those occurring in my cases—as choreography. Enmeshment as concept should be considered in future studies concerning animals and fencing, as the relation allows for MTH emergence, beyond resistance.

3.c. Enfleshment's Arendtian Approach to Metabolic, Probiotic, and Reproductive Labour

Often, when more-than-human or animal geographers use Marx's labour theory to discuss animal labour, they are tasked with first acknowledging Marx's explicit exclusion of nonhuman animals from labour. Instead, I counter by using Arendt's theory of labour, which explicitly includes nonhuman life, with labour defined as the connector between all living organisms, as a life-producing force (Arendt, 1958). Using Arendt's theory of labour can expand more-than-human geographers' conceptualisations of nonhuman labour in different ways, as the product of labour is the life of an organism. This ties my analysis into metabolic labour, which has been traditionally conceptualised in agricultural production, but which I try to expand beyond the production of an animal body for meat to the production of the conditions for other life (probiotic labour) and the reproduction of life anew (reproductive labour). While I do not conflate the three, I use metabolism and an Arendtian approach to labour to link the cycles of labour together as indicative of the more-than-human 'work' that goes into the (re)production of Nature-based Solutions. It is this layered labour that enfleshes animals as infrastructure. This novel take on more-than-human labour can be reproduced and expanded by other more-than-human scholars interested in how labour (re)produces life, both outside and within agricultural production.

3.d. Areas for Future Research

As this thesis has shown, more-than-human living beings are being—and will continue to be—enroled, enmeshed, and enfleshed as the infrastructure of Nature-based Solutions, with different implications for their lives and the ways in which multispecies work and live, together. While I provided a comprehensive look at this process, through two case studies, this thesis has also opened up more questions and more areas requiring future research.

One area through which this thought can be further expanded is by viewing animal infrastructure through a welfare framework. What does animal welfare look like in the context of those animals being enroled/enmeshed/and enfleshed as the infrastructure of Nature-based Solutions? Does the current animal welfare legislation and the 5 Freedoms framework adequately capture this unique, probiotic position in which animals are placed? This would be a way to capture wider significance for the animals involved, beyond multispecies collaboration, or perhaps the two in conversation could generate interesting, and potentially impactful, findings.

Another logical next step from this thesis is to further develop the concept of choreography as a more-than-human mode of engagement and analytic. It could be expanded into other cases, seeing how it 'holds up' in different places, where animals' roles are conceptualised differently. Would choreography translate to lab animal research, or to seeing eye dogs? While infrastructure does not apply to all animals—if their material relation is not captured to (re)produce organised practices—choreography may capture a broader set of more-than-human relations. Based on its development here, I could see choreography having a distinct impact on animal geographies, if replicated and expanded in these directions.

Shifting from more-than-human theory to research designed for policy integration, I believe another area for future research should surround the integration of the more-than-human meaningfully into the growing policy-directed scholarship on Nature-based Solutions. This would begin with a redefinition of Nature-based Solutions with the more-than-human beings that make up the infrastructure of NbS at the centre (on which I make my start below). Translating the more-than-human makeup of Nature-based Solutions and developing the

research on Nature-based Solutions with the more-than-human at the centre, could prove to be impactful academically, politically, and materially for all involved.

4. Redefining Nature-based Solutions

I close this thesis with an attempt to redefine Nature-based Solutions as they have appeared throughout the last seven Chapters: with the more-than-human at the centre. This is an attempt to make visible the often-invisibilised infrastructure (Star, 1999) that subtends Nature-based Solutions, bringing the more-than-human drivers of material relation to the fore in an infrastructural inversion (Bowker, 1994). It is also an attempt to 'embrace the situated technical projects and their people' (Haraway, 2016, p. 3), making generative oddkin across both species and disciplinary divides by engaging with Nature-based Solutions rather than doing away with it. My hope is that this redefinition opens up opportunities for multispecies collaborations by a) bolstering the respect for the animals and their work in a given project, b) ensuring their work is consensual and unforced, and c) creating recognition over the shared purpose of mutual survival and/or multispecies community in the Anthropocene. Thus, I add my (re)definition to the Table of Nature-based Solutions definitions from Chapter 1. I invite others to play with it, expand upon it, and bring it forward within the scaling up of these more-than-human projects we term Nature-based Solutions.

Organisation (Person)	**Nature-based Solutions definitions**
E.A. Welden	Organised environmental practices which involve selected more-than-human bodies (often keystone species or environmental engineers) entering (or made to enter) into material relation with ecologies to (re)produce material transformations amongst more-than-human beings and things that benefit humans, biodiversity, and climate (Welden, this work).
IUCN	Actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits (Cohen-Shacham et al., 2016).
EC	Solutions that are inspired and supported by nature, which are cost effective, simultaneously provide environmental, social, and

	economic benefits, and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient, and systematic interventions (EC, 2015).
UN	Actions to protect, conserve, restore, sustainably use, and manage natural or modified terrestrial, freshwater, coastal, and marine ecosystems, which address social, economic, and environmental challenges effectively and adaptively, while simultaneously providing human well-being and biodiversity benefits (UNEA-5.2, 2022).

Table 3: Varying definitions of Nature-based Solutions across (four) defining agencies (people).

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Appendix

Appendix A: CUREC Materials

A.1. Participant Information Sheet

Animal Infrastructure: The Animals Enrolled as Nature-based Solutions

PARTICIPANT INFORMATION SHEET

Ethics Approval Reference: SOGE 1A2020-100

1. ***What is the purpose of this research?***

   This research aims to investigate how some environmental projects involve non-human animals in order to mitigate climate change and biodiversity loss. The purpose is to better understand the way humans interact with animals in environmental projects and what this means for the way humans and animals may interact in the future.

   As someone who is involved in some of these projects and/or interacts with some of these animals, I am interested to know what you think.

2. ***Why have I been invited to take part?***

   You have been invited because you are a listed participant of an organisation involved with beaver reintroduction/regenerative agriculture.

3. ***Do I have to take part?***

   No. You can ask questions about the research before deciding whether or not to participate. If you do agree to participate, you may withdraw yourself from the study at any time, without giving a reason , by advising the researchers of this decision.

4. ***What will happen to me if I take part in the research?***

   Online: If you are happy to take part in the research, you will be asked to join me for an informal conversation (semi-structured interview) on a video platform (i.e. Zoom call). On this call, I will ask you questions connected to the work you do. This should take approximately one hour of your time. You can also ask to pause or stop the conversation at any time.

   When we hop on the call, I will talk you through the study procedures and give you the chance to ask any questions. If you are still happy to take part, you will then be asked to give informed, oral consent to participating.

   Following the interview, I may contact you for a second interview if I find there are further topics to discuss. However, there is no obligation to take part in a second interview.

I will ask for your consent to audio record you, so I can have an accurate record of your thoughts and/or opinions.

In-person: If you are happy to take part in the research, you will be asked to attend a 'go-along' with me, where we would have an informal conversation as we walk around the area where your 'NbS' project is/the animals are. I invite you to lead me around the place and show me aspects that you find interesting/important. The go-along should take approximately one hour of your time. You can also ask to pause or stop the go-along at any time.

When we arrive, I will talk you through the study procedures and vie you the chance to ask any questions. If you're happy to continue, I will ask you to read and sign a consent form.

Following the interview, I may contact you for a second interview if I find there are further topics to discuss. However, there is no obligation to take part in a second interview.

I will ask for your consent to audio record you, so I can have an accurate record of your thoughts and/or opinions.

I may ask for your consent to take some photographs or videos of the area and/or animals present where we are walking.

5. ***Are there any potential risks in taking part?***

There are minimal risks involved if you take part in this study.

A breach of confidentiality is a risk. This will be addressed and reduced by pseudonymising all data and storing it securely according to university guidelines, including encryption.

In-person: COVID-19 is a risk. This will be addressed and reduced by following of all government-mandated procedures at the time of the go-along. Further, I will contact you one day prior to our scheduled meeting, confirming that I have experienced no symptoms of COVID-19 and ask if you will do the same. If either party exhibits symptoms before the meeting, we will cancel or postpone.

6. ***Are there any benefits in taking part?***

There will be no direct benefit to you from taking part in this research.

7. ***What happens to the data provided?*** [1]

The information you provide as part of the study is the **research data**. Any research data from which you can be identified (name, date of birth, audio recording) is known as **personal data**. It does not

[1] Please refer to CUREC's Best Practice Guidance on Data Collection and Management (BPG 09)

include data where the identity has been removed (pseudonymised data). We will minimise our use of personal data in the study as much as possible.

Your responses will be psuedonymised.

The **research data** will be stored confidentially in a password-protected, encrypted, external USB drive in a locked cupboard or, if paper copies (including consent forms), will be stored in the department of Geography and the Environment at the University of Oxford (a state safe location) for at least three years after publication or public release of the work of the research, as per university guidelines.

Personal data will be stored confidentially using a password-protected, encrypted, external USB drive in a locked cupboard as long as required for double checking research summaries and transcriptions. Once those are checked, pseudonyms will be used. If audio recorded, data will be stored in a password/biometric protected phone until transcribed, pseudonymised, and transferred to the USB device.

The researcher and supervisors will have access to personal/research data.

I would like your permission to use direct quotes against a pseudonym in any research outputs.

All research data and records will be stored for at least 3 years after publication or public release of the work of the research. We may retain and store your personal data for an additional period of time as necessary for the purposes of the study, and for further research.

We would like your permission to use pseudonymised data in future studies, and to share data with other researchers (e.g. in the UK Data Archive). All personal information that could identify you will be removed or changed before information is shared with other researchers or results are made public.

8. Will the research be published?

The research may be published in an academic journal or book.

The University of Oxford is committed to the dissemination of its research for the benefit of society and the economy and, in support of this commitment, has established an online archive of research materials. This archive includes digital copies of student theses successfully submitted as part of a University of Oxford postgraduate degree programme. Holding the archive online gives easy access for researchers to the full text of freely available theses, thereby increasing the likely impact and use of that research.

The research will be written up as a thesis. On successful submission of the thesis, it will be deposited both in print and online in the University archives, to facilitate its use in future research. The thesis will be openly accessible.

9. Who is organising and funding the research?

This research is being organised by the School of Geography and the Environment at the University of Oxford and is partially funded by a Sloane Robinson Scholarship and Keble College.

10. Who has reviewed this study?

This study has been reviewed by, and received ethics clearance through, the University of Oxford Central University Research Ethics Committee (Reference: SOGE 1A2020-100).

11. Who do I contact if I have a concern about the study or I wish to complain?

If you have a concern about any aspect of this study, please speak to Annie Welden [email: annie.welden@ouce.ox.ac.uk; Tel: +44 7756 311587], who will do her best to answer your query. The researcher should acknowledge your concern within 10 working days and give you an indication of how they intend to deal with it. If you remain unhappy or wish to make a formal complaint, please contact the relevant chair of the Research Ethics Committee at the University of Oxford who will seek to resolve the matter in a reasonably expeditious manner:

Chair, **Social Sciences & Humanities Inter-Divisional Research Ethics Committee**; Email: ethics@socsci.ox.ac.uk; Address: Research Services, University of Oxford, Wellington Square, Oxford OX1 2JD

12. Data Protection

The University of Oxford is the data controller with respect to your personal data, and as such will determine how your personal data is used in the study.

The University will process your personal data for the purpose of the research outlined above. Research is a task that we perform in the public interest.

Further information about your rights with respect to your personal data is available from http://www.admin.ox.ac.uk/councilsec/compliance/gdpr/individualrights/.

13. Further Information and Contact Details

If you would like to discuss the research with someone beforehand (or if you have questions afterwards), please contact:

E. A. (Annie) Welden
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Tel: +44 7756 311587
Email: annie.welden@ouce.ox.ac.uk

A.2. Scope of semi-structured interview/go-along transcript

Preliminary Scope of Questions:

This represents a starting point for semi-structured online interviews and go-alongs. Questions will vary depending on the responses of participants to researcher questions and the location if a go-along.

1. Introductory questions about their role in the organisation, the organisation itself, and how/why they got involved.

2. Questions about the political drivers of the projects: How do these projects come to be? (Funding, organisation, etc.)? resource questions more generally? Who are the interest groups, how is it sustained/ PROJECT STRUCTURE

3. Questions about the animals: How is animal x involved in the organisation/projects? Can you tell me about what the animal does? What impact does this have/why is it important? Could you do your job without x?

4. Questions about the human-animal relations: What is your relationship to the animal? How do you feel about the work the animal does? What is your role in the system?

5. Questions about the whole system: What needs to happen for the infrastructure (?) to function? Can you describe how the ecosystem works? What keeps this env looking the way it does? What are the key objectives of conservation/restoration in this area and what parts of that system help you do that?

6. Questions around Nature-based Solutions: How they feel their work aligns with Nature-based Solutions. What does NbS mean to them?

A.3. Example introductory letter to participants

Hello, I'm Annie Welden, and I am a PhD researcher at Oxford's School of Geography and the Environment. For my PhD, I'm broadly researching how some agricultural practices—like managed/mob grazing—involve non-human animals to mitigate climate change and biodiversity loss. The purpose of the project is to better understand the way humans interact with animals in these contexts and what this may mean for the future of governing agriculture and the wider environment in the UK. I'm passionate about this project, as I grew up working with horses (and some cows) on ranches in California, and I am excited about how livestock can play a role in shaping our agricultural and environmental policies.

To answer the broad questions, it's important that I get into the specifics and speak with people who are doing this kind of work. That's where you come in. You're probably reading this because you are a farmer associated with the PFLA, who is practicing mob grazing with your livestock. Because of this, I'm asking whether you'll help with my research by sharing your experience and expertise with me, allowing me to visit your farm. If I visit your farm, I would like you to show me how you do your managed grazing—you can walk/drive me

around your farm, introduce me to your animals, and/or show me what and why you do what you do. You get to choose what you think is most important to show me.

A typical visit like this will take about an hour or two of your time, depending on how much time you have. I may also ask you some questions as we walk and talk. Examples of questions are: why did you start managed grazing; what impact do the grazing animals have on the farm; could you do your job without them; what does your daily interaction with the animals look like; what do you see in the future for your farm? Your answers to these questions along with seeing this practice in action on your farm will greatly benefit my research, giving me an inside scoop into what happens when managed grazing is put into practice.

But, what's in it for you? While I cannot promise financial compensation, I can promise that your insights and stories will be shared (under pseudonyms for privacy purposes) with people working in policy spheres in the UK. This will happen as I present my research findings at academic and non-academic conferences, participate in policy engagement and collaboration, and publish in interdisciplinary, peer-reviewed journals. I will also share my findings with you, so that you may benefit from the research as well. Hopefully, the synthesis of everyone's stories of their unique managed grazing practices can be helpful to those looking for new tactics and/or expanding their practices.

Thank you for your consideration of my research project. If you have any questions, there is more detailed ethical information on the attached 'Participant Information Sheet,' or please feel free to reach out to me with any questions at annie.welden@ouce.ox.ac.uk or 07756 311587. I look forward to meeting you and learning from you!

-Annie

Appendix B: NVIVO Codebook

Nodes**Cattle**

Name	Files	References
Affiliation	0	0
Pasture Fed Livestock Association	3	3
Sustainable Food Trust	1	1
Care	1	1
Health (system)	9	17
Plant	1	3
scale and care	1	1
Self care + time	10	16
Welfare	8	12
Climate Change	4	6
Biodiversity	15	39
Carbon	17	35
Community	13	21
Celebrity	8	19
COW	0	0
Breed	12	24
Cow Narratives	10	14
Death and Welfare	12	25
Feeding	3	3
Friends of Cows	11	19
Grazing	9	18
Movement	16	69
Rumination	6	12
Technologies	13	41
Human-Cow Relations	10	22
Adaptive	9	14
Meat	9	14
Certification	5	7
production	6	8
value	5	5

Name	Files	References
Ecofeminism	8	13
Family	6	8
Finance	11	29
Big Companies	1	4
Grants	5	6
Infrastructure	2	2
animal	16	60
Enmeshment	4	5
tools	4	4
farming system	8	8
industrial	10	20
resistance	3	3
Knowledge	2	2
Labour-Work	9	21
Management	11	25
manipulation	2	2
Measurement	11	29
Nature based Solutions	10	13
Ownership + Tenancy	3	3
Policy	6	9
ELMS	12	15
Restoration	1	1
Scales	2	2
farm to global	6	10
molecular to field	6	10
field to farm	7	8
Soil	9	14
Pasture	4	7
golf course	2	5
Terminology	1	1
General Terminology	9	17
Grazing terminology	10	12
Transformation	14	31

Name	Files	References
futures	6	7
Over the Fence	8	16
Veganism	10	16
Water	3	5
Wild	9	22

Nodes\\Beaver

Name	Files	References
Affiliation	1	1
Agriculture + beavers	3	7
Class	2	3
Human-beaver relations	12	12
Coexistence	11	12
human-beaver conflict	12	15
traces of beaver	11	11
Welfare	1	1
Infrastructure	12	14
animal	14	22
Enmeshment	12	13
BDAs	3	4
FCDs	1	1
industrial	1	1
Management	12	16
Conservation	11	12
Control	11	11
Lethal	1	4
Measurement	12	13
Movement	12	17
Choreography	11	11
Enclosure	6	10
Relocation	12	16
Nature based Solutions	16	25
Biodiversity	12	13

Name	Files	References
Climate change	12	13
Drought	1	1
Natural Flood Management	13	14
Policy	15	23
Trials	11	12
Thinking with beavers	1	3
Transformation	11	11
Futures	12	12
Wild	4	116
illegal beavers	2	9
Work-labour	10	10
Collaboration	10	10
Ecosystem Engineer	11	11
regenerative	11	11
Reproductive	11	11

Appendix C: Table of the evidence from DEFRA (2021) Consultation document, *Approach to beaver reintroduction and management in England*

Beaver interactions with…	Benefits	Risks	Risk Mitigation
water	35. Enhance Natural function of rivers: store water, create ponds and wetland habitats, and create more diverse in-stream habitats. This results in biodiversity increase and potential drought resilience 36. Enhance water quality, as dams trap sediment and diffuse pollution 37. Enhance water storage and can naturally attenuate flood flows in rivers to reduce downstream flood risk (River Otter Trial)	38. May increase risk of localized flooding and erosion in some locations	39. Guidance is required to enable stakeholder management against negative impacts (e.g. protecting vulnerable infrastructure) 40. notching dams or installing flow control devices can lower water levels where localized flooding a concern
woodland and forestry	41. Enhance woodlands through felling or coppicing trees, creating complex and open woodlands, increasing biodiversity. Enhance Woodlands through flooding, increasing deadwood, increasing habitat availability for many invertibrates 42. Dams restore hydrological processes to woodlands, 'likely at a much lower cost than some existing restoration programmes which use heavy machinery and large capital works programmes to bring about changes.' (9-10)	43. Beavers may fell valuable trees, within 10 miles of the watercourse 44. Flooding may negatively impact commercial crops of trees or forestry roads.	43.Use mitigation techniques, such as tree guards or fencing, to protect trees of value 44. Forestry sector likely able to accommodate beaver impacts with buffer zone
fish and fisheries	45. enhance and sustain fish population at catchment scale, more likely to be	47. passability of dams for migrating fish,	48. more research on impact on commercially important fish

	sustainable in climate change 46. enhance fish population, leading to increased abundance and productivity, due to habitat diversity and water quality	local changes in habitat structure, prey availability, predation, and thermal regimes	 49. Consider fish populations in any future reintroductions and beaver management
other species (excluding fish)	50. Species-dependent, but overall positive effect 51. Enhanced habitat diversity can increase abundance and diversity of species of animals and plants (River Otter Trial) 52. Increased diversity and abudance of prey species benefits predator species.	53. Potential risks at local levels for rare or threatened species	53. Conduct local risk assessment, if needed
Agriculture	55. Attenuate floods, slowing flow of water and maintaining baseflow.	54. Low lying arable land on floodplains at risk of flooding from beaver wetlands 55. conflict possible where those who benefit from beaver activity may not be those who bear the cost	
Public and animal health		56. Potential disease risk (at same level of existing native wildlife) 56. If imported, low risk of tape worm parasite	

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