Biodiversity after Brexit:

Agri-environmental policy in England after Brexit and private investment in ecosystem services

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LUCSUS
Lund University Centre for Sustainability Studies

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Supervisor: Stephen Woroniecki, LUCSUS, Lund University

Abstract:

The process of agricultural intensification in England has brought with it significant negative environmental and biodiversity impacts associated with large-scale land use change. The Common Agricultural Policy, implemented at the European Union level, has historically been a significant driver of this intensification, but has also introduced agri-environmental (AE) policies for managing these negative environmental impacts. These AE policies are considered to be among the most important tools for managing biodiversity conservation. The British exit from European Union in 2019 means a new agricultural and AE policy within England, and there are indications that this will entail significant restructuring.

In this work of Sustainability Science, I apply a mixed-methods policy analysis to examine the proposed post-Brexit AE policy in terms of it's relationship to wider policy objectives, and the roles of the public and private sectors. Government policy documents, project proposals, and interviews with key actors provide the data for this policy analysis. I find that the proposed AE policy is related to wider economic and development objectives because of it's importance for managing the basis of continued development, and that it integrates with these objectives through a "natural capital approach". Furthermore, the role of public sector will be to correct the outcomes of market failures, while the private sector will be encouraged to invest in natural capital through approaches such as Landscape Enterprise Networks.

Subsequently, I follow an immanent critical approach in analyzing the potential of increased private investment to achieve AE objectives, as well as ways in which this approach may be limited. I use a scenario to make plausible assumptions about the agriculture and environment in post-Brexit England, and outline the criteria for success that are internal to the policy framework. I then apply empirical evidence and principles from Conservation Biology and Ecological Economics. I find that, in at least some cases, increased private investment has the potential to contribute to AE objectives by increasing landscape heterogeneity. The approach is potentially limited, however, by the use of a natural capital approach for resolving trade-offs between the delivery of ecosystem services, and biodiversity conservation. This potential limitation must be overcome in order to reliably conserve biodiversity. Social choice is suggested as an entry-point for further research in overcoming this limitation and integrating possible non-environmental, social concerns.

Keywords: ***agri-environmental policy, post-Brexit, immanent critique, biodiversity***

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AE	Agri-environmental
BITC	Business in the Community
DEFRA	Department for Environment, Food and Rural Affairs
EA	Environment Agency
ES	Ecosystem services
EU	European Union
LENs	Landscape Enterprise Networks
LU	Land use
NCC	Natural Capital Committee
NE	Natural England
NRN	Nature Recovery Network
PES	Payment for ecosystem services
RSPB	Royal Society for the Protection of Birds
UK	United Kingdom
WTO	World Trade Organization

Prologue

Prior to this research, I spent several months working at a consultancy in Oxford, UK, participating in research around the Landscape Enterprise Networks (LENs) project, which would later be announced as a potential component of the broader post-Brexit AE policy framework (see DEFRA, 2018a). Through some initial readings relating to post-Brexit AE policy, it seemed that forms of private investment might feature an expanded role; a hopeful synthesis of environmental sustainability and business. This aspect, specifically, captured my interest. As Hodge & Adams (2014) point out, even Adam Smith was skeptical of private actors' ability to provide public goods in the context of the English countryside. On the other hand, there are many examples of positive environmental outcomes generated in large part by private actors (Bakker, 2005), and the environmental outcomes of market-based instruments certainly cannot be discounted as *a priori* negative (Carton, 2016).

Although I do not directly call upon my previous personal experience within this thesis, it was instrumental as a 'jumping off' point. I therefore view my academic research as a form of further contribution to internal "problem-solving" needs, as well as addressing the urgent need for "critical" research relevant to this context, per Cox (1981)(see also Jerneck et al., 2011).

I want to emphasize that my use of a form of *critique*[1] should not be interpreted as an attempt to discredit the years of hard work, tangible positive impact, and dedication from the practitioners, consultants, and policy makers who have contributed to the policies and projects examined in this research, including those who took the time to offer me invaluable insight as part of this research. I am humbled by the contributions that these individuals and organizations have made. Instead, I seek to show what proposed strategies *can* and *cannot* do in terms of the desired *ends*, and so to aid the further development of policy and management mechanisms (see e.g. Boda, 2018; Stahl, 2013).

1. It is important to further distinguish *critique* from *criticism* (Nielsen, 2007).

1 Introduction

Since the early 20th century, England has seen a trend of dramatic **agricultural intensification**, bringing with it considerable environmental impact associated with large-scale land-use (LU) change (Dallimer et al., 2009; Robinson & Sutherland, 2002). In particular, this intensification has been driven by policies such as the EU Common Agricultural Policy (CAP) (Hodge, 2012; Robinson & Sutherland, 2002). Since the mid-1980s, a number of **agri-environmental** (AE) policies[2] (Dobbs & Pretty, 2004; Hodge, 2012), have achieved various degrees of success in managing the environmental impacts associated with agricultural LU (Batary, Dicks, Kleijn, & Sutherland, 2015; Hardman et al., 2016; Natural Capital Committee, 2013; Wretenberg, Lindström, Svensson, Thierfelder, & Pärt, 2006) (but see also Kleijn, Rundlöf, Scheper, Smith, & Tscharntke, 2011; Kleijn & Sutherland, 2003).

More than thirty years after their introduction, AE policies are now considered to be one of the most important tools for biodiversity conservation within England (Batary et al., 2015; Lawton, 2010). After all, at roughly 70% of England's LU, the "conservation interest of farmland may exceed that of nature reserves" (Robinson & Sutherland, 2002, p. 158).

That being said, biodiversity has certainly not recovered to pre-intensification levels (Robinson & Sutherland, 2002). In fact, since the introduction of AE policies, many indicators of biodiversity have continued to decline (DEFRA, 2017a; Natural Capital Committee, 2013; Robert et al., 2014), as well as ecosystem services (ES) indicators (see DEFRA, 2017a; DEFRA & Government Statistical Service, 2018; Robert et al., 2014).

Until now, England's AE and agricultural policy has largely been determined at the EU-level by the CAP (see Baylis, Peplow, Rausser, & Simon, 2008; DEFRA & HM Treasury, 2005). In short, the two components of the CAP – (1) general support for the agricultural sector and (2) AE and rural development – known as Pillar 1 and Pillar 2 – dictate how much public funding can be spent, and what it can be spent on within England (Baylis et al., 2008; Hodge, 2012).

2. AE policies have encompassed a wide range of additional social and economic objectives, such as rural development (Dobbs & Pretty, 2004).

Once the UK leaves the European Union in March 2019, the UK will no longer fall under the jurisdiction of the EU CAP. So, what will replace CAP? From the sounds of it, the intent is for something entirely new. As the Secretary of State for Environment, Food and Rural Affairs stated,

> For more than forty years, the EU's Common Agricultural Policy (CAP) has decided how we farm our land, the food we grow and rear and the state of the natural environment. Over that period, the environment has deteriorated, productivity has been held back and public health has been compromised. Now we are leaving the EU we can design a more rational, and sensitive agriculture policy which promotes environmental enhancement, supports profitable food production and contributes to a healthier society. (DEFRA, 2018b, p. 5)

Clearly, the **restructuring of agricultural and AE policy** is of tremendous significance for **environmental integrity** within England. Taking this restructuring as an impetus for academic research, I use this thesis as an opportunity to examine the structure and content of proposed post-Brexit AE policy, before investigating the potential of the proposed mechanisms to achieve their intended outcomes.

2 Research aim and approach

In this section, I will describe the relation of this thesis to Sustainability Science, the research questions that I explore, and the immanent critical approach that I follow throughout the research. Lastly, I will say some words as to ontology and epistemology, as well as the scope and structure of this thesis.

2.1 Contribution to Sustainability Science

This research is situated within the field of Sustainability Science, and as such addresses elements of complex sustainability challenges, integrates knowledge across disciplines, and incorporates elements of both critical and problem-solving research.

Sustainability Science can be characterized by the *types* of problems that it works with. Namely, “sustainability challenges”, which are “imminent or *future* problems that society as a collective is just starting to understand and grapple with” (Jerneck et al., 2011, p. 71). The object of this research is at the nexus of two sustainability challenges, **land-use change** and **biodiversity loss** (Jerneck et al., 2011). Furthermore, this research seeks to contribute to a key task of Sustainability Science: “**to critically [analyse] proposed mechanisms for and pathways to sustainable societies** [emphasis added]” with the hope of providing “insights on how to design better institutions” for dealing with new sustainability challenges (Jerneck et al., 2011, pp. 71–76). Within this imperative to examine management for sustainability transitions, an element of this research contributes to “[scrutinizing the] effectiveness” of marketization” (Jerneck et al., 2011, p. 77).

Lastly, following Boda (2018), this research contributes to the use of **immanent critique as an emerging research programme** for Sustainability Science. To my knowledge, the methodological approach to policy analysis that I used for this research – detailed in section 3: *Policy analysis methodology* – is a novel contribution to the use of immanent critique in this context.

2.1.1 Research Questions

Within this research programme, my thesis seeks to answer the following research questions:

- **RQ 1A**: What relationship does the agri-environmental policy bear to wider policy goals at the national level, such as economic and environmental policy?
- **RQ 1B**: What roles do the public and private sectors play within this policy framework?
- **RQ 2**: Broadly, what is the potential for this approach to successfully achieve agri-environmental outcomes?
- **RQ 3**: Are there potential limitations to this approach in its ability to achieve agri-environmental outcomes or wider policy goals, and what are they?

2.2 Immanent critique as research approach

An imminent critical approach guides the design of this research and choice of methodology, as well as informing the structure in which this research is presented. Broadly, the research is composed of **two parts**: a policy analysis which aims to ***understand* the object (RQ 1A & 1B)**, and a form of immanent critique which aims to expose the ***merits* and the *tensions* within the object (RQ 2 & 3)**. This research approach consults theories and methodologies only when they become necessary (per Boda, 2018); this leads me variously through the fields of Sustainability Science, Hermeneutics, Conservation Biology, Microeconomics, Ecological Economics, and the literature on ES.

This approach is well-suited for addressing my research questions; as demonstrated by Boda (2017, 2018), immanent critique is suitable for analyzing policies or strategies that attempt to manage sustainability challenges (see also Carton, 2016). Furthermore, this approach aims for relevance outside of the academic context, while nevertheless presenting a more "stable" critique by aiming at internal tensions which cannot be resolved simply with changes to implementation (see Carton, 2016). This emphasis upon the internal *logic* is particularly helpful in the case of proposed post-Brexit AE policy, seeing as very few details of implementation have been proposed at all!

2.2.1 The process of immanent critique

So how is an immanent critique actually conducted? A rigorous application first requires that the object of critique "be presented as accurately as possible" (Isaksen, 2018, p. 6), as there is "little point in demolishing a straw figure" (Nielsen, 2007, p. 81). Speaking in the broadest sense, once this precondition is satisfied, an immanent critical approach asks "what must be the case for that… position to be possible" (Bhaskar, quoted in Nielsen, 2007, p. 82). These conditions are then examined for contradictions or inconsistencies: "theory-theory, theory-practice, and/or theory-data inconsistencies" (Isaksen, 2018, p. 1).

In other words, immanent critique takes "premises and conclusions *that are presently available* and then develop[s] them *on their own terms"* (Isaksen, 2018, p. 2); beginning with a given system's "own logical structure and assumed

content”[3], the critique seeks to point out conceptual limitations, and opens the way to resolution of these limitations or contradictions (Boda, 2018, p. 240). Similarly, Hartwig (Hartwig & Bhaskar, 2008), describes the approach as making use of “transcendental (and other) arguments to demonstrate that the account is internally inconsistent or beset with problems that cannot be solved in its own terms” (p. xiv).

In practice, this means beginning with an understanding of the intended outcomes, as well as the strategies that will be used to achieve these outcomes. From there, the relationship between the two is examined against theory and empirical evidence.

2.3 Critical Realism

My use of immanent critique, as well as the other methods employed, are consistent with a critical realist ontology and epistemology (Bhaskar, 2011; Nielsen, 2007; Sayer, 1984, 2000). As such, my research hinges upon the assumption of a non-discursive external reality; the role of science in this context is to improve understanding of this external reality, in order to enable better practice.

2.4 Scope

The scope of this research is limited to the connections between **English AE policy and the mechanisms it employs**, and **environmental sustainability**, or more specifically, biodiversity. That being said, English AE policy is notorious for multiple objectives, which are not easily separated (Batary et al., 2015; Dobbs & Pretty, 2004; Hodge, 2012; Hodge & Adams, 2014). There will undoubtedly be social impacts associated with changes to these policies, and there is certainly a need for further research regarding dimensions of justice and power. As will become evident in the conclusion, I believe that my research can offer something to this further research.

3. As such, whenever possible I reference sources that are ‘internal’ to the policy framework, or at least located within its context, naturally while retaining an awareness of the broader academic literature. Throughout the critique, I will refer to assumptions and understandings that are ‘internal’ to the policy framework.

I want to emphasize that my research is nevertheless relevant to social impacts, issues of justice, and power, because **environmental sustainability** is an essential part of the **foundation for human well-being and development** (Daly & Farley, 2010; Folke, Biggs, Norström, Reyers, & Rockström, 2016), and can be seen as a prerequisite to distributive justice (Pelletier, 2010)(see also Daly & Farley, 2010). As such, this research relates to the concepts of ***social-ecological resilience*** and ***biosphere-based sustainability science*** discussed by Folke et al. (2016). I follow Carton's (2016) assertion that, while these dimensions may be closely entwined, "a distinction between [environmental and non-environmental] outcomes is analytically useful" (p. 20), in part because environmental sustainability does not *necessarily* follow from social equity.

Furthermore, this research spans across multiple spatial and governance **scales**. It considers a global sustainability challenge – biodiversity decline – at a national level, and how approaches to AE management at the landscape or catchment-scale interact with the requirements for large-scale biodiversity conservation and sustainable development.

Studying post-Brexit policy specifically within *England* allows me to exclude many of the variables associated with the devolved administrations of the UK. As will become apparent, I make use of a scenario which allows me to further restrict the variables associated with AE policy at the national scale. An interpretation of my research and results should necessarily take these assumptions into account.

2.5 Structure

Before presenting my research, I must make a note on structure, as my argument spans across several disciplines and topics. Thus far, I have described my research questions, and the broad approach that will guide me in answering them.

Sections 3 and 4 address **research questions 1A and 1B**; in these sections I describe the collection of data, analysis, and synthesis of the results.

In **section 5**, I provide the foundation for addressing research questions 2 and 3; namely, **a scenario** which allows me make plausible assumptions about a wide

range of variables, providing a basis for further analysis according to immanent critique.

Section 6 directly addresses **research question 2**, showing that – in at least some cases – there is some merit to the post-Brexit AE management approach, judged against the framework's own criteria of success.

Section 7 directly addresses **research question 3**, showing that despite these merits, there are inherent tensions which – in at least some cases – jeopardize the framework's realization of success.

Section 8 briefly reflects on this research, including limitations and shortcomings.

3 Policy analysis methodology

The methodology that I employ here is intended to provide a nuanced understanding of the proposed post-Brexit AE policy framework, specifically in relation to my first research question **(RQ 1A & 1B)**.

I conducted semi-structured interviews and selected key policy documents, and then analyzed this data using a combined hermeneutic policy analysis and policy component analysis approach. The **results of these methods are synthesized and discussed** (see Phillips & Brown, 1993) in **section 4**, *Post-Brexit agri-environmental policy*. Through the analysis, I aim to "break down the whole" and examine the parts, while the synthesis aims to produce "a whole greater than the sum of the parts" (see Figure 1, next page) (Phillips & Brown, 1993, p. 1568) (see also Bryman, 2012). Before reviewing these results, I will briefly explain the strategy and logic to my **data collection** and **methods of analysis**.

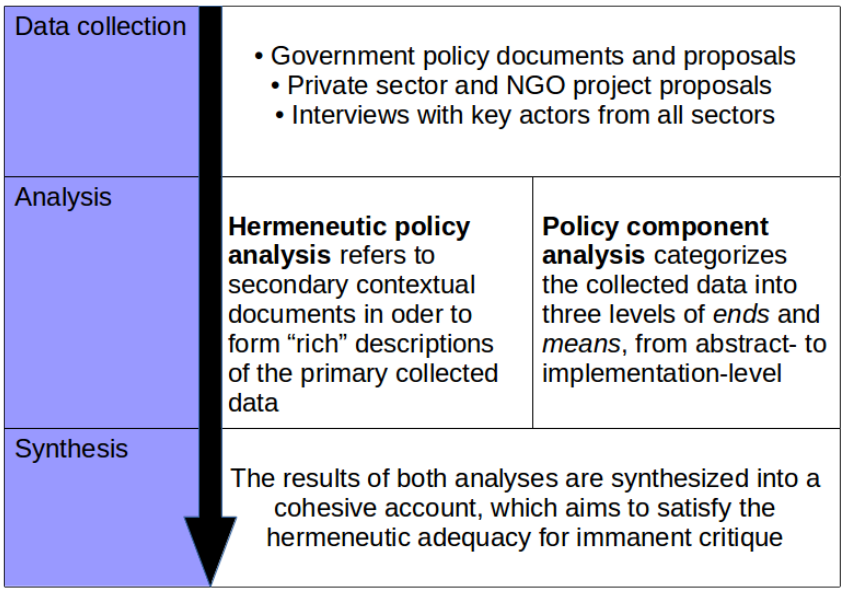

Figure 1. The method of policy analysis. Collected data, including policy documents, project proposals, and interviews, is analyzed with a hermeneutic policy analysis and policy component analysis, the results of which are synthesized. Own figure.

3.1 Data collection

To address my research questions, I conducted **purposive sampling** of interviewees, policy documents, and project proposals, until I reached a sufficient level of theoretical saturation (per Bryman, 2012). The time-line of this process is roughly illustrated by the dated order of interviews and documents in the table in Appendix II.

The **policy documents** constitute the official proposal for post-Brexit AE policy framework, while the **project proposals** outline a specific element of the AE policy framework (LENs) relating to blended private/public sector funding. I selected LENs as specific case because it is specifically mentioned within the 25 Year Environment Plan (DEFRA, 2018a), and is one of the few explicitly described approaches within this context, and thus is useful for answering my research questions. Due to these characteristics, as well as having emerged primarily from the NGO and private sectors, LENs may serve as a *paradigmatic* case within this context (per Flyvbjerg, 2004).

Specifically, these documents consist of (1) *A Green Future: 25 Year Environment Plan*, (2) *Health and Harmony: the future for food, farming and the environment in a Green Brexit*, both commissioned and published by DEFRA, as well as (3)

Healthy Ecosystems Cumbria: A Landscape Enterprise Networks opportunity analysis, and (4) *Healthy Ecosystems East Anglia: A Landscape Enterprise Networks opportunity analysis*, both commissioned by BITC from 3Keel, with public funding from NE. As explained in the analysis method, an abundance of secondary policy documents, speeches, and government publications were consulted in the analysis of these primary texts. These secondary, contextual, texts are detailed in the Appendix I.

Additionally, I conducted five **semi-structured interviews** with individuals who are instrumental in the design and/or implementation of post-Brexit AE policy elements that are within the research scope. This relatively small sample size is sufficient owing the range of additional data that I draw upon, such as policy documents. My use of small, targeted samples in this context is further supported by Mann & Schweiger (2009): "the problem with a large number of policy programmes is that only a very few individuals in charge… can provide important information on the scale and scope of the programme in question" (p. 446) (see also Crouch & Mckenzie, 2006).

Three interviewees are employed by public institutions (DEFRA and NE), one is employed by a non-profit with public and private funding (BITC), and one is employed by a private consultancy (3Keel). Owing to the wide range of locations, I conducted interviews remotely via Skype, with one exception, the interviewee from 3Keel[4], which was face-to-face.

3.1.1 Ethical considerations

All interviewees were aware of the aims of my research, their role within it, the fact that interviews were recorded and transcribed, and the opportunity for anonymization. Informed consent was given verbally. To the best of my knowledge, my approach follows the Swedish *Ethical Review Act* (The Ministry of Education and Cultural Affairs, 2003).

4. The interviewees are referred to by their organizational position throughout the research.

3.2 Policy component analysis

I employed the **model of policy composition** advanced by Howlett & Cashore (2007) as an **analytic framework** for separating the ends and means of the post-Brexit AE policy documents[5], as well as the project proposals. This method is particularly useful for an **immanent critical** approach, which directly considers the suitability of a means to reach a given ends (Boda, 2017; Stahl, 2013). See Figure 2, below, for the analytic criteria that make up this taxonomy of policy components.

After coding[6] the policy documents and interview transcripts accordingly, I compiled the results into a table found in Appendix II.

Policy Ends	**Goals**	**Objectives**	**Settings**
	General ideas that guide policy development	What policy formally aims to address	Specific on-the-ground requirements of policy
Policy Means	**Instrument Logic**	**Mechanisms**	**Calibrations**
	General norms that guide implementation preferences	Specific types of instruments that are utilized	Specific ways in which the instrument is used

Figure 2. Policy component taxonomy employed for data analysis. Figure adapted from Howlett & Cashore (2007).

3.3 Hermeneutic policy analysis

The second approach taken in the analysis of interview transcripts and policy documents follows a hermeneutic method of policy analysis (see Lejano & Leong, 2012; Lejano, Leong, & Park, 2012); in plainer language, this might be described as a contextual policy analysis. The approach aims at a "**thick description**" that considers not just literal textual meaning, but also the broader context (Lejano & Leong, 2012) (see also Bryman, 2012). Essentially, after an initial "thin" description that considers only the primary text, a thick description deepens the analysis with secondary texts that are either explicitly or implicitly referred to by

5. Although this framework was conceived as an improvement upon Hall's (1993) understanding of policy change (Howlett & Cashore, 2007), I see no reason why it cannot be used as an analytic tool in this context.
6. The open-source software *R Package for Qualitative Data Analysis* (RQDA) (Huang, 2016) was used for this process.

the primary text (Lejano et al., 2012). Appendix I contains sources for the secondary texts that contribute to these accounts.

The thick description generated by the analysis is to be judged on the basis of its **richness** and **explanatory adequacy** (Lejano & Leong, 2012)(see also Bryman, 2012). In other words, when there are two narratives that can both be "empirically verified", the better narrative is the one that is "richer"; it is more coherent, unambiguous, and takes account of complexity (Lejano & Leong, 2012, p. 795).

This hermeneutic approach is suitable for **immanent critique** because it brings in elements that are present, but may be left unsaid, uncovering "public silences about contradictions" and "tacit, non-ostensible meanings of a policy" (Lejano et al., 2012, p. 2), which aims at the accurate understanding of the policy that immanent critique requires (per Isaksen, 2018). Furthermore, the method is consistent with critical realist research because it draws upon the principles of abductive reasoning, and uses a contextual method that deals with complexity and layered, open systems (Sayer, 1984).

My use of the hermeneutic narrative methodology departs from the conception by Lejano & Leong (2012) in that I am explicit about the existence of external reality, and about the role of the *subjective* within the research. A central premise of this research is that there is an external reality, and that the policy framework corresponds to an understanding of this reality which may be fallible.

Although Critical Discourse Analysis (CDA) would certainly have been a workable method, I chose not to use CDA because of the close association with emancipatory social change[7] (Bryman, 2012, p. 536), which may have interfered with my ambition to begin the critique "*within*" the object of critique (rather than from a prior standpoint), casting the AE policy framework as a position "in its strongest possible light" (Nielsen, 2007, p. 81) (see also Isgren, 2018).

7. Nevertheless, I realize that the project of immanent critique, and, indeed, critical realism, are themselves emancipatory (Bhaskar, 2009; Nielsen, 2007).

4 Post-Brexit agri-environmental policy

Within this section, I present the **results of the policy analysis** described above, and seek to answer **research questions 1A & 1B:** the relationship of post-Brexit AE policy to wider policy goals, as well as the intended role of the public and private sectors.

I begin by giving an account of the relationship between post-Brexit AE policy and wider policy goals. Subsequently, I describe the expected role of public and private actors within post-Brexit AE policy. Representative quotes from the primary and secondary, contextual data is used to illustrate salient themes or elements, and sources are given where a particular document provides the most indicative account.

4.1 Relation to the wider policy goals

The post-Brexit AE policy framework relates directly to **economic and development policy goals**. Stated simply, AE management is seen as an essential element for continued economic growth and development, united through expanded accounting for "natural capital" that guides policy design and implementation.

4.1.1 Economy, development, and environment

The policy analysis reveals that a central project in the policy framework is the alignment and coordination of **economic and environmental** policy. Continued economic development and growth is the ultimate goal of economic policy, and to a large degree environmental policy dovetails with this ends; "environmental protection is at the heart of the [Industrial] strategy" and the 25 Year Environmental Plan will, in turn, support "economic growth and productivity over the long term" (DEFRA, 2018a, p. 18). It is assumed that, through the proper design and decision-making methods, that "environmental enhancement" and economic growth are mutually inclusive, and are seen as **two elements of the same project** (DEFRA, 2018a; Natural Capital Committee, 2013, 2017a). In this regards, the *25 Year Environment Plan* and *Industrial Strategy* are referenced as "complementary approaches that reinforce one another given the relationship between the environment and the economy" (DEFRA, 2018a, p. 18).

The necessary synergy between economic and environmental policy follows from a conception of the economy as finite, and contained within the environment; “the economy exists within the natural world, and cannot be separated from it” (DEFRA, 2018a, p. 84). This relationship is reconciled with market-driven increases in resource efficiency, a strategy termed “Clean Growth”, which is the key to both continued economic development and environmental sustainability (HM Government, 2017).

The economy relies upon goods and services provided by the environment as an “essential basis for economic growth and productivity over the long-term” (HM Government, 2017, p. 135)(see also Natural Capital Committee, 2013, 2017a), and the role of the environmental policy in this regard is to ensure that this essential basis is maintained (DEFRA, 2018a; HM Government, 2017). This forms part of the duty of the public sector to “[provide or fund]… the foundations of productivity” (DEFRA, 2018b, p. 34).

It is clear that AE policy is critical for this purpose, as agricultural practices “shape our natural environment” (DEFRA, 2018b, p. 6), agriculture forms the dominant LU within England (DEFRA, 2018a), and appropriate AE management has the potential to “contribute to delivering against many of the key outcomes set out in the 25 Year Environment Plan and the Clean Growth Strategy” (DEFRA, 2018b, p. 36).

4.1.2 The natural capital approach

In terms of policy components, the two prominent policy *goals* are environmental protection, and continued economic development and growth. The dominant ***instrument logic***, one of the primary tools to achieve both of these concerted ends, is the ***natural capital approach*** (see Figure 3, next page). This entails an emphasis upon economically efficient resource allocation and the integration of economic and environmental decision-making (Natural Capital Committee, 2013, 2017a).

Policy Ends	Goals	Objectives	Settings
	Environmental protection, continued economic development	Improve England's ecological network, manage the biodiversity impacts of agriculture	Considerations about the necessary quantity and quality of natural capital
Policy Means	**Instrument Logic**	**Mechanisms**	**Calibrations**
	Natural capital approach, efficiency and cost-effectiveness, correcting market failure, social optimum	Public-funded AE schemes, LENs, etc	Increased private investment in natural capital, phasing-out CAP Pillar 1, etc

Figure 3. Synthesis of proposed post-Brexit AE policy *ends* and *means*, necessarily including some overlap with broader policy goals. An unsynthesized policy component analysis, for each individual text, is located in Appendix II. Figure adapted from Howlett & Cashore (2007).

In essence, the natural capital approach entails the **accounting of ecosystem functions** and **ecosystem goods and services**[8]; it is assumed that proper accounting of this natural capital and it's internalization in economic decision-making will lead to conserved or increased natural capital, but also overall increased capital (i.e. economic growth) (see Natural Capital Committee, 2013, 2017a). In its use of the natural capital approach, the goal of "environmental enhancement" (see DEFRA, 2018a) is effectively operationalized as "preserved or increased natural capital". One interviewee, the Head of Water at BITC, demonstrated this logic with the assertion that

> the natural environment is a very, very effective machine that has been neglected and undervalued for many, many years. If we can start recognizing and respecting the value that [it] brings – not just to business – but to our economy, to our society, and to our general growth and wellbeing, then we will look after it a lot better.

8. N*atural capital* is defined by the NCC as "those elements of nature which either directly provide benefits or underpin human wellbeing" (Natural Capital Committee, 2018, p. 11). In this research I am specifically considering *biotic natural capital.* On the other hand, the terms *ecosystem service(s)* and *ecosystem function(s)* or *intermediate service(s)* hardly appears throughout the most of the policy documents analyzed (see e.g. DEFRA, 2018a, 2018b). In this context, I understand *natural capital* to largely encompass all of these terms.

The use of the natural capital approach, as well as the positioning within market logic and economic development, have **implications** for the role and scope of action that the **public sector** takes in AE management, as well as the types of mechanisms that it uses. The new "environmental land management system" which will constitute the "cornerstone of [post-Brexit] agricultural and land management policy" (DEFRA, 2018b, p. 31), is "underpinned by natural capital principles" (p.36). If policy implementation is to stay true to the above principles, AE policy will hinge upon an imperative to preserve the natural capital which underpins continued economic development, as well as including market principles such as cost-efficiency.

4.2 A new environmental land management system

The above relationship to wider policy goals impacts the **internal view of the agricultural sector**, particularly in regards to the role of **public policy and spending**. I will briefly examine this relationship, before explaining the role of the public and private sectors within post-Brexit AE policy.

4.2.1 The agricultural sector

The internal view is that the existing framework of agricultural policy – Pillar 1 and 2 of CAP – has poorly managed the environmental impact of agriculture, especially in regards to this environmental basis for economic development and growth. According to Michael Gove:

> The CAP has evolved, and indeed improved, over time. But it is still a fundamentally flawed design. Paying land owners for the amount of agricultural land they have is unjust, inefficient and drives perverse outcomes. It gives the most from the public purse to those who have the most private wealth. It bids up the price of land, distorting the market, creating a barrier to entry for innovative new farmers and entrenching lower productivity. Indeed, perversely, it rewards farmers for sticking to methods of production that are resource-inefficient and also incentivises an approach to environmental stewardship which is all about mathematically precise field margins and not truly ecologically healthy landscapes. As recent scholarship has shown, the so-called greening payments in Pillar

> One have scarcely brought any environmental benefits at all. We can, and must, do better. (Gove, 2018b, p. 5)

As “one of the main drivers of land use and management over the last 45 years” (DEFRA, 2018a, p. 36), CAP has constrained farmers into practices that have resulted in “significant environmental damage” (DEFRA, 2018a, p. 36), and has stifled innovation and increases in productivity, and is an inefficient use of public funds (DEFRA, 2018b). Many of these consequences result from the market-distorting effects of CAP as a government subsidy (DEFRA, 2018b; DEFRA & HM Treasury, 2005). Simply said, by correcting this market distortion, introducing market pressures, and policies that encourage innovation and private sector insurance to “help farmers smooth income volatility” (DEFRA, 2018b, p. 53), the agricultural sector can become more efficient and prosperous (DEFRA, 2018b).

The role of public institutions in respect to the agricultural sector, therefore, is realigned to ensuring the basis for a **healthy market-driven sector** (DEFRA, 2018b), and ensuring the provisioning of **environmental public goods** which cannot be provided by the market (Gove, 2018b). The provisioning of these environmental public goods is closely linked to ensuring continued economic development, and the use of market logic relates to the imperative for efficiency in policy instruments.

4.2.2 “Public money for public goods”

Under all of the officially proposed scenarios (see DEFRA, 2018b), post-Brexit agricultural policy will **phase out CAP Pillar 1-type policies**, and **focus upon CAP Pillar 2-type policies** – those that directly manage the environmental impacts and potential benefits of agricultural LU. By now, the rationale is clear; Pillar 1-type policies are market-distorting, trade-distorting, innovation-stifling, not cost-effective, (see DEFRA, 2018a, 2018b; DEFRA & HM Treasury, 2005), while Pillar 2-type policies are required for those (environmental) public goods which cannot be provided by the market at the social optimum (see DEFRA, 2018b; Downing & Coe, 2018; Gove, 2018a, 2018b). The “**payment of public money for the provision of public goods** [emphasis added]” is the guiding directive that underpins the new agricultural policy (DEFRA, 2018a, 2018b; Gove,

These national priorities generally refer to biodiversity conservation, for example through the creation of a “Nature Recovery Network” (NRN), which will create an ecological network of habitats that is integrated with agricultural LU (DEFRA, 2018a, p. 59), seeking to provide “more habitat, in better condition, in bigger patches that are more closely connected” (DEFRA, 2018a, p. 58). The NRN will have a degree of multifunctionality, providing wider ecosystem goods and services (DEFRA, 2018a).

Following the natural capital approach and the logic of marginal utility[9], government spending on environmental public goods will be seen as an investment (Downing & Coe, 2018; Natural Capital Committee, 2017a), with spending justified by the extent to which there is “good value for money” (Downing & Coe, 2018, p. 14).

4.2.3 “Innovative funding mechanisms”

“Public money for public goods” is just one side of the coin; the obvious logical (implicit) counterpart is “private money for private (or market) goods”. This logic underlies the intended phasing-out of Pillar 1-type payments and the emphasis upon the beneficial aspects of market pressures. But the new AE policy framework goes one step further: it will “**take steps to encourage private sector investment wherever possible**, targeting public funds at projects that provide purely public goods (DEFRA, 2018a, p. 144), and only those “clear public goods the market will not, left to itself, provide” (Gove, 2018a, p. 14). New mechanisms will “**encourage private investment in natural capita**l” which will contribute to “**increased levels of public benefits from improved environmental outcomes**” (DEFRA, 2018b, p. 37)(see also DEFRA, 2014). What are these new mechanisms, and how will they work?

The new AE mechanisms that make use of private investment in natural capital are broadly referred to as “innovative funding and delivery mechanisms” (see DEFRA, 2018a, 2018b), and will be incorporated into the new environmental land management system (see DEFRA, 2018a, p. 36). In fact, mixed private and public investment in natural capital will be “crucial” to the delivery of environmental

9. Marginal utility is the change in benefit from a *marginal* increase in a good or service (Wolff & Resnick, 2012).

enhancement (DEFRA, 2018a, p. 141), and will play a strong role in post-Brexit environmental policy, as well as AE policy more specifically:

> [In addition to public funding,] **increased private sector investment in natural capital will equally be crucial** [emphasis added]. The development of natural capital thinking, data and tools will usher in more opportunities to generate revenue from projects that improve the natural environment. By measuring the benefits of natural capital improvements we will sharpen the business case for private sector investment and help to unlock new markets, funding streams and private finance for natural environment projects. The Government will take steps to encourage private sector investment wherever possible, targeting public funds at projects that provide purely public goods... [In addition to government-funded pilot schemes,] we have since seen pioneering schemes from water companies, and environmental NGOs working with businesses and other organisations willing to fund environmental improvements because benefits accrue to them. (DEFRA, 2018a, p. 144)

Essentially, private sector investment will **complement** (and in at least some cases replace) traditional, publicly-funded environmental and AE mechanisms wherever possible (DEFRA, 2014). These new mechanisms could take the form of "private payment for ecosystem goods and services" (DEFRA, 2018a, p. 59), and will be encouraged and facilitated by the public sector.

In short, these "innovative funding mechanisms" represent a conception of private investment, that – to some degree, in at least some cases – provide environmental public goods. These mechanisms are relatively new, and are currently few and far between (DEFRA, 2018a, p. 37)(see also DEFRA, 2014, 2017b). Within the primary policy documents, only a few approaches or projects are named specifically; some are led and funded by public agencies, such as the "pioneer project" in North Devon, which uses a stakeholder approach to value natural capital in a catchment, and enroll communities and commercial interests to make investments in natural capital (DEFRA, 2018a; North Devon Biosphere, 2018; Thomson, 2016).

4.2.3.1 The Landscape Enterprise Networks approach

LENs bears some similarities to the approach described above, but is primarily led by the private sector, although with some public funding. A closer look at LENs provides insight into how these mechanisms that facilitate private investment might be designed, their intended outcomes, and the logic that guides them. In a nutshell, LENs attempts to facilitate private investment in natural capital, and provides opportunities for integration with government AE objectives.

The approach operates at the landscape scale (e.g. at the scale of catchments), and leverages the common interests of commercial actors in terms of "landscape assets" and "landscape functions"[10]:

> LENs provides a framework for business collaboration, by identifying shared [commercial] interests in landscape assets and developing enterprise-based solutions for improving the health of those assets… once we know what and where the shared assets are, we can work on identifying the sorts of investments, market opportunities, or agreements that could secure and enhance those assets. (3Keel & Business in the Community, 2017a, p. 7)

These commercial actors are motivated by the "**business case**" to invest (see Figure 4, next page). One interviewee, the Head of Water at BITC, pointed out that water utilities companies have already invested in natural capital due to the avoided cost of built infrastructure, as well as the insurance industry, which is interested in mitigating risk, and that LENs aims to expand these types of investments:

> [The goal is] trying to get… broader businesses to be able to understand [the benefits of investing in their landscape], and to be able to put a figure on it. This is the value of the landscape, this is the value of what we extract from the landscape, this is the cost to us if that landscape starts to

10. These landscape *assets* and *functions* most clearly relate to natural capital (per Natural Capital Committee, 2013) or ecosystem functions, and ES (Fisher, Turner, & Morling, 2008), respectively.

degrade or fails, and therefore this is the cost of effectiveness of our investment within this landscape. LENs is a really key part of that.

Another interviewee, a partner at 3Keel, indicated that this business-case is what drives LENs as a whole, and described the motivation of large commercial interests:

> ...they have these... massive, massive investments, that will basically be... stranded assets if... the environment around them ceases to be able to operate.

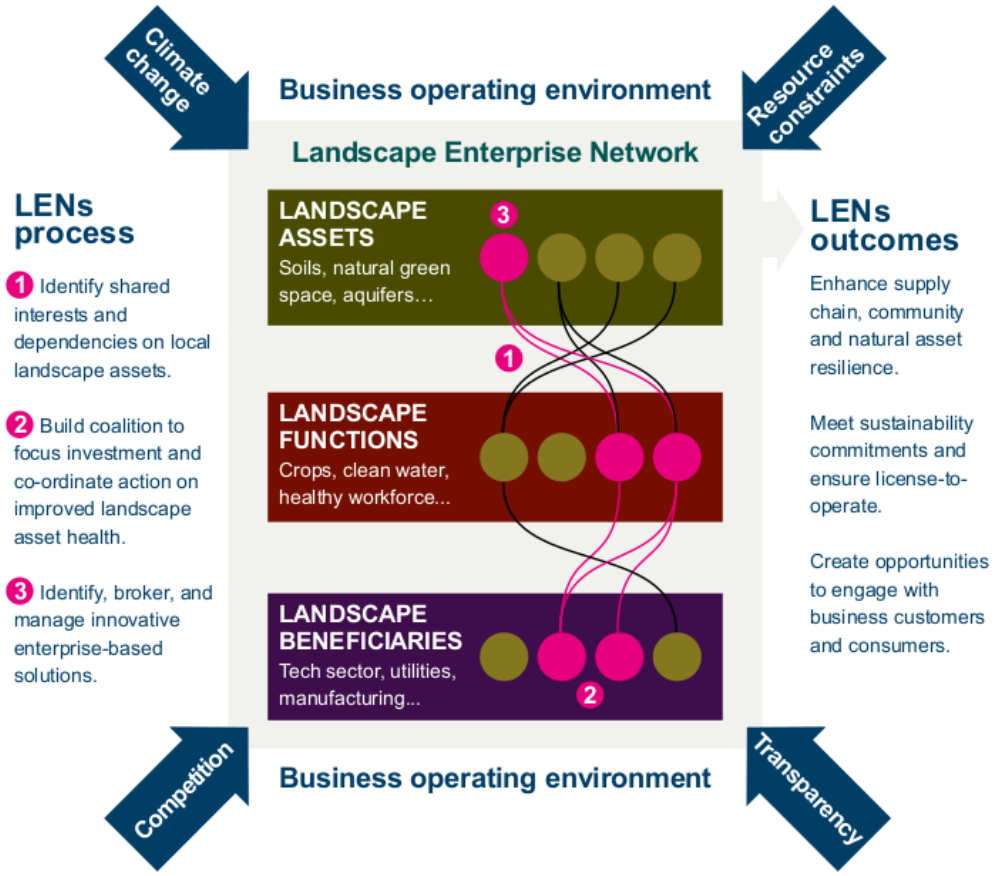

Figure 4. The LENs concept. LENs facilitates coordinated private investments in landscape assets (natural capital) to support the landscape functions (ES) which have an impact upon commercial interest. Source: 3Keel & Business in the Community (2017a).

The explicit intent is for LENs to **complement** or **coordinate** with public policy and spending, for example in terms of AE objectives (3Keel & Business in the Community, 2017a), as well as the wider economic and development goals

described earlier. As the same interviewee indicated, LENs is intended to deliver emergent conservation objectives:

> The pursuit of the original goal [of conservation and multifunctionality objectives] becomes an emergent outcome… in order to get to that, you kind of put it to one side, recognize your theory of change, which is 'we'll make a multifunctional landscape by driving it through multiple economic forces, and it'll turn into something heterogeneous, which will be good for biodiversity.

Other interviewees from the public sector were optimistic about the potential that LENs offers for collaboration with the private sector. One of the interviewees who implements catchment-sensitive farming with NE indicated that there is an "opportunity to help each other" and that private sector investment appears to be very closely aligned with AE objectives, but cautioned that the **continued involvement** of the **public sector** is necessary in order to achieve AE objectives, due to the risks associated with markets. A desire, or need, for cost-effectiveness in public-funded AE initiatives was indicated by several public-sector interviewees as a primary motivation for collaboration with private sector.

4.3 In summary

By now it should be clear how the pieces fit together in the post-Brexit AE policy, particularly in regards to **research questions 1A and 1B**:

- The proposed post-Brexit AE policy relates directly to wider **economic and development goals**, particularly in regards to an understanding of natural capital as necessary for continued economic development.
  - AE policy will be one of the most important tools for managing this natural capital.
  - The natural capital approach provides a prescribed method of decision-making which will integrate economic and AE/environmental policy and goals.
- **The state** will fund certain types of natural capital through AE schemes:
  - **Public goods** that cannot yet be provided by the market, such as clean air and climate regulation.

- **Biodiversity**, as the fundamental basis for continued economic growth and development.

- The **natural capital approach** will largely dictate the necessary quantity and quality of natural capital (e.g. expected returns in terms of economic growth, or profit).
- Through incentives and institutional arrangements such as LENs, the state will **facilitate private investment in natural capital.**
  - As much as possible, **private sector investment** will be used to provide ES as well as to contribute towards general 'environmental enhancement', including environmental public goods.

5 A scenario for post-Brexit agriculture and environment

While this policy analysis can tell us about the relation to wider policy goals, and the intended roles of public and private sectors within post-Brexit AE policy (RQs 1A & 1B), there is still a great deal of ambiguity; the amount and allocation of public spending, the possibility of structural changes within the agricultural sector, changes to environmental regulations, and so on.

In order to answer **research questions 2 and 3**, regarding the potential for success and limitations to the proposed post-Brexit AE policy, I move forward with **a scenario which describes plausible outcomes for UK agriculture and the environment post-Brexit.** The scenario is selected from a report commissioned by the Land Use Policy Group (LUPG)[11] (Baldock et al., 2017); the full text can be found in **Appendix IV**. Although a number of interest groups and think tanks have issued scenarios[12], this particular report has a degree of internal credibility, having been commissioned by an independent body composed of representatives from government agencies.

11. The UK Land Use Policy Group is comprised of the environment, conservation, and countryside statutory bodies, including NE, the EA, and DEFRA. The express purpose of the report is to enable further analysis of "the opportunities and challenges that could arise for the environment" (Baldock, Buckwell, Hart, & Marechal, 2017, p. 18).
12. Notably, the National Farmers' Union (NFU) report *Implications of a UK exit from the EU for British Agriculture* (Van Berkum, Jongeneel, Jager, Vrolijk, & Van Leeuwen, 2017).

In this section I will describe my **selection and use of the scenario,** as well as its **implications for AE management**, before directly addressing research questions 2 and 3 in the following sections.

5.1 Choosing a scenario

Specifically, I follow the scenario *Greener shades of liberalisation*, selected from five scenarios provided by the report (Baldock et al., 2017). In particular, *Greener shades of liberalisation* most closely corresponds to the results of the above policy analysis and broader trends. These correlations add to the plausibility of my assumptions, as well as to the potential applicability of my research. Namely:

- The rapid phasing-out of CAP Pillar 1-type payments
- An emphasis upon increasing resource efficiency within the agricultural sector (such as 'precision' or data-driven farming)
- Maintained or strengthened (agri-)environmental objectives
- Maintained or strengthened legal/regulatory baseline for agriculture
- Heavy encouragement of private transactions around ES from agricultural LU
- Encouraging farmers to diversify the ES that they provide – effectively seen as 'land managers' rather than 'farmers'
- Confidence in market pressure to spur innovation, productivity, and efficiency
- Emphasis on advice and capacity building rather than direct funding
- Strong pressure to reduce public spending and the search for market-based alternatives
- Integration industrial and (agri)-environmental strategies

Additionally, the scenario corresponds to broad trends within government. For example, within England there has been a historic trend to maximize the CAP Pillar 2 (AE) payments relative to direct payments such as CAP Pillar 1, at or close to the maximum of 15% (DEFRA, 2013b), as well as a long-standing ambition to reduce or eliminate CAP Pillar 1-type payments and liberalize the agricultural sector (DEFRA & HM Treasury, 2005; Natural Capital Committee, 2017a). There is

also a long-standing trend of vigorous efforts to stimulate private investment in ES provided by agricultural LU, and corresponding increases in private funding (Catchment Based Approach, 2018; DEFRA, 2014, 2017b; Eves, Carlisle, & White, 2015). Additionally, the *Scenario E* corresponds to stagnating public funding for biodiversity (Joint Nature Conservation Committee, 2017) and large cuts in AE-related budgets.

It is difficult to ascertain the degree to which *Scenario* E corresponds to the latest indications as to the post-Brexit trade relationship between the UK and EU. As of the time of this writing, there is an ambition for a partnership that is "as close as possible" in "trade and economic cooperation", but acknowledgment of tensions which necessarily "limit the depth of such a future partnership" (European Council, 2018, p. 2). This is, of course, one of the biggest 'wild cards', but further analysis necessitates making assumptions.

5.1.1 Additional assumptions

I make additional, informed, assumptions within the parameters of the scenario:

- I interpret the results of the policy analysis as a statement of intent on behalf of the government, and incorporate these intentions into the scenario.
  - Chiefly, I assume that 'natural capital thinking' forms the basis of (agri-)environmental policy and public spending, with cost-benefit analysis forming the primary tool for decision making (see esp. DEFRA, 2018a; Natural Capital Committee, 2013, 2017a).
- Beyond the scenario's assumption of general increased "pressure on farmland biodiversity" due to farm consolidation and intensification of production (Baldock et al., 2017, p. 70) (see also Robinson & Sutherland, 2002), I don't consider the nuances of possible structural changes to the agricultural sector in terms of environmental impacts. This might include farm abandonment in marginal areas, increased farm consolidation and specialization, and 'precision' farming. Making further assumptions about the nature of structural change would impact this analysis to varying degrees.

    - For example, afforestation from farm abandonment could have both positive and negative impacts upon biodiversity (Baldock et al., 2017).
    - The move to 'precision' farming – to some extent implied by the results of the policy analysis – could have mixed biodiversity impacts, depending on the particular route taken (Baldock, 2017).
- I assume that private investments will primarily be *combined* with public-funded AE schemes[13], rather than *independent* (see DEFRA, 2015b)(see also DEFRA, 2013a).
- I assume a large decline in total public funding for agriculture relative to the current *combined* CAP Pillar 1 and Pillar 2 budget.
- I do not consider the possibility of increased AE funding effectiveness due to reduced opportunity costs associated with lower food prices - consistent with WTO rules (see Dobbs & Pretty, 2004).

5.2 Direct implications for agri-environmental management

Before applying these assumptions, I want to explicitly outline some of the central **implications that impact research questions 2 and 3** – the potential for success and potential limitations to the proposed post-Brexit AE policy:

- Initially, the public budget for AE schemes will not be drastically changed, and will not merely inherit a re-purposed Pillar 1 budget (see also Natural Capital Committee, 2017a).
- This public budget for AE schemes will be under constant pressure to justify spending, and private investment in ES will be aggressively pursued as an alternative; specifically, the scenario lists "continuity of funding" as a risk, as well as "tight budgetary constraints" (Baldock et al., 2017, p. 67).
    - Public AE spending must be justified in terms of 'value for money' that it delivers for economic development (per DEFRA, 2018a; Downing & Coe, 2018; Natural Capital Committee, 2017a).
    - Wherever possible, private investment and collaboration with the private sector will be used as to add 'leverage' to public funding.

13. The existing cases within England (see e.g. Catchment Based Approach, 2018; DEFRA, 2013a; Eves et al., 2015; Papacharalampou et al., 2017; "The Feasibility of a Nitrogen PES Scheme in the Poole Harbour Catchment," 2013), as well as wider trends (see Gómez-baggethun & Muradian, 2015), indicate that private investment is almost always combined with public investment and support as part of AE management or biodiversity conservation.

- Due to farm consolidation and specialization, there is a heightened need to manage the environmental impacts of agriculture.

6 Exploring the potential for success: private investment and agri-environmental management

Within this section, I will directly address **research question 2**. First, I will demonstrate that, consistent with immanent critique (see also Isgren, 2018), there is an **internal criteria for success** against which increased private investment can be measured. I will then discuss the **factors that shape** the **investments** we can expect from **private actors** in this context, before **applying evidence and theory** from conservation biology to this context.

6.1 An internal criteria for biodiversity conservation

But against what criteria should we judge the success of the proposed AE approach? The method of immanent critique indicates that an **internal criteria for success** should be used (Isaksen, 2018). Specifically, the most relevant internal standard is the approach outlined by Lawton et al. in the report *Making Space for Nature* (2010). The approach is referenced by the *25 Year Environment Plan* as the basis for the successful conservation of the biodiversity which "underpins much of the economic and social benefit we gain from nature" (DEFRA, 2018a, p. 58), as well as by a myriad of other internal sources (DEFRA, 2017a; Ecosystem Markets Task Force, 2013; see e.g. Natural Capital Committee, 2017a). Furthermore, the approach outlined in *Making Space for Nature* correlates to external accounts of large-scale biodiversity conservation (see e.g. Haddad et al., 2015).

If **private investment** is to meaningfully contribute to post-Brexit AE policy – the provision of public as well as private environmental goods, and protection of the foundation for continued economic growth and development – then it must contribute to **biodiversity conservation**. Specifically, it must meaningfully reverse the trend of biodiversity loss associated with English agricultural LU (see DEFRA & Government Statistical Service, 2018; Field, Hill, Carroll, & Morris, 2016; Lawton, 2010; Robinson & Sutherland, 2002). Biodiversity represents the **ultimate means**, in so far as it supports other ES, which in turn support human

well-being and prosperity, and the basis for continued economic growth and development [14].

6.1.1 A coherent and resilient ecological network?

The *Making Space for Nature* report (Lawton, 2010) was commissioned by DEFRA to assess the "coherence and resilience" of England's EN (p. 20); essentially, whether the network meets the conditions for long-term biodiversity conservation. Finding that the EN to be neither coherent nor resilient, the report specifies that biodiversity conservation efforts target the network's five components (see Lawton, 2010, p. 16):

1. *Core areas*, which are semi-natural habitats that are usually designated, protected areas
2. *Corridors and 'stepping stones'*, which serve to connect these larger habitats
3. *Restoration areas* which will one day become core areas
4. *Buffer zones*, which surround and protect the above components from direct pressures
5. S*ustainable land use areas* within the wider landscape that serve to reduce direct pressures upon the above components. These this larger area is referred to as the LU 'matrix' within which the EN sits.

These components are illustrated in Figure 5, next page. The distinction between these categories is not perfectly exclusive, and there is a degree of overlap between them. Furthermore, there is a degree of possible trade-offs between these components, as more of one necessitates less of the others (Lawton, 2010).

14. As previously explained, this relationship between biodiversity, ES, well-being, and economic development is an explicit assumption that is internal to the policy framework; "without action, we face the progressive loss of the natural capital on which all growth… ultimately depends" (Gove, 2018b, p. 3)(see also esp. DEFRA, 2018a; Lawton, 2010; Natural Capital Committee, 2017a). The critical importance of biodiversity for ES (see e.g. Fu, Wang, Su, & Forsius, 2013; Groot, Wilson, & Boumans, 2002), and of ES for human well-being and economic development (see e.g. Daly & Farley, 2010; Robert et al., 2014) are also evident within the wider literature.

That being said, effective biodiversity conservation must target each of the above components[15] (Lawton, 2010) .

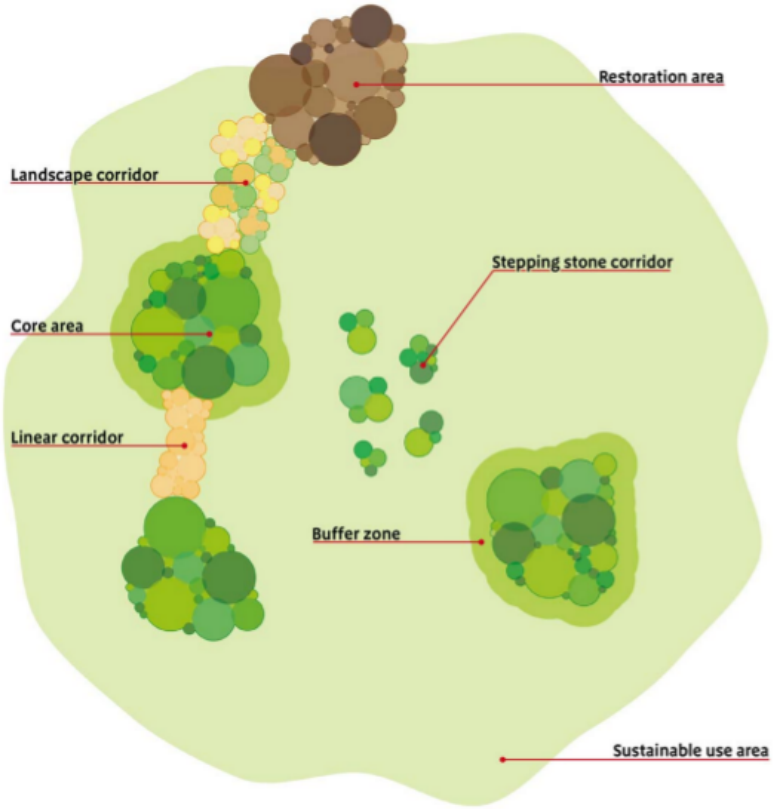

Figure 5. The components of ecological networks. Source: Lawton et al. (2010).

These principles are relevant because **agricultural LU** is the largest component of the **LU matrix** (per DEFRA, 2017a) and is "**critical**" to **England's ecological network** as a whole (Lawton, 2010, pp. 26, 83), such that AE schemes may be the most decisive mechanism in managing large-scale biodiversity conservation in England (Lawton, 2010).

Specifically, a '**soft**' **agricultural LU matrix** provides connections between semi-natural habitats and is "permeable and less hostile to wildlife", serves as a habitat for populations of wildlife that are "dependent upon, or at least tolerant of, certain forms of agriculture" (Lawton, 2010, p. 16), and buffers or reduces

15. These recommendations are operationalized within the *25 Year Environment Plan* (DEFRA, 2018a) as the NRN, within which agricultural LU plays a prominent role. That being said, even when not explicit, AE schemes are central to the integrity of the EN; according to Lawton et al. (2010), the HLS is the "single most important tool for managing many components of England's ecological network" (p. 81)

direct pressure on the semi-natural habitats (Lawton, 2010, p. 26). There is overlap with the concept of *connectivity*, as this matrix should be “permeable to wildlife, through environmentally-friendly farming techniques” (Lawton, 2010, p. 49), as well as with the concept of *buffer zones* that reduce direct pressure upon habitat.

These relate to **physical features** (see Figure 6, below) within agricultural LU that are of high conservation value: linear elements such as hedgerows or paths, as well as general “richness and complexity” (Lawton, 2010, p. 50) and “little patches of habitat and features” on agricultural land (Lawton, 2010, p. 60). These include small woods, “‘messy edges’ (ecotones), ponds”, and “rough corners in fields” (Lawton, 2010, p. 64). These structures are part of general landscape heterogeneity that Lawton et al. (2010) recommend as essential to the ecological network.

Figure 6. Natural features associated with a ‘soft’ agricultural LU matrix. From top to bottom: agricultural LU with a range of ‘ecotones’ and riparian buffer strip at edge of water course; buffer strip at edge of field; traditional, linear field boundary (hedge). Source: Author’s photos, 2018

Beyond physical features, agricultural **management practices** – such as the application of agrochemicals and regimes of grazing, crop rotations, and plowing – relate to the 'softness' of the matrix, as well as the pressures that it exerts upon surrounding habitat and corridors (Lawton, 2010). These practices are of particular concern, for example, in regards to eutrophication and pesticide pollution due to agricultural run-off (Lawton, 2010) and the breeding and food needs of endangered farmland birds (Royal Society for the Protection of Birds, n.d.)

This characterization of the agricultural LU elements which are most relevant to biodiversity conservation in England is consistent with a wide range of research and studies (see e.g. Eschen et al., 2012; Kleijn et al., 2011; Oliver, Roy, Hill, Brereton, & Thomas, 2010; Rey Benayas & Bullock, 2012; Robinson & Sutherland, 2002; Royal Society for the Protection of Birds, n.d.; Wretenberg et al., 2006).

In summary, a strong indication as to whether **private investment** in ES from agricultural LU can meaningfully contribute to AE management under the conditions of the scenario, is **the degree to which** it can fulfill the **criteria** for a **sustainable LU matrix** per Lawton et al. (2010).

6.2 Factors that guide private investment in this context

Success in this regard is closely related to **factors that guide the behavior** of **private actors** in this context. The range of potential outcomes from these private transactions is bounded by the expectation of a **return on investment**, and the distinction between **public and private goods**. **In this section** I will discuss these factors, and the **implications** for the object and outcome of these investments

6.2.1 The need to generate returns

The expectation of a return on investment is certainly a familiar concept, but it is necessary to emphasize that investment in this context is clearly distinct from philanthropic or CSR spending. As discussed, a 'business case' for private investment in natural capital (Business in the Community, 2016; DEFRA, 2015a,

2018a) is necessary to stimulate “investment in ecosystems” (DEFRA, 2014, p. 1).

Internal to the AE policy framework, the ambition to increase private investment closely resembles Milder, Scherr, & Bracer’s (2010) description of “private sector buyers acting voluntarily” (p. 2). A DEFRA report (DEFRA, 2017b) described these investments as “operational improvements”, “where the resultant improvement in natural capital provides some level of return to an investor” (p. 6), and “improvement to business operations” is a motivation for the project (p. 7)[16]. Another DEFRA report (2015b) found similar types of motivations (such as cost-avoidance or risk management) in potential private-sector investors. As such, these investments might be more accurately referred to as *private PES transactions*[17], where a farmer or land manager is paid by a private actor for delivering ES above the legal required minimum.

In practice, this often takes the form of avoided costs or risk mitigation. For example, Wessex Water Services Limited proudly quotes the estimated savings of a PES scheme called EnTrade[18], which avoids the cost of chemical and mechanical water treatment by paying farmers to reduce agricultural run-off within the catchment (Wessex Water, n.d.)(DEFRA, 2018a; see also Papacharalampou, Mcmanus, Newnes, & Green, 2017; “The Feasibility of a Nitrogen PES Scheme in the Poole Harbour Catchment,” 2013).

In other cases, investment in ES may directly enhance production of a commodity. For example, Nestle’s funding for certain dairy farming practices within the company’s supply chain in Cumbria, with the intention of increasing supply chain resilience and quality of produce (The Waste and Resources Action Programme, n.d.).

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16. Naturally, real-world behavior is rarely so black and white; for example, the report notes that CSR-related concerns often play a significant role (DEFRA, 2017b). Nevertheless, while CSR may be considered an investment, a central goal in the AE policy framework is increasing private investment in natural capital beyond charitable spending (DEFRA, 2018a; Natural Capital Committee, 2017a).
17. For additional reasons outlined in the literature (e.g. Daly & Farley, 2010; Gómez-baggethun & Muradian, 2015; Kroeger & Casey, 2007), the term *transactions* is more suitable than *markets*.
18. Both of these cases are upheld as examples of private investment in natural capital by policy documents (DEFRA, 2017b, 2018a) and several interviewees.

Already, **return on investment is one of the strongest motivations for private spending on 'natural capital' within England**. A recent DEFRA report (2017b), observed that the significant majority of private investment in natural capital (63%) is classified as 'operational improvements', and an additional 6% as 'certification or product development project' (p. 7). The same report estimates that 'operational improvement' projects are under-represented within the sample (DEFRA, 2017b, p. 5) . Another DEFRA report (DEFRA, 2014) found that there is a growing private interest in PES schemes within England, and predicts a significant increase in certain types of private investment in ES. As such, publicly-funded efforts to increase these private PES transactions, as well as growing private sector engagement, are already underway. Within our scenario, this trend continues.

6.2.2 The spectrum of public/private goods

Presently, efforts to correct 'market failures'[19] and increase private PES transactions center around a range of ES on the **spectrum of private/public goods**[20]. Specifically, a DEFRA report (2014) identifies the opportunities for increased private investment in PES specifically in terms of ES that lie in closer to the middle of this spectrum (see Figure 7, next page). External accounts correlate that these would be the most logical targets of efforts to expand the range of 'marketable' ES (see e.g. Fisher et al., 2008; Kroeger & Casey, 2007). In comparison, publicly-funded AE schemes are generally designed to deliver ES that are closer to the 'pure' public goods ends of the spectrum.

19. These sources of market failure include difficulties with quantification, high transaction costs, scale, and so on (Daly & Farley, 2010; DEFRA, 2014; Kroeger & Casey, 2007). The scenario assumes the 'successful' overcoming of these challenges.
20. Rather than a black-and-white distinction ES are more accurately located on a public/private goods spectrum (see e.g. Daly & Farley, 2010; Fisher et al., 2008).

Type	'pure' private ES	← →	'pure' public ES
Description	Discrete goods, readily quantified and valued. Excludable.	Primary target of increased private PES transactions. Mixed qualities.	May be the object of publicly-funded AE schemes. Difficult to quantify or value. Non-excludable
Examples	*Food, water, plant fiber*	*Soil formation and retention, water regulation, water quality*	*Biodiversity, UV protection*

Figure 7. Spectrum of ES. ES can be classified along a spectrum between private and public goods. In the context of English agricultural LU, pure private ES are typically marketable, and many pure public ES fall under AE schemes, whereas the middle column represents the potential object for expanded ES transactions. Source: own figure, informed by DEFRA (2014) and Fisher et al. (2008).

The data shows a strong precedence for private investment in ES in England which are closer to the 'private goods' end of the spectrum. Of private investments in natural capital surveyed in a DEFRA report (2014), 28% were directly associated with food provision, and 19% were directly associated with water regulation, purification, and waste (p. 8); they form the top two categories of investment. Illustrating the importance of agricultural LU, enclosed farmland constituted the dominant plurality (39%) of private natural capital investments sampled. Another report (DEFRA, 2017b), found the highest potential for expanded private PES transactions around ES such as food production, water quality, and water quantity; the report cites agricultural LU as one of the primary providers of these ES. A further report (DEFRA, 2015b) outlined private-sector actors with a high potential for integrating private PES transactions into AE management: water companies, food producers and retailers, as well as developers and the insurance industry (p. 39).

In short, 'pure' public goods – biodiversity conservation, for example – will not be the object of private PES transactions. Private investment will focus upon, rather, what Kleijn et al. (2011) typify as the delivery of "functional aspects of biodiversity" (p. 478)[21]. **If we are to expect biodiversity conservation, then**

21. The increased delivery of certain ES is not *a priori* favorable for biodiversity, as there are trade-offs between different ES 'bundles', including biodiversity (Coria et al., 2014; Holt et al., 2016; Spake et al., 2017). Increased food production, for example, has had negative impacts upon biodiversity.

it must be a co-benefit that might be ‘bundled’ along with the target ES (see Chan, Shaw, Cameron, Underwood, & Daily, 2006; Kroeger & Casey, 2007).

6.3 A (more) sustainable agricultural land use matrix?

So, are we to expect biodiversity – operationalized as an improved agricultural LU matrix (per Lawton, 2010) – from private PES transactions in post-Brexit England? To re-assert the assumptions made within our scenario, there will (at least initially) be equivalent levels of public funding for AE schemes, as well as increased pressure placed upon biodiversity as a result of increased farm consolidation and specialization[22]. Furthermore, as part of the overall AE management strategy, private PES transactions will be primarily *combined* with public-funded AE schemes (rather than *independent*) (per DEFRA, 2015b).

In this section, I will argue that, given the above conditions, **increased private PES transactions have the potential to increase the sustainability** or ‘softness’ **of the agricultural LU matrix**. In doing so, I draw some general indications from the theoretical literature that applies to this context, as well as turning to practical examples.

6.3.1 Incentivizing multifunctionality

As previously discussed, the English agricultural landscape is generally typified by **specialized**, **intensive agriculture** (Dallimer et al., 2009; Robinson & Sutherland, 2002), in which crop production has been heavily incentivized. The effect of CAP Pillar 1 payments as an incentive for increased crop production – and ensuing agricultural intensification – is noted both internally (DEFRA, 2018a, 2018b; Gove, 2018a), as well as within the wider literature (Benton, Vickery, & Wilson, 2003). Furthermore, the trade-offs that generally accompany decisions around ecosystem service provision (Coria, Robinson, Smith, & Sterner, 2014; Eigenbrod et al., 2009), especially in regards to agricultural intensity (Klasen et al., 2016) mean that many non-market ES are negatively impacted by the current mode of intensive agricultural production within England (Field et al., 2016).

22. For a discussion of farm consolidation and specialization in relationship to biodiversity within the England, see Robinson & Sutherland (2002).

This focus upon intensive agricultural production means that other ES (for which there is currently not a market) **are under-provisioned** by agricultural LU (Kroeger & Casey, 2007)(see also Kleijn et al., 2011). It follows that making these other ES 'marketable' will lead to an increase in their provisioning (Kroeger & Casey, 2007), even if we are only talking about the purchasing power of private actors. Because farming practice in England is largely determined by the financial incentives and market drivers that farmers face (Field et al., 2016; Holt, Alix, Thompson, & Maltby, 2016), it follows that if there are **price signals** for a **wider range of ES** from agricultural land (and no CAP Pillar 1-style payments that incentivise for food production), then agricultural LU will provide a more diverse range of ES[23].

There is a range of evidence to suggest that agricultural LU which provides a **wide range of ES** may have **biodiversity conservation co-benefits** in comparison with intensive agriculture which is focused more heavily upon crop production. For example, within "structurally simple" landscapes (Kleijn et al., 2011, p. 478) – such as this context (Jiang, Bullock, & Hooftman, 2013; Robinson & Sutherland, 2002) – there is a correlation between agricultural LU that provisions multiple ES ('multifunctionality') and positive biodiversity outcomes (Holt et al., 2016)(see also Kleijn et al., 2011), associated with increased habitat or landscape heterogeneity (see Figure 8, next page) (see e.g. Benton et al., 2003; Hardman et al., 2016; Oliver et al., 2010).

23. This diversification is consistent with the scenario, as well as being explicitly outlined in some of the texts analyzed (DEFRA, 2018b; Gove, 2018a, 2018b).

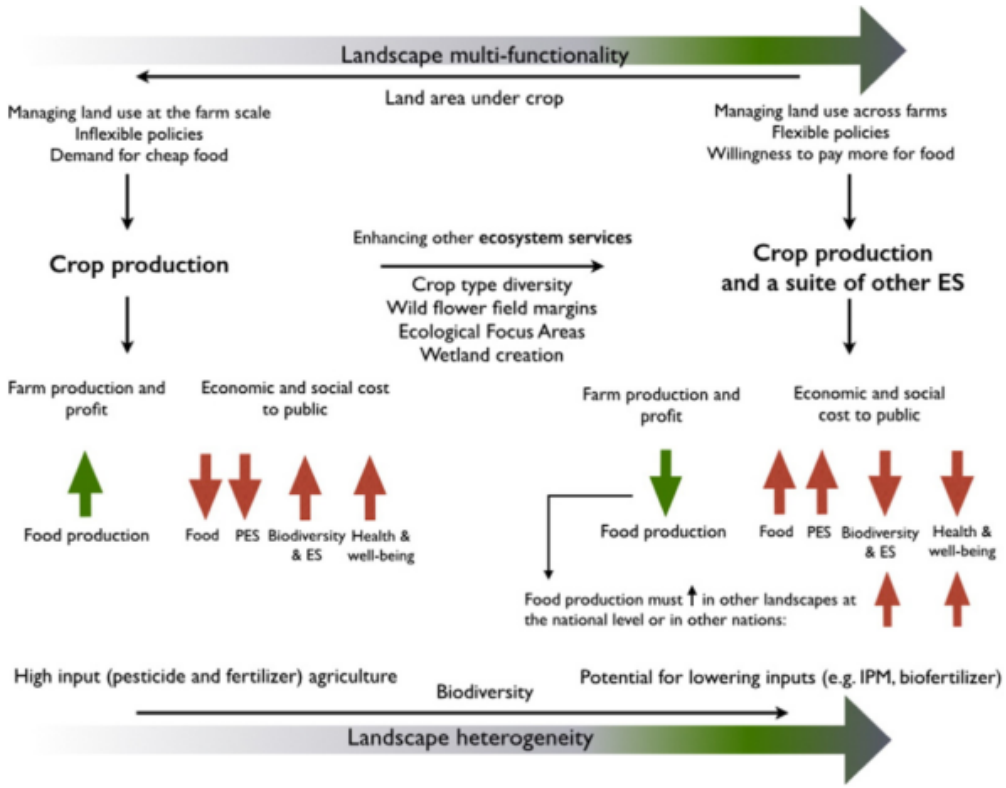

Figure 8. Landscape multifunctionality, heterogeneity, and biodiversity. There are broad correlations between agricultural LU multifunctionality, in terms of the range of ES produced, landscape heterogeneity, and positive biodiversity outcomes. Source: Holt (2016, p. 1423).

6.3.2 Examples from water quality and water regulation

Within this context, **increased multifunctionality** generally requires the use of '**green infrastructure**'[24] (CBEC Eco-Engineering, 2017; DEFRA, 2013a)(see also Kleijn et al., 2011), i.e. the "environmental features" which deliver ES (Natural England, n.d., p. 7); this green infrastructure is instrumental for biodiversity conservation (Liquete et al., 2015)(see also Natural England, n.d.). Other aspects of increased multifunctionality require changes in agricultural management practice that reduce the ES trade-offs associated with intensive agricultural production (Coria et al., 2014).

Here I will **illustrate some of these principles** in practice with **examples from the implementation** of private PES transactions around water quality and

24. Within the literature, green infrastructure usually relates to physical ecological structures (CBEC Eco-Engineering, 2017; European Commission, 2013). The changes in farming practices, such as different plowing regimes, grazing density, and so on, may alter ecological structures; as such, there is a degree of of overlap

natural flood management influenced by English agricultural LU. In comparison with other possible ES transactions, these examples represent a ‘critical case’ (per Flyvbjerg, 2004). This is to say that PES-type transactions around water quality are increasingly widespread (see e.g. DEFRA, 2014, 2017b; Mcgonigle et al., 2012; Papacharalampou et al., 2017); meanwhile, agricultural LU-related eutrophication is one of the biggest threats to biodiversity in England (Lawton, 2010). This may be the **most-likely ES to see increased private-private transactions** (DEFRA, 2014, 2015b, 2017b; Eves et al., 2015), and there are claims of **significant potential for biodiversity co-benefits** (A. J. Morris et al., 2003, 2007; J. Morris et al., 2010; “The Feasibility of a Nitrogen PES Scheme in the Poole Harbour Catchment,” 2013).

For the delivery of water quality or flood management, delivery measures might take the form of buffer strips along field edges and waterways (CBEC Eco-Engineering, 2017), wetland or grazing marsh creation, reduction in grazing intensity or grazing regimes, changes in crop rotation and plowing regimes (Kay, Edwards, & Foulger, 2009), changes in crop sowing date (Entrade & Wessex Water, 2017), how slurry is stored and applied, reduced use of agrochemicals such as chemical fertilizers and pesticides (Kay et al., 2009; Mcgonigle et al., 2012) grassed ditches, sediment traps, ponds and basins, and linear structures such as hedges or stone dykes (Environment Agency, 2012) (see also Environment Agency, 2012; Everard, 2012; Frontier Economics, 2013; Mcgonigle et al., 2012; A. J. Morris et al., 2003; J. Morris et al., 2010; “The Feasibility of a Nitrogen PES Scheme in the Poole Harbour Catchment,” 2013).

Within the English agricultural landscape, the above measures all have biodiversity co-benefits, whether through the creation of habitat, or a reduction in pressures upon adjacent habitat (Benton et al., 2003; see e.g. Environment Agency, 2012), and may specifically benefit priority species (see e.g. Oliver et al., 2010; Royal Society for the Protection of Birds, n.d.). Furthermore, it is clear that the addition of these measures relate directly to Lawton et al.’s (2010) recommendations for increasing the sustainability or ‘softness’ of the agricultural LU matrix.

Given our assumptions and use of the scenario, then, **increased private PES transactions can contribute to biodiversity conservation** in post-Brexit English agricultural LU, in at least some cases.

6.3.3 The caveat

Within the scenario and assumptions of this research, however, the main **caveat** is the **relationship to public-funded of AE schemes**. Our post-Brexit scenario assumes continued public funding for AE schemes – initially at constant rates – combined with private sector PES transactions extra 'leverage'. Justification for public spending on natural capital will be determined foremost through use of 'natural capital thinking'; specifically, "a program of investment in natural capital by the private and public sectors is required to deliver the [25 Year Environment] Plan… [and] resources and investments should be guided by the valuations of the net benefits they generate" (Natural Capital Committee, 2017a, p. 6). This rationale will determine both *which* natural capital is to be invested in, as well as *how much*[25].

This is important because although **private PES transactions can contribute to AE management** in at least some cases, **whether it is *enough*** to reverse the existing long-term decline in biodiversity (not to mention the increased pressures on biodiversity within our scenario) **depends upon the economic decision-making of both private and public sectors**. Assuming the internal goal of continued economic development, this leads to potentially problematic outcomes.

6.4 In summary

By now, it should be clear how this section relates to **research question 2**:

- The criteria outlined by Lawton et al. (Lawton, 2010) is a meaningful **internal standard** against which to judge the potential AE outcomes of private PES transactions.

25. It is true that I paint a fairly black-and-white picture of natural capital thinking, and there are nuances, however the primary focus of natural capital thinking is to integrate natural capital into economic decision-making (Natural Capital Committee, 2013, 2017a, 2017b).

- In particular, the AE management can contribute to large-scale biodiversity conservation by increasing the 'softness' or sustainability of the agricultural LU matrix.

- Within this context, private actors cannot be expected to directly invest in biodiversity conservation – e.g. a sustainable agricultural LU matrix.
  - Rather, these **biodiversity conservation** be a **co-benefit** of transactions around a range of ES.
- Theory suggests that increased private PES transactions, facilitated by the public sector, has the **potential to encourage multifunctionality** in agricultural LU
  - In this context, multifunctionality is broadly associated with **positive biodiversity conservation outcomes** which correlate with the criteria from Lawton et al. (2010).
- Likewise, the specific **green infrastructure** used to deliver some of these private PES transactions correlate with the criteria from Lawton et al. (2010)
- Naturally, a significant **caveat** upon which this potential success hinges is the degree to which **public-funded AE schemes** are continued, increased, or decreased.

7 Necessary limits

This section addresses **research question 3**, and seeks to uncover potential limitations to the proposed use of increased private PES transactions in regards to the desired ends. I argue that there are **limitations** associated with the use of **natural capital thinking** as a method for **resolving trade-offs** between the private sector and public sector objectives, which have the potential to undermine biodiversity conservation, and with it the basis for continued economic development and growth. Furthermore, I will show has these limitations are not resolvable without the use of a different method for resolving trade-offs.

7.1 Private/public collaboration and trade-offs

While we have established that within this context there is a large degree of potential overlap between private PES transactions and biodiversity, a great deal of evidence shows that the two should not be conflated (e.g. Coria et al., 2014;

Ekroos, Olsson, Rundlöf, Wätzold, & Smith, 2014; Gómez-baggethun & Muradian, 2015; Kleijn et al., 2015, 2011). In fact, there is strong reason to believe that private sector interest in ES is not sufficient to support biodiversity conservation. For example, ES are often provided by a relatively small range or subgroup of species, which often do not contain priority or endangered species (Kleijn et al., 2015), whereas biodiversity conservation requires maintaining existing ecological diversity at stable population levels (Kleijn et al., 2011; Lawton, 2010). Furthermore, in the context of agricultural LU, there are many examples of trade-offs between the goals of increased ES provisioning and biodiversity provisioning (e.g. Bradbury, Stoate, & Tallowin, 2010; Field et al., 2016; Klapwijk et al., 2014; Kleijn et al., 2011; A. J. Morris et al., 2007; J. Morris et al., 2010).

This means that private funding can simply be added to public funding as increased leverage (or vice versa)(Bradbury et al., 2010; Kleijn et al., 2011; A. J. Morris et al., 2007) ending up with a pure win-win scenario. Instead, **coordinated planning and integration** is necessary from the outset (Kleijn et al., 2011; A. J. Morris et al., 2007; J. Morris et al., 2010).

Relating to the examples that I have used earlier, green infrastructure (specifically, washlands) associated with agricultural LU within England has both "**synergy and conflict of interest** [emphasis added]… amongst flood storage, environment, and farming objectives" (A. J. Morris et al., 2007, p. 379) (see also A. J. Morris et al., 2003). There are real, practical effects in terms the environmental features that result as an outcome of different decisions about these trade-offs, documented through a number of different project implementations (for a thorough description of these trade-offs please see A. J. Morris et al., 2007; J. Morris et al., 2010). In another example, the implementation of the much-lauded EnTrade scheme mentioned earlier in section 6.2.1 required a long process of coordination with the public sector, conservation NGOs such as the RSPB, and so on (see e.g. DEFRA, 2013a; Norman et al., 2017; Papacharalampou et al., 2017; "The Feasibility of a Nitrogen PES Scheme in the Poole Harbour Catchment," 2013; Wessex Water, n.d.).

7.2 Resolving trade-offs and economic choice

Clearly, these trade-offs are important for biodiversity conservation associated with agricultural LU, achieving AE outcomes, and therefore extremely relevant for England's ecological network as a whole. My concern here is about the method which will apparently be used to resolve these trade-offs, given our assumptions and use of the scenario, and informed by the results of our policy analysis. Namely, it appears that **economic choice**[26] will be used to determine the trade-offs between the provisioning of certain ES – the "functional aspects of biodiversity" (Kleijn et al., 2011, p. 478) – and biodiversity conservation.

Because the premise of economic choice is a central element of this critique, I will review some of the key evidence:

- The *25 Year Environment Plan* proudly states that "this is the first time in the world that government strategy centers on natural capital considerations" (DEFRA, 2018a, p. 130), which will explicitly be used to make decisions about the appropriation of public funds (see DEFRA, 2018a, p. 20).
- Similarly, the new AE management approach described in *Health and Harmony* will be "underpinned by natural capital principles", including its appropriation of public funds (DEFRA, 2018b, p. 36), and will prominently incorporate "actions which encourage private investment in natural capital" (p. 37).
- The NCC, which directly informs the above understandings (DEFRA, 2018a), states that: "integration of natural capital into decision making at all levels is crucial to supporting and promoting future growth. This requires that natural capital is incorporated into national and corporate accounts **as well as into project appraisal** [emphasis added]" (Natural Capital Committee, 2013, p. 8).

26. My understanding of *economic choice* here follows that of Boda (2018) see also. I must repeat that the internal account is nuanced; the NCC acknowledges, for example, limits to substitutability among forms of capital (see Natural Capital Committee, 2013), and the *25 Year Environment Plan* acknowledges that the natural capital approach is "not an absolute arbiter" (DEFRA, 2018a, p. 18). That being said, the primary tool for maintaining and managing this natural capital is economic valuation and accounting (Natural Capital Committee, 2013, 2017a, 2017b).

- In a workbook aimed at guiding implementation of the natural capital approach (Natural Capital Committee, 2017b), the NCC instructs that "there are clear advantages in trying to put the various benefits and costs of environmental investments into common units, **specifically in terms of economic value**. In particular, **this allows us to compare the trade-offs that almost all changes to the natural environment entail** [emphasis added]" (p. 22).

Applied to this context, what does economic choice look like? Presumably, the social costs and benefits (in economic terms) of biodiversity conservation, versus the increased delivery of specific ES that are demanded by a private actor, are weighed against one another.

Although easily actionable, the use of economic choice for weighing trade-offs in this context is ultimately problematic in terms of the internal ambition towards **sustainable development**[27]. Within this ambition, as well as within the wider literature, we have seen how biodiversity plays a critical role in supporting all other forms of natural capital. In this way, even if we assume that continuous increases in resource efficiency are possible, the central question is one of sustainable scale: biodiversity must be maintained at above a certain critical 'level', conscious of thresholds, stable population rates, and so on (see e.g. Lawton, 2010).

This is important because there are **insurmountable contradictions** and unintended consequences in the use of internalization and economic valuation for achieving sustainable scale; in this case, maintaining biodiversity. Daly (2010) describes this fallacy as attempting to "**subsume scale under allocation** [emphasis added]" (p. 365), because, after all, economic choice is first and foremost an economic tool for satisfying assumptions about efficient allocation (see Daly & Farley, 2010; Wolff & Resnick, 2012), and is poorly suited for this context.

27. With 'sustainable development' I am referring to the coordination and alignment of economic and environmental policy discussed most explicitly within the *25 Year Environment Plan* (DEFRA, 2018a)(see also HM Government, 2017, 2018).

One manifestation of this shortcoming can be illustrated in terms of the microeconomic principles of marginal costs and benefits. Cost-benefit-analysis is made using assumptions about marginal costs and benefits: “how much an extra unit of [a given] commodity would cost” (Wolff & Resnick, 2012, p. 102), balanced against how much utility, or benefit, an additional unit of a given commodity would deliver. Marginal analysis, however, is poorly equipped – indeed it fails – to deal with “**non-marginal outcomes** [emphasis added]” (Farley, Schmitt, Burke, & Farr, 2015, p. 246) (see also Bithas, 2011), for example the **non-linear systems behavior** that we expect from biodiversity, which is known to have **thresholds** beyond which irreversible system change occurs (Fisher et al., 2008; Lawton, 2010; Natural Capital Committee, 2013; Steffen et al., 2015). Dealing with another commodity, it is clear to see that a marginal increase or decrease in the number of bicycles may have a marginal increase or decrease in utility; it is another thing entirely to deal with biodiversity, where a marginal decrease may lead to ecosystem collapse.

Furthermore, Daly & Farley (2010) point out that price signals and so on – tools that are typically employed for the purpose of economic allocation – cannot be used effectively as a tool for determining the optimal level of a given resource – a question of scale. Attempting to do so employs “circular reasoning” and necessary contradictions (Daly & Farley, 2010, p. 365) (see also Bithas, 2011). Rather, questions of scale must be determined by “quantitative restrictions upon the market” (Daly & Farley, 2010, p. 365).

Within the context of post-Brexit AE management, following the assumptions of our scenario, it could be argued that environmental regulations, forming the legal minimum for farming practice, represent this quantitative restriction. But these environmental regulations have not been enough to stop England’s ecological network from falling into state that is neither coherent nor resilient (Lawton, 2010). And if the natural capital approach lies at the center of the environmental policy (per DEFRA, 2018a), then cost-benefit thinking may very well be used to determine the appropriate level of environmental regulation, weighed against the benefits of increased economic development, for example.

Rather, limits to biodiversity depletion is a question of ecological sustainability, which is not composed of "personal tastes, and cannot be reflected in the market by individualistic actions" (Daly & Farley, 2010, p. 365). This holds true even when the public sector is the arbiter, and no matter how sophisticated the method of valuation; **these tensions arise from the use of the tool**, no matter who uses it. A further consequence is that these tensions **cannot be resolved with internal improvements**, such as the development of better valuation or the inclusion of a wider range of environmental indicators and empirical data. Failures in terms of negative environmental outcomes will always be interpreted as the result of an error in valuation, the result of an incorrect calculation, or incomplete internalization of environmental externalities (Daly & Farley, 2010) [28].

Determining a sustainable level of biodiversity must be settled with the use of a method that overcomes these inadequacies of economic choice. One interviewee, a NE employee, shared that he views his work as "consensus building"; "we represent what society wants", but also "a lot of what we do is making sure that society really understands what the opportunities are in front of them, and also what the threats and risks are". There is extensive literature in regards to a suitable method in this regard, such as the method of social choice, as conceived by Sen (Anand & Sen, 2000; Sen, 1999, 2013) and advocated by Boda (2017, 2018) within the field of Sustainability Science. As a method for resolving trade-offs and managing development more broadly, there may be potential for integration with dimensions of justice and power that were indicated at the beginning of this thesis. As well as exploring these possible overlaps, further research should investigate the suitability of **social choice** within this context.

8 Reflections on this research

This research has been a journey through a wide range of fields and subjects; throughout the process I have reflected upon the topic and data, and my use of

28. The internal accounts are replete with calls for more effective valuation and internalization, blaming environmental decline as resulting from incomplete accounting (DEFRA, 2018a; Natural Capital Committee, 2013, 2017a, 2017b).

theory and methods. Overall, I believe that my approach was well-suited, but that is not to say that it is without limitations.

One of the most difficult issues throughout the research process was ongoing developments and uncertainty around Brexit in general, and agricultural, environmental, and AE policy specifically. My use of the scenario was an attempt to deal with this issue, however a narrower focus and research questions may have been effective in this regard. Naturally, these uncertainties and assumptions impact the applicability and stability of my argument.

Secondly, there are certain places where I would have liked to engage with the research questions in more depth. In addressing research question 2, for example, the use of modeling tools such as the open-source software InVEST (Natural Capital Project, 2018) could have added strength to my argument. That being said, a precise comparison of biodiversity conservation outcomes from specific PES transactions would be highly dependent upon local conditions and conservation priorities (Lawton, 2010), and the size of the project, the specific ES to be delivered, and so on (Kleijn et al., 2011; Kleijn & Sutherland, 2003; A. J. Morris et al., 2003; J. Morris et al., 2010). These details would be particularly difficult to fill, as the large majority of the policies and projects within this research, have not moved beyond the conceptual phase, and the details of implementation are still vague.

Thirdly, my methods treat a variety of policy documents, government reports, and project proposals as parts of the same whole, representing a more-or-less cohesive position and intent. To a large degree, this follows Hall's (1993) original conception of policy paradigms, from which Howlett & Cashore (2007) developed the policy component taxonomy that I employ. Of course, we know the propensity for politicians and governments to say one thing and do another, which is not necessarily intentional. There may be compromises or concessions to political, economic, or social interests, for example.

Lastly, further insight could have been gained by explicitly including the current agricultural and AE framework within the collected data and policy analysis, as a

way of comparing the degree and significance of policy change (what Hall (1993) calls policy paradigm change).

9 Conclusion

Within England, the long-term trend of agricultural intensification and LU change has resulted in negative environmental impacts at the national level, which AE policies attempt to manage. Both the policies which have historically driven agricultural intensification and LU change, as well as these AE polices, are largely determined at the EU-level through the CAP. The British exit from the EU in March 2019 necessitates a restructuring of these agricultural and AE policies.

The first aim of this research was to examine the content of the post-Brexit AE policy in relation to wider policy goals, and the respective roles of the public and private sectors. The second aim of this research was to examine the potential for success, as well potential limits to the proposed AE approach. An immanent critical approach structures the research.

I conducted a mixed-methods policy analysis using policy documents and project proposals which comprise the proposed post-Brexit policy framework. In response to the first aim, I found that **post-Brexit AE policy relates to wider economic and development goals**, where a central objective of AE policy is **conserving this natural capital through integration with economic decision-making**. Furthermore, the role of the public sector will primarily be to c**orrect market failures**, and to facilitate the private sector to make **investments in natural capital**.

In response to the second aim, I found that there is **potential** for increased **private investment** in natural capital **to meaningfully contribute to biodiversity conservation**, with some caveats. There are, however, inherent trade-offs between the provision of functional aspects of biodiversity demanded by private actors, versus pure biodiversity conservation. **Economic choice is an insufficient method for resolving these trade-offs** in this context. The suitability of social choice is recommended as a potential entry point for further research.

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Appendix I: Secondary texts consulted for hermeneutic policy analysis

The primary texts are listed in order of analysis, taking account of the progressive expansion of contextual reference points throughout the process of analysis and interpretation.

Primary text	**Secondary texts**
Healthy Ecosystems East Anglia: a Landscape Enterprise Networks approach	(Business in the Community, 2016; DEFRA, 2018a)
Healthy Ecosystems Cumbria: a Landscape Enterprise Networks approach	
A green future: Our 25 year plan to improve the environment	(Catchment Based Approach, 2018; DEFRA, 2012, 2014, 2017a, 2017b; DEFRA & HM Treasury, 2005; Ecosystem Markets Task Force, 2013; HM Government,

	2017, 2018; Lawton, 2010; Natural Capital Committee, 2013, 2017a, 2017b; North Devon Biosphere, 2018; Robert et al., 2014; Rural Payments Agency, 2018; Wessex Water, n.d.)
Health and Harmony: The future for food, farming and the environment in a Green Brexit	(Conservative Party, 2015; Lawton, 2010; Natural Capital Committee, 2013, 2017a)
Interview: DB	(3Keel & Business in the Community, 2017a, 2017b; DEFRA, 2018a; Natural England, DEFRA, & Environment Agency, 2016; The Waste and Resources Action Programme, n.d.)
Interview: TC	(3Keel & Business in the Community, 2017a, 2017b; Business in the Community, 2016)
Interview: CT	(Catchment Based Approach, 2018; Environment Agency, 2012; Natural England et al., 2016; Rural Payments Agency, DEFRA, Natural England, & Environment Agency, 2018; The Waste and Resources Action Programme, n.d.)
Interview: JL	(Caldecott, Hall, & Ives, 2017; Catchment Based Approach, 2018; DEFRA, 2018a, 2018b, Gove, 2018a, 2018b; Natural England et al., 2016; Wessex Water, n.d.)
Interview: KS	(3Keel & Business in the Community, 2017a, 2017b; Business in the Community, 2016; HM Government, 2017, 2018; International Conference on Water and the Environment, 1992; UNDESA, 2014)

Appendix II: Policy component analysis results

Relates to LENs or policy framework Agency	Interview: T[redacted] C[redacted]	Interview: J[redacted] L[redacted]	Interview: C[redacted] T[redacted]	The Future of Farming: Health and Harmony	Interview: K[redacted] S[redacted]	Interview: K[redacted] S[redacted]
	LENs	policy framework	policy framework	policy framework	LENs	policy framework
	Skeel	Natural England, DEFRA	Natural England, DEFRA	DEFRA	BITC	BITC
Date of publication or interview	22 Feb 2018	1 Mar 2018	2 Mar 2018	27 Feb 2018	12 Mar 2018	12 Mar 2018
Policy Ends_Goals	Increased leverage for landscape-scale environmental conservation. Multifunctional landscapes, in terms of social optimization. Increased economic and environmental resilience	Multifunctionality, environmental protection.	Environmental protection. Increasing natural capital.	Increased resilience in the agricultural sector. Economic development. Protection of natural capital that is critical both for the agricultural sector, as well as the wider economy.	Encouraging and facilitating responsible business. Economic resilience. Resilient supply chains. Continued economic development.	Healthy society, healthy environment.
Policy Ends_Objectives	Increased provisioning of environmental goods and services from agricultural land, apart from food production.	Preventing pollution. Ensuring biodiversity.		Increased productivity and resource efficiency in the agricultural sector. Delivery of environmental public goods.	Protecting the natural capital that businesses rely upon.	
Policy Ends_Settings		Setting the legal environmental baseline for land managers. Setting prices for ecosystem goods and services, for example in the case of pollution.		capital is 'critical'. Understanding how ecosystem goods and services are impacted by management practices. Valuation of natural capital, including landscape values. Cost-benefit-analysis.	Correct valuation of business-critical natural capital	
Policy Means_Instrument Logic	Integration of ecosystem goods and services into business decision-making	Internalizing externalities – 'reflecting the true cost'. Natural Capital approach. Market logic are correcting market failures. Cost effectiveness and efficiency in policy. Public money for public goods, but also the inverse: private money for private goods. Social optimal. The best use of natural resources is the one that optimizes utility. Withdrawal of the state, transfer of governance to the private sector wherever possible.	Market logic; market failures; outcome-based payments for environmental results. Natural capital approach.	Market logic, efficiency of public institutions.	Natural capital approach. Optimization of resource use. Compatibility of Clean Growth and environmental sustainability.	Public money for public goods. Cost-effectiveness and efficiency. Eliminating unnecessary public spending.
Policy Means_Mechanisms	Governance / institutional arrangements that facilitate LENs	Incentives rather than command-and-control policy. Polluter-pays and internalization of environmental costs; also for the agricultural sector. Outcome, results-based policy. Correcting market failure through public-funded/encouraged opening of markets and private investment. Public intervention, where markets are unable to provide public goods, such as targeted work with land owners to protect biodiversity.	Mixed public and private funding for environmental objectives/natural capital; Governance and collaboration.	Environmental land management system (aka agri-environmental schemes) – both 'broad and shallow' as well as 'narrow and deep'. Liberalisation of policy , and increased application of market mechanisms.	Governance arrangements that facilitate private investment in natural capital, by overcoming the barriers to investment.	Governance; collaboration within the private sector, and between private and public sectors. Creation of new markets.
Policy Means_Calibrations		Increased investment in the ecosystem goods and services. Changes in public funding for the agricultural sector, both in terms of amount and type.		The end of direct income subsidies for farmers. Public funding for environmental public goods, where they cannot be provided through private funding. Simplification of regulatory process, increased self-regulation and NGO involvement in regulation.	Increasing commercial investment in ecosystem goods and services impacted by agricultural land use	Decreased overall public spending. Increased private investment in ecosystem goods and services from agricultural land use.

	LENs proposal: East Anglia	LENs proposal: Cumbria	25 Year Plan for the Environment	Interview: D[redacted] B[redacted]	Interview: D[redacted] B[redacted]
Relates to LENs or policy framework	**LENs**	**LENs**	**policy framework**	**LENs**	**policy framework**
Agency	Commissioned by BITC from 3Keel, with funding from DEFRA	Commissioned by BITC from 3Keel, with funding from DEFRA	DEFRA	DEFRA	DEFRA
Date of publication or interview	8 Dec 2017	8 Dec 2017	11 Jan 2018	21 Feb 2018	21 Feb 2018
Policy Ends_Goals	Making landscapes work for business and society. Regional development and economic resilience.	Regional economic resilience and continued regional development and economic growth.	Enhance natural capital, sustainable development (sustainable growth and economic development - by extension it is assumed social justice and well-being)	Lower environmental impact from supply chains.	Environmental protection. What is best for society.
Policy Ends_Objectives	Protect and enhance the natural capital upon which the regional economy relies, specifically in a way that best enables continued economic growth.		Protect and increase natural capital and ecosystem services, primarily those that support economic growth and development (by extension, the ES that underpin a healthy workforce, and the ES that are highly culturally valued) but also those that indirectly support the economy such as biodiversity. Increase private finance. Increase resource efficiency.		Social optimal of ecosystem goods and services.
Policy Ends_Settings	Economic choice will determine the optimum investment in natural capital *beyond the baseline public incentive/regulatory framework*		Correct valuation of natural capital and ecosystem services, determining which public goods can/can not be provided by the market.		Determining which public goods and services can be provided by the market, or at least subsidized by the market; determining where there are market failures. Determining what the social optimal is.
Policy Means_Instrument Logic	Market logic and economic choice. Cost-effectiveness and efficiency.		Natural capital approach, 'public money for public goods', economic choice, cost-effectiveness, efficiency.	Collaboration between public and private sectors. Business case for sustainability. Correcting a market failure.	Natural capital approach. Empowering and enabling communities and businesses to recognize opportunities in the environment. Correcting market distortions. Efficiency in terms of cost-effectiveness and reducing bureaucratic procedures. Public money for public goods, where they cannot be provided by the maret.
Policy Means_Mechanisms	Collaborative action, ie new governance structures and the creation of market mechanisms *(termed as 'markets', although they are not real markets)*		market mechanisms/market arrangements, governance structures, public-private-partnerships	Consulting private actors and facilitating business-to-business ecosystem goods and services transactions.	Outcome-based environmental land management schemes.
Policy Means_Calibrations	Determining where there is significant commercial interest in an environmental service/natural capital, either through finance-pooling, or the interest of one major actor. Secondly, determining possibilities for securing provisioning, either through collective agreements, or the provision by fewer larger land managers.		Decreased public funding for agricultural commodity production, etc		

Appendix III: Interview guides

All interviewees received the same information prior to the semi-structured interview, and all gave verbal consent. No interviewee requested anonymity, and no interviewee requested to withdraw from the research. This informational statement and the interview guides used are detailed below:

> The purpose of the research is to understand how LENs relates future policies that manage the environmental impact of land use, particularly by private land managers and farmers. Specifically, I want to explore post-Brexit policy logic, and how this relates to the provisioning of public goods.
>
> The research will be a part of my MSc dissertation in Environmental Studies and Sustainability Science at Lund University, Sweden. It will be published internally, as well as archived on the publicly available LUMES MSc program website
>
> I am happy to provide a final copy of the research, in the hope that it is relevant for the future of the project.
>
> The interview should take roughly 45 minutes, and will be recorded. All interview data collected may be anonymized upon request; by default I will use your organizational position within my research rather than your name. Participants are able to withdraw from this research at any time before the conclusion of the project.

Interviewee	DB	TC
Organization	Natural England	3Keel
Position	Senior Advisor, Supply Chain Partnerships	Partner
Date of Interview	21 Feb 2018	22 Feb 2018
Interview Guide	1) Please tell me about the history of your involvement in LENs. 2) Tell me about the LENs pilots *(Not so much the end vision, but the process of implementation, the current state, and anticipated next steps)* 3) What are the desired outcomes of LENs? *(prompt if necessary: environmental, social, economic, landscape)* 4) Ideally, how does LENs achieve these outcomes? *(prompt if necessary: no shortcuts; follow a train of logic from the method through to the outcomes)* 5) How would a LENs implementation resolve/make decisions about trade-offs? *(prompt if necessary: for example prioritizing certain ecosystem goods or services, or certain outcomes)* 6) What are the risks? 7) What are the challenges? *8)* Broadly speaking, why is LENs needed? 9) How might LENs complement or replace other policies or schemes designed to influence land management or agricultural practice? 10) How does LENs relate to the successes or failures of other environmental management policies or schemes? *(if necessary prompt with: strengths and weaknesses, goals, failures, successes, structural constraints, opportunities, tensions)* 11) Why do you think that LENs might be desirable to public bodies such as Natural England and Defra? 12) How do you think LENs relates to dominant pressures pushing environmental management policy? 13) Is there anything else that I should know about LENs, or its context? 14) Who else should I consider contacting for an interview? (especially about the direction of environmental management policy, how LENs relates to conservation, or the perspective of land managers)	

Interviewee	JL
Organization	Natural England & DEFRA
Position	Natural England Government Advice Team DEFRA Wildlife Team
Date of Interview	1 March 2018
Interview Guide	1) Please tell me about your position and briefly what it is that you do. 2) What is your involvement with policy relating to agriculture and environment? 3) *Private funding is mentioned in the 25 year plan for the environment, as well as several other government documents relating to the future of agri-environmental policy, but not much is mentioned specifically.* What could private funding mechanisms for agri-environmental outcomes look like in application? 4) Are you familiar with Landscape Enterprise Networks? *(if not: LENs, for short, was mentioned in the 25 year plan for the environment. It is an attempt to facilitate private investment in environmental services. It seeks to identify overlaps in the needs of private actors, who then have increased purchasing power for environmental services that might be provided by agriculture. Suggested services include water quality and flood management, and live-ability)* 5) What kinds of outcomes do you think private funding could ideally provide? 6) In which cases might private funding be best suited to providing environmental public goods? 7) In which cases might private funding not be suited to providing environmental public goods? 8) What role do you think that private funding might play in future, post-Brexit agri-environmental policy? 9) How do private funding mechanisms relate to the strengths and failures of agri-environmental policy? *(for example, outcome vs practice-based payments)* 10) As I understand, agri-environmental policy has primarily been publicly funded since it's inception in the mid 1980s – are private funding mechanisms becoming increasingly attractive to policy makers, and why do you think this could be? 11) What types of risks could you anticipate in private funding mechanisms for agri-environmental outcomes? 12) Is there anything else that I should know about LENs, or its context? → are there any other policies or schemes that use private funding that you're aware of? 13) Is there anyone I should consider contacting for an interview? In particular, the perspective of practitioners in conservation or agriculture?

Interviewee	CT
Organization	Natural England
Position	Catchment Sensitive Farming Officer
Date of Interview	2 March 2018
Interview Guide	1) Please tell me about your position and briefly what it is that you do. 2) What is your involvement with agri-environmental policy and implementation? 3) Are you familiar with the Landscape Enterprise Networks project, or other attempts to attract private investment in environmental services provided by agriculture? 4) What are the desired outcomes of LENs/private investment in environmental services from agriculture? *(prompt if necessary: environmental, social, economic, landscape)* 5) In relation to the new directive of agri-environmental policy - "public money for public goods" - When might private funding mechanisms such as LENs best be suited to providing environmental public goods? 6) What might be potential obstacles towards achieving those environmental public goods? 7) What are the potential challenges to implementation? 8) Broadly speaking, why is LENs needed? 9) How would you place schemes like LENs in relation to agri-environmental

	policies and schemes? 10) How does LENs relate to the successes or failures of other environmental management policies or schemes? *(if necessary prompt with: strengths and weaknesses, goals, failures, successes, structural constraints, opportunities, tensions)* 11) As I understand, agri-environmental policy has primarily been publicly funded since it's inception in the mid 1980s – are private funding mechanisms becoming increasingly attractive to policy makers, and why do you think this could be? 12) Is there anything else that I should know about LENs, or its context? → are there any other policies or schemes that use private funding that you're aware of? 13) Is there anyone I should consider contacting for an interview? In particular, the perspective of practitioners in conservation or agriculture?

Interviewee	KS
Organization	Business in the Community
Position	Head of Water
Date of Interview	12 March 2018
Interview Guide	1) Please tell me about your position and briefly what it is that you do. 2) Can you tell me about the beginnings and development of LENs? 3) What are the desired outcomes of LENs? *(prompt if necessary: environmental, social, economic, landscape)* 4) Ideally, how does LENs achieve these outcomes? *(prompt if necessary: no shortcuts; follow a train of logic from the method through to the outcomes)* 5) In which cases do you think LENs might be able to provide the best outcomes? 6) How does LENs relate to the strengths or failures of other schemes for working with the environment? 7) What is significant about getting private actors involved in providing public goods? 8) Why is LENs desirable? 9) What types of risks could you anticipate in private funding mechanisms for agri-environmental outcomes? 10) Is there anything else that I should know about LENs, or its context? 11) Is there anyone else I should consider contacting for an interview? In particular, the perspective of practitioners in conservation or agriculture?

Appendix IV: "Greener Shades of Liberalisation"

In this research, key assumptions draw upon the scenario *Greener Shades of Liberalisation*, from the LUPG-commissioned report *Potential Implications of Leaving the EU for UK Agriculture and the Rural Environment* (Baldock et al., 2017, pp. 66–70). I include key parts from of the original text below:

General Synopsis

In this scenario there is no FTA with the EU and WTO rules apply to external agricultural trade. The effects on trade and farm incomes are as described under Scenario B but the level of environmental ambition is substantially higher. Lower food prices are important in political and economic terms, as are savings in public expenditure. Domestic support

levels for agriculture are low (as in Scenario B) but a substantial proportion of available resources is focused on public goods provision and the environment.

Technological development and productivity growth within the agricultural sector and within the economy as a whole are also seen as a priority and are reflected in a greater focus on R&D, training and investment aid. The share of support aimed at longer term infrastructure and capacity (physical and human) is greater than now and there is a tendency to favour investment aid and training rather than large scale support for farmland management. Technological and organisational innovation is regarded as critical for productivity and environmental management. The linkages between agriculture and the wider bioeconomy and renewable energy sector are promoted, including the increased utilisation of wastes and residues such as straw. There is less interest in maintaining traditional, but unprofitable, production and land management systems for their own sake or for their socio-cultural value but a willingness to assist those HNV systems where environmental performance is demonstrably high.

Collective schemes and integrated food chain initiatives are encouraged, with public authorities playing more of a facilitative role. Where it is seen as cost-effective to transfer rural services, such as flood control and other aspects of catchment management to private suppliers, (which could include farmers in mixed consortia) there is little hesitation in doing so.

There are no direct payments to farmers within this scenario, at least after an adjustment period, but some aid is provided in relation to risk management. There is also a range of environmental public goods incentive measures, together with active efforts to secure a bigger role for the private sector. Aid is available in return for introducing new approaches such as precision farming and agro-forestry. Rapid structural change in the agricultural sector is accepted as likely, including in HNV areas and forms a base for productivity growth.

Environmental legislation affecting the countryside remains broadly the same as it is now, although more ambitious goals such as for reducing GHG emissions from farming and reducing flood risk are introduced over time. Concrete goals are developed for specific time periods, as in Scenario C, so that government interventions can be better targeted and results assessed more easily. Closing the gap between many of the existing environmental targets in the countryside (outlined in Chapter 2 and the Annex to it) and the current level of performance is a key priority

Implications for land use and farming patterns

The existing trend towards a smaller number of generally larger farms and increased contracting is likely to be exacerbated. Such farms will be capable of achieving a higher levels of productivity and surviving in competitive markets with much less support than today and much of the policy focus is on strengthening this component of the agriculture sector and increasing their environmental performance. The role of precision farming and lower input regimes on arable farms receives more prominence and qualifies for time limited but not insignificant support. Smaller farms might choose a variety of strategies, including greater co-operation, income diversification, specialisation in higher value products (including organic and certified foods) the supply of leisure facilities and ecosystem services and other ways of utilising their resources and skills. As in Scenario B, some land seems likely to go out of agricultural production and into a range of different uses.

Low margin systems will be under much greater pressure than today, which suggests a decline in those outdoor grazed livestock systems currently strongly dependent on CAP payments. The sheep sector is particular vulnerable to a potential lack of access (or costlier access) to its traditional export markets. These currently absorb up to 40% of

domestic production, 96% of which goes to the EU (National Sheep Association 2017). Concern about this issue is already being expressed in certain parts of the UK (Welsh Assembly 2017). Under this scenario there is no FTA with the EU and there is significant potential for a major disruption to the sheepmeat market.

The extent to which the UK Government and the Devolved Administrations are ready to provide some form of generic support to the beef and sheep sectors is a key question. This might be at a much lower levels than those schemes currently in place and might either be made permanent, albeit carefully and more narrowly targeted, or available on a transitional basis. Livestock related interventions might be placed in a wider policy frame and relate to plans to build a lower carbon food system with an emphasis on high quality sustainable products with a well-established provenance for example.

This raises questions about the future readiness of these administrations to intervene if there is a severe dip in market prices. For example, what level and type of government support might be available in the face of a severe shock, such as UK producers being shut out of a major export market? The Treasury may be more inclined to provide time limited support for structural adjustment than for crisis relief but other authorities may have a different approach.

The assumption under this scenario is that there would no equivalent of the current direct payments system, albeit with the possible exception of a modest payment linked to a domestic successor to the CAP Greening measures. However, there would be expenditure on AECMs of different kinds and perhaps a version of the LFA/ANC regime (as currently deployed in Scotland but probably more targeted). Such measures would comprise a larger proportion of overall support for agriculture than at present but would not have a larger budget. They would be more selective in a number of ways and perhaps put more emphasis on collective as well as individual contracts. This would help to sustain a portion of the current population of grazing livestock, but some reduction in numbers would nevertheless appear likely.

Policy in the uplands will be influenced by the considerable concentration of protected landscapes and sites designated for nature conservation purposes that can be found there. The uplands Severely Disadvanted Area in England for example is the largest proportion of the overall LFA and extends to about 1,625,437 ha, of which 1,250,000 or 77% is thought to be grazed. About 27% of the whole SDA is designated as SSSIs and 18% as Natura 2000 sites. About 74% is protected either as a National Park or an AONB. In total 1,247,973 ha of the SDA, around 77%, is designated under one or more of these categories, which overlap in some cases (information from Natural England).

The LEI/Wageningen study trade liberalisation scenario anticipates sizeable falls in the prices of sugar, pork and poultry as well as both sheepmeat and beef. By contrast, there would be price rises for grains and several dairy products (including cheese and skimmed milk powder) with production being adjusted accordingly (van Berkum 2016). Nonetheless, farm incomes fall for all sectors other than horticulture because of the sharp reduction in support.

Farms adjusting to the transition (and the likely fall in rents and land values) would be eligible for some support in relation to risk management and investment aid. This would have a significant environmental focus in scenario E. For example, selective investment in environmental management on arable and dairy farms would be supported, perhaps alongside the introduction of market measures to encourage the production of ‘greener’ milk. At the same time there would be more focus on the retention of grassland of conservation value by comparison with Scenario B, together with some tailored support for HNV farmland, focussed on the areas of greatest biodiversity value.

Implications for farmland management

Larger scale farms would predominate alongside an increased deployment of precision agriculture. More attention would be paid to soil and water management and climate mitigation measures than under Scenario B. Voluntary measures, such as sustainability protocols, would be developed within the food chain, exerting growing influence on farm management practice. The current standards for water protection and agrochemical authorisation would remain in place alongside schemes like the Pollinator Initiative. Private sector certification schemes would play a more important role in incentivising compliance with regulatory standards and developing good practice. The organic labels would remain a leading part of the certification system, but public support for organic farms would be adjusted downwards alongside other AECMs.

Under scenario E, the extensively grazed sheep and beef systems are supported by certification schemes and a selective quantum of agri-environment support, much of it focussed on key biodiversity sites and most valued cultural landscapes. A plan to reduce GHG emissions from agriculture would be established and backed up with aid for investment and management changes as part of a wider focus on innovation. The same would be true for ammonia emission reductions and IPM development, albeit all of these would operate on relatively small budgets.

Extensively managed stock eligible for AECMs on key nature conservation sites rather than the whole current LFA, (which may or may not survive as a designation in the UK outside the EU) might be one target for intervention because of biodiversity goals. However, the incentive system would need to be sufficiently attractive to farmers to achieve satisfactory participation in economically challenging circumstances. Over time there might well be a further retreat in the area of extensively grazed semi-natural vegetation and an expansion in woodland cover. The latter is likely to take place through natural re-generation as this Scenario assumes limited grant aid for afforestation, because of cost consideration

Many farms would no longer qualify for public support and labour would be withdrawn from landscape management on a considerable scale, because of the reduced number of holdings, fewer farm families and less hired labour and, a reduced affordability for non-essential contractors. The result would be more signs of low maintenance in the countryside and extensive growth of scrubby vegetation, especially outside key sites, as referred to in precious scenarios.

Implications for the environment as a whole

Scenario E would be expected to see reductions in pollution from agriculture and progress towards a lower carbon food system taking place on a faster timescale than under Scenario B. More private capital would be deployed in agriculture for environmental purposes than under Scenario B and certification schemes would be more influential, reinforced by government support and a continued emphasis on the importance of regulation and targets. It would be difficult to raise some standards much above the current level, however, given reduced support and pressure on farm incomes arising from imports, which would seem likely to inhibit progress. With some overall increase in imports likely in a more liberalised trade regime, the UK’s environmental footprint in source countries for these products would rise.

Funds for maintaining semi-natural grazing systems would be limited, but would be focussed on areas of the greatest biodiversity value. There would be more land available for NGOs and the public to acquire and utilise for extensive farming systems, but their response would be conditional on the resources available and these might be much more limited. The skills required to manage land in this way might also be in much shorter supply. Significant land use change would occur, affecting traditional landscapes in the

lowlands as well as the hills. Taken together these factors suggest more pressure on farmland biodiversity outside key sites and less focus on maintaining landscape features in the countryside which would be potentially in danger of neglect or removal following farm amalgamation.