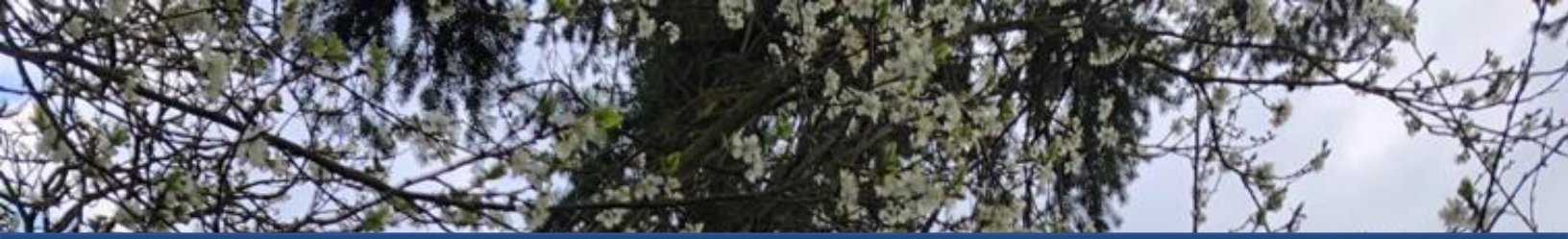

ON ENGLAND'S GREEN AND PLEASANT LAND

A Study on the Biodiversity Net Gain Mandate

In partnership with CEPA Ltd.

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The cover photo was taken by one of the authors of this report and is used with their permission.

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ACRONYMS

BNG	…	Biodiversity Net Gain
BUs	…	Biodiversity Units
Defra	…	Department for Environment, Food & Rural Affairs
DEECA	…	Department of Energy, Environment, and Climate Action
Eftec	…	Economics for the environment
LPA	…	Local Planning Authority
NNL	…	No Net Loss
NVCR	…	Native Vegetation Credit Register
PES	…	Payments for Ecosystem Services
RIBITS	…	Regulatory In-Lieu Fee Bank Information Tracking System
USACE	…	US Army Corps of Engineers

EXECUTIVE SUMMARY

This report provides a comprehensive assessment of England's Biodiversity Net Gain (BNG) mandate on the cusp of its implementation in November 2023.

1. Policy Context & Purpose

The UK is one of the least biodiverse countries in the world, having experienced significant habitat loss and diversity decline in the last half-century (Environmental Audit Committee, 2021). The BNG mandate will come into effect in November 2023 and require all new developments in England to deliver a 10% improvement in biodiversity. It will create a market for biodiversity offsets with the aim of efficiently improving biodiversity and pushing the cost of those improvements onto those who directly benefit from new development. We aim to assess what the regulatory landscape and new legal obligations created by the mandate will look like, what will be the dynamics of the market created by the mandate, how that market might develop and mature, and what risks there are to the mandate delivering cost-efficient biodiversity gains.

2. Conceptual Framework

Section 2 will briefly survey and summarise relevant academic literature on markets for environmental services, before developing a framework for assessing the maturity of those markets. It analyses what characterises a mature or 'high functioning' market for environmental services compared to a new or immature market.

This conceptual framework helps us to map how the BNG mandate might develop and identify possible barriers to the market's development and growth. It will also help to frame the subsequent analysis of the UK's BNG mandate and international case studies.

3. International Case Studies

Section 3 examines two international case studies of biodiversity markets to draw relevant lessons for the BNG mandate's development: the US wetlands market and the Australian state of Victoria's native vegetation management market. These case studies suggest that

decentralised regulatory management for offsetting schemes might not perform as well as schemes with centralised regulators. Further, government support for market matching and price discovery and help to lower transaction costs, improve market efficiency, and support the development of offset markets and biodiversity improvements.

4. The BNG Mandate

Section 4 analyses the regulatory landscape created by England's BNG mandate. Given the market for environmental services will be created by regulation, to understand how that market will function we have to understand exactly what obligations have been created by the regulation and how those obligations will be monitored and enforced. This section first explores the policy context and legislative history leading to the adoption of the BNG mandate, before examining the intricacies and mechanics of the mandate.

5. The BNG Market

Section 5 reviews the economic dynamics that will shape demand, supply, prices, intermediation, delivery, and financing in the market created by the BNG mandate, before examining risks to the market's operation from price uncertainty, compliance uncertainty, and policy uncertainty. Demand for biodiversity units (BUs) is likely to be relatively inelastic, and there will be strong pressure from the biodiversity metric to 'buy local', which will shape the split in demand between on-site and off-site BUs. Prices will be heavily shaped by the costs of supply, which will also be shaped by the spatial and temporal risk multipliers in the metric. There will be significant opportunities for financing to support off-site suppliers and for habitat banks to provide efficient intermediation services as the market matures. There could be significant short-term uncertainty about costs and prices, while compliance and policy uncertainty could also create distortions, all of which could deter private off-site supply and hinder market development.

6. Quantitative Analysis

Section 6 is a quantitative analysis of the BNG market. We estimate the annual size of the biodiversity market will be around £135 million by looking at the total possible supply,

annual demand, and the likely price of BUs from existing models and forecasts. A new contribution we make to existing literature is to estimate the monetary value of biodiversity improvements under the BNG mandate, at about £20.2 million annually.

We also look at the market's development in the short and long-term, arguing that both the quantity and price of BUs will increase in the short-term. However, in the long-term, while the quantity is expected to increase and prices stabilise, the likely eventual equilibrium price level remains uncertain.

7. Policy Recommendations

Using the foundational understanding of the BNG mandate provided by section 4, and the insights gained from the market and quantitative analyses in sections 5 and 6, this final section begins by identifying regulatory constraints that could impede efficient market function and real biodiversity improvements. One headline finding from our analysis is that the annual cost of administering the scheme for LPAs, at around £9.5 million, is about half the estimated annual monetary value of additional biodiversity improvements we expect the mandate to deliver, at about £20 million. Given risks to the market's functioning and development and the delivery of real-world biodiversity improvements that we identify, policymakers will have to closely monitor the scheme's performance to ensure that relatively marginal gain of extra £10 million annually is actually delivered.

We then propose several policy recommendations to address these barriers, including expanding the Biodiversity Gain Site Register, providing capacity support to LPAs, and interventionist market approaches like demand guarantees.

1. INTRODUCTION

1.1 Policy Context

Global concern over biodiversity loss has grown significantly in recent decades, alongside concerns about human impact on the climate and other environmental systems. The state of the world's biodiversity has been subject to increasingly dire predictions that human land use is placing nearly a million species at risk of extinction in the next decade (Kolbert, 2014; IPBES, 2019). At the same time, there has been increasing awareness of the importance of the 'ecosystem services' that nature provides to human societies and economies – for example, agriculture yields depend on clean water, clean air, and soil fertility, which can all be difficult to sustain without a healthy and biodiverse ecosystem (OECD, 2016).

In the face of these pressures, global ecological policymakers have sought to make it an 'accepted norm' that 'no net loss' of biodiversity should be the minimum standard for managing the trade-offs between human land use and biodiversity (Maron et al., 2020). Some have even begun to examine 'net gain' policies that require baseline biodiversity values to be improved (Bull & Brownlie, 2018; Maron et al., 2018).

However, communities around the world have proven reluctant to make costly economic and social adjustments for the sake of protecting the environment (Nature, 2020). In this context, policymakers have sought new tools that soften the short-term economic costs and adjustments required to achieve environmental goals. For biodiversity, this has meant finding new ways to allow development and human land use while enhancing or mitigating the effects on biodiversity (Simmonds et al., 2020).

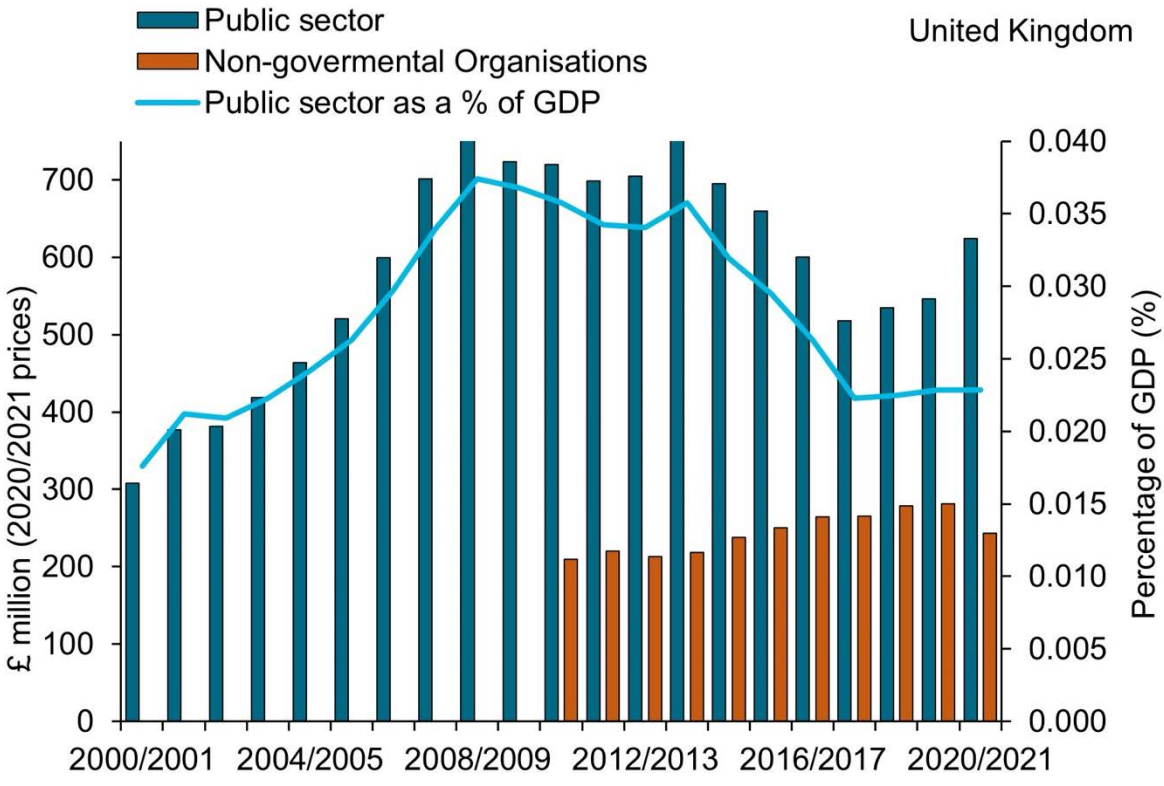
Biodiversity offsetting is one such tool, where biodiversity losses that cannot be avoided or compensated on-site of a development can be compensated through the creation or enhancement of biodiversity off-site of the development (OECD, 2016). This approach has been enthusiastically embraced by policymakers worldwide (Bull & Strange, 2018).

1.1.1 England's Biodiversity Net Gain Mandate

The UK is among the least biodiverse, most nature-depleted countries in the world. Over the last five decades, there has been a 40% decline in species diversity, with 15% facing possible extinction, and a 60% decline in 'priority species' (Environmental Audit Committee, 2021). The UK National Ecosystem Assessment (UK NEA) was a comprehensive analysis of the country's natural environment stock released in 2011. It indicated that 40% of the UK's most crucial habitats were in decline.

At the same time, as Figure 1.1 shows, public funding to protect and enhance biodiversity has been inconsistent. The Joint Nature Conservation Committee (2022) estimated that public expenditure on biodiversity in the UK declined by 42% in just five years between 2013-14 and 2017-18, from around £670 million to £470 million. Funding rebounded in nominal terms to £624 million in 2020-21, but this is a flat trend in %GDP terms.

Figure 1.1 – UK public expenditure on biodiversity, 2000-01 to 2020-21



Source: Joint Nature Conservation Committee, 2022

It is in this context that the UK is implementing a Biodiversity Net Gain (BNG) mandate, seeking to harness private markets and financing to increase the flow of funds for biodiversity improvements in England. This is a relatively innovative policy framework. The UK was the first European country to legislate such a requirement in the Environment Act 2021 and the policy is due to come into effect for most developments in November 2023 (Simpson et al., 2022). The mandate will require developers to deliver a 10% net increase in the amount of biodiversity present on the land of their development. The mandate will create a biodiversity offset market with the aim of delivering cost-efficient biodiversity gains and pushing the cost of those improvements onto those who directly benefit from new development. An efficient and properly operating market for biodiversity offsets should ensure that developers will not pay more for biodiversity offsets than the value of their development, while suppliers of offsets will not accept less than the opportunity cost of creating those offsets (Simpson et al., 2021). In this way, the BNG mandate seeks to deliver a cost-efficient and equitable management of the trade-off between development and biodiversity.

1.2 Research Question

This report provides a comprehensive assessment of the BNG mandate on the cusp of its implementation. We aim to assess what the regulatory landscape and new legal obligations created by the mandate will look like, what will be the dynamics of the market created by the mandate, how that market might develop and mature, and what risks there are to the mandate delivering cost-efficient biodiversity gains. In doing so, this report contributes to the literature on biodiversity offsets, the creation of markets for environmental services, and serves as a case study for policymakers.

The first section provides some additional background on environmental services, natural capital, and market-based instruments, before constructing a conceptual framework to assess the maturity and development of environmental services markets. The second section looks at two case studies of international biodiversity markets: the US wetlands market and the Australian state of Victoria's native vegetation management market. We draw lessons from these examples about the challenges the BNG mandate might face and the kind of support it

might need to function and development successfully. The third section provides a detailed assessment of the regulatory landscape created by the BNG mandate and identifies where there are still gaps and uncertainties in the regulation. The fourth section analyses the offset market that will be created by the mandate to understand what the economic dynamics shaping that market will be, what business and financing opportunities there will be, and what risks there will be to the market's smooth functioning and development that could threaten the delivery of BNG. The fifth chapter provides a quantitative assessment of that market, estimating key prices and the size and likely development of the market in the short and long-term. The sixth chapter concludes by drawing from our preceding analysis, conceptual framework, and international case studies to present some key risks to the BNG mandate's success in the short and long-term and offer some policy recommendations to address those risks.

1.3 Methodology

We utilise literature reviews and secondary research as our core methodological approach in each section. In addition, we conducted six interviews with key stakeholders in Local Planning Authorities (LPAs), the Department for Environment, Food & Rural Affairs (Defra), which is responsible for the BNG mandate's legislation, and an environmental consulting firm, Eftec. We spoke to ecological and planning officers from Warwickshire, Leeds City, and Tunbridge Wells LPAs. These LPAs are each 'early adopters' that have been operating BNG-like schemes for several years and participated in the UK government's 2012-14 pilot program for biodiversity offset markets (Defra, 2013). To allow these policymakers to speak more freely and protect their privacy, these interviews were conducted under a modified version of 'Chatham House rules' (Chatham House, 2023). We gained prior permission to name the LPAs and use the insights gained in the interviews, but we did not record the interviews and do not attribute specific comments to specific individuals or LPAs in this report. Appendix B contains a list of the questions we asked in each interview.

The second section on the BNG regulatory landscape also drew on legal and regulatory research to understand what obligations will be created and who will be responsible for

managing the mandate. The fourth section, our quantitative assessment of the 'BNG market', used two complimentary methodologies. First, we conducted a literature review of studies that quantitatively forecast or model aspects of the 'BNG market'. Second, we drew from existing models and forecasts of land use and biodiversity in England and used our own calculations to construct simple estimates that give a sense of the likely size of the BNG market and the value of the biodiversity benefits produced by the mandate.

2. MARKETS FOR ENVIRONMENTAL SERVICES

As policymakers have sought new tools to manage and soften the trade-offs between environmental protection and economic activity, there has been increasing interest in using market-based instruments (MBIs) to secure more efficient and equitable outcomes. In recent decades, the framework of 'environmental services' has emerged to characterise what value human societies and economies derive from nature, construct monetary values for those services and incorporate them into markets (Simmonds et al., 2020). To analyse the market in England and whether it can achieve its intended outcomes, we need to understand the economic reasoning underpinning the creation of markets for environment services and what characteristics determine the development of such markets.

This section reviews the current literature and theoretical context behind the creation of markets for environmental services and develops a conceptual framework for assessing the maturity of environmental services markets. First, this section discusses the theoretical background behind the use of markets to environmental policy goals by drawing a comparative analysis between MBIs and prescriptive regulatory approaches. Second, it provides and discusses a typology of the main types of environmental services markets. Finally, it provides a conceptual framework to characterise a high-functioning or mature market for environmental services.

2.1 Why Create Markets for Environmental Services?

The need for MBIs in the context of environmental services is based on the conceptualisation of environmental problems as 'externalities'. The environment positively contribute towards the wellbeing of individuals and economic development through 'environmental services'. However, these services are rarely reflected in the economic incentives faced by private land users. Landowners and managers who invest in the production and maintenance of the environment are not rewarded for the benefits they provide to others, and businesses and firms which reduce or destroy natural capital and environmental benefits do not bear the costs for the actions they impose on others. This phenomenon is referred to as an externality and the presence of externalities can lead to what is known as a market failure (Murtough et al.,

2002). These market failures can lead to a reduction in the provision of benefits from the environment beyond a socially optimal point.

In theory, issues arising from market failures can be remedied through government intervention. In the context of environmental services, two main types of government intervention come through prescriptive regulation approaches, often labelled as 'command-and-control', and MBIs. MBIs aim to provide financial incentives to minimise environmental harm and encourage sustainable innovation. Such instruments can be implemented through market signals like prices and mechanisms like taxes and subsidies (Stavins, 2003), financial transfers between organisations that harm the environment and society (Mazaheri et al, 2022), and other kinds of market mechanisms, which will be examined in detail in the next section.

In contrast, 'command-and-control' approaches directly dictate what firms and organisations can or cannot do, typically by restricting activities or mandating limits to firms' environmental impacts (Salzman & Thompson, 2010). This involves mandating firms to adopt environment-friendly technologies or setting limits on environmental impact. Such regulations alone can generate high transaction costs associated with monitoring and compliance (Muradian & Gomez-Baggethun, 2013).

In the political arena, governments view MBIs as cost-effective and innovative tools for environmental conservation in comparison to traditional prescriptive regulations (Coralie et al., 2015). MBIs can harness private financing to secure new flows of funds to protect and improve the environment, which is attractive for governments facing budget constraints (Boisvert et al., 2013). The lack of funding to achieve biodiversity conservation targets was identified as a reason for adopting MBIs in the EU Biodiversity Strategy for 2020. It was argued that the lack of public funding meant that new sources of funding that can emerge through MBIs had to be sought to conserve biodiversity (Pirard, 2012).

In the business arena, firms, large corporations, and financial institutions are drawn towards MBIs to protect the environment. First, by putting an economic value to biodiversity losses, it enables developers to anticipate their offset obligations and thereby reduce costs and limit risk exposure (Coralie et al., 2015). Unlike regulatory measures which require compliance

with strict targets, MBIs enable businesses to make change their behaviour in a way compatible with their market models and preferences (Henderson & Norris, 2008). This should translate into lower compliance costs. Second, investors are drawn to the potential of MBIs to offer financial benefits. For example, in 2011 the biodiversity offset market in the US wetlands alone was estimated to be around US$2.4 - 4 billion (Masden et al., 2011).

2.2 Typology of Markets

Using MBIs to manage environmental problems has grown markedly across the globe which is reflected in the vast range of markets for environmental services present today. Figure 2.1 provides a typology of the main types of markets for environmental services. Certain markets may have combinations of different mechanisms to provide greater flexibility. For example, a cap-and-trade market can also allow the creation of additional credits through mitigating offset arrangements (Whitten et al., 2003). Importantly, the common characteristic of all environmental services markets is that they provide price-signals to decision-makers to different degrees and in different ways.

Figure 2.1 – Types of markets of environmental services

Market Mechanism	Description
Biodiversity Offset and Biodiversity Net Gain Credit Markets	Biodiversity Offsetting is based on the principle that environmental losses resulting from development can be compensated by equivalent gains elsewhere i.e., no-net loss (NNL). In this market, landowners/companies who generate environmental services sell these services to companies looking to offset environmental impacts. These offsets are used by firms to meet their environmental regulatory requirements. Net gain credit markets are markets where units of biodiversity emerging from environmental improvements are bought and sold, either through market transactions or direct deals. However, unlike the

	offset market, such markets fund investment in environment services with a net biodiversity gain from pre-existing baseline.
Cap-and-Trade	In this market, limits or caps are set on environmentally harmful activities or by-products and provides the firm with a limited number of annual permits to conduct such activities. These permits can also be sold and traded in the market, providing firms with a secondary market and revenue stream.
Habitat Banking, Wetland Mitigation Banking, Conservation Banking	This market involves the banking of any environmental services which includes lands, species, habitats, wetlands and streams etc. The credits are produced prior to the environmental impact since the goal is to create or enhance habitat before the impact in order to compensate for future losses. Development impacts are considered to debits and credits are awarded for restoration of habitat.
Payment for Ecosystem Services (PES)	Broadly, the concept of PES refers to when producers of environmental services receive direct compensation from the users and beneficiaries of such services for the benefits provided. These are voluntary transactions between service users and providers on the condition of biodiversity conservation and provision of that service.

Source: Mazaheri et al., 2022; Coralie et al., 2015; Boisvert et al., 2013

2.3 Characterising a Mature Environmental Services Market

MBIs are one way to value the environment and reduce over-consumption and under-protection of environmental services (Martin et al., 2018). However, the history of market instruments in the environmental services landscape shows that creating mature and high-functioning markets is contingent on a complex array of regulatory structures, governance

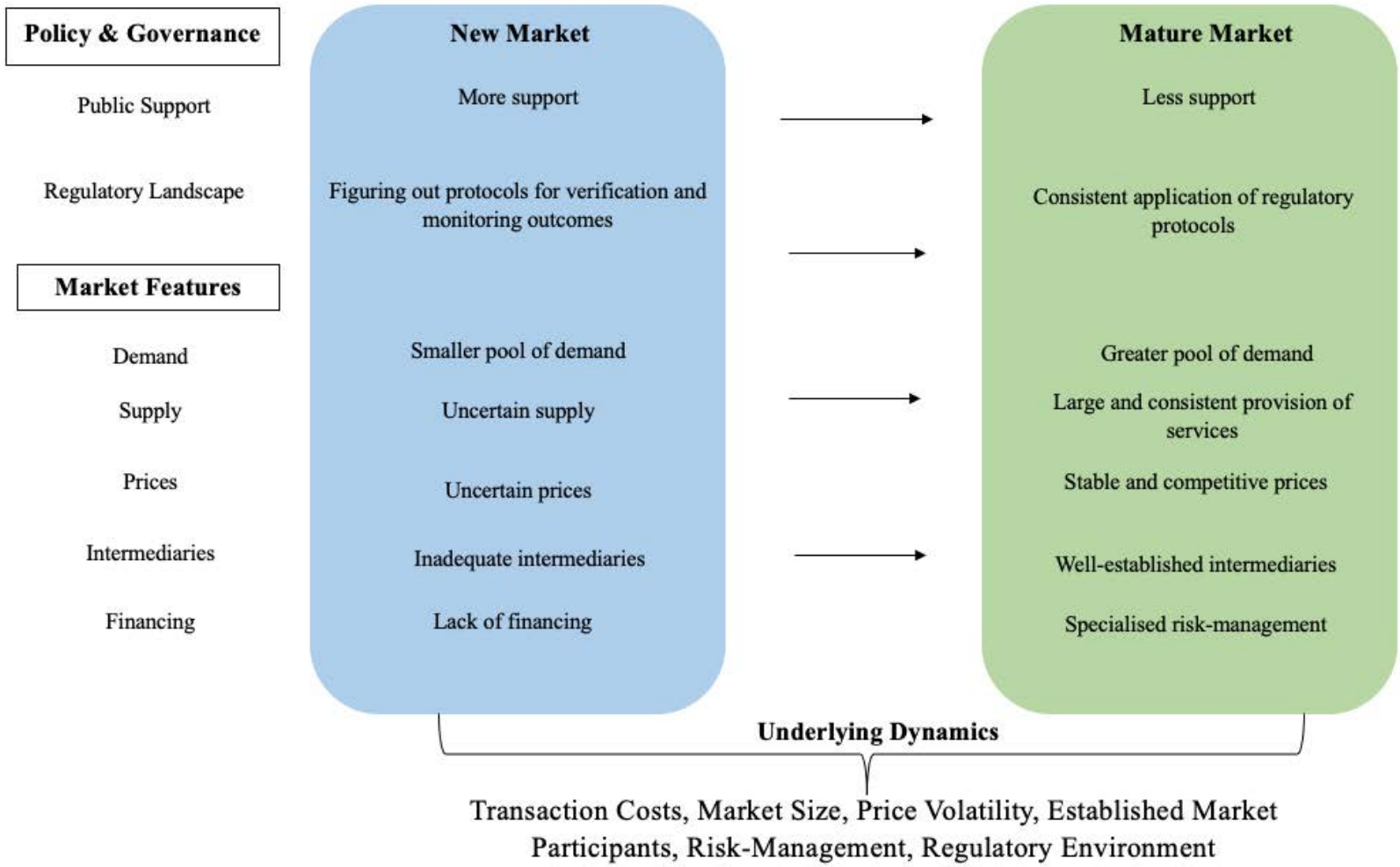
systems, and market variables. In the biodiversity offsetting context, a well-functioning market plays a dual role in minimising the economic costs to developers for preventing future loses in biodiversity as a result of development activities and provides incentives to landowners to invest in the production and maintenance of environmental services (Simpson et al., 2019). Firms who harm biodiversity during development must secure offsets to compensate for that impact. These credits are purchased from landowners who invest in the restoration of the environment and earn financial benefits from the sale of credits. In this sense, the price of credits should reflect the marginal cost of securing the offset (Armsworth, 2014). Importantly, the degree to which aggregate economic costs can be minimised is dependent on the nature of the offset trading market.

The report develops a conceptual framework, shown in Figure 2.2, which illustrates the main characteristics that determine the functioning of an environmental services market as it moves from the stage of a new or emerging market to the stage of a mature or high-functioning market. The framework divides these characteristics into two central categories of Policy & Governance, which comprises public support and the regulatory landscape, and Market Features, which comprises demand, supply, prices, intermediaries, and financing. The framework outlines the main underlying dynamics that influence these components and thereby determine the functioning and development of the market.

Transaction costs are defined as costs involved in the buying and selling of goods in a market (Coase, 1960). In the context of environmental services, governments incur transaction costs in the form of information gathering, legislative, administrative and bureaucratic functions. The private sector incurs transaction costs in the form of negotiating a contract, obtaining approvals, monitoring activities and ensuring compliance (Jindal & Kerr, 2007). Transaction costs are a significant component of environmental services market, with one study showing that transaction costs involved in carbon sequestration projects ranged from 6% to 45% of total costs (Guillozet, 2016). In general, high transaction costs reduce in the quantity of environmental services traded, the gains from trade, and the size of the market. In a high-functioning market, transaction costs are lower, which are reflected in the greater pools of demand and large provision of supply of environmental services. This can be achieved

through various measures like the standardised, transparent, and consistent application of regulatory and monitoring protocols, through intermediaries and negotiating contracts with groups of landowners instead of single landowner to increase economies of scale, which are observed in mature markets.

Figure 2.2 – A conceptual framework for assessing market maturity



Source: Authors' construction

Market size and *price volatility* are related to each other such that thin markets, comprising of smaller number of buyers and sellers can lead to inconsistent and unpredictable prices. Highly variable provision of services in the market would decrease the confidence of private actors on returns from investment and deter investments in the future (Canning et al., 2021). In a mature market one would observe larger number of buyers and sellers and more predictable and competitive prices, which is critical for the financial viability of the market. *Established market participants* like intermediaries are also crucial in determining the functioning of the market by reducing the economic costs involved in matching buyers and sellers in the market. In the environmental services landscape where there is imperfect information and uncertainty about offsets, intermediaries provide specialised and strategic information that helps in offset finalisation and brokering of offset exchanges (Coggan et al., 2010). In Australian environmental offset markets, intermediaries influenced transaction costs in the market through provision of information and time-intensive services like negotiating, contracting and monitoring (Coggan et al., 2012). Therefore, in a mature market one should observe large, well-established and centralised intermediaries who can provide these services at a lower cost than what the buyers and sellers would incur themselves.

Finally, *regulatory environment* and *risk-management measures* are crucial in increasing both buyer and seller confidence in the market. Regulatory measures like measurement and accounting of credits, verifying offsets, monitoring the provision and maintenance of services play a direct role in ensuring additionality (Gosal et al., 2020). In a mature market, a robust and standardised regulatory landscape translates into more data transparency on the outcomes of the market, increased confidence among participants and wider ecological benefits. Similarly, insuring market participants against financial risks like failure to deliver the required credits by sellers or failure of buyers to meet the monetary commitments fosters confidence in the market, which in turn attracts investment (Gunn et al., 2021). This is reflected in a high-functioning market through the availability of specialised and sophisticated insurance and risk-management products.

3. INTERNATIONAL CASE STUDIES

This section looks at two case studies of international biodiversity offset markets to draw lessons for the BNG mandate's operation and development. These case studies also illustrate some of the dynamics discussed in the conceptual framework in the previous section – the US wetlands market provides a good example of a mature and relatively high-functioning offset market, while the Victorian case study illustrates a market that is still developing.

Environmental services markets exist globally. Several are very niche, only looking to conserve a certain species in a small part of a country, with payments sponsored by non-profit foundations or wealthy benefactors. However, there are some that are quite established, covering wide swaths of territory, and aspire for a more generalized conservation programme. Two of these programmes, Wetland Mitigation Banking in the United States and the Native Vegetation Management Framework in Victoria, Australia are evaluated below.

3.1 The US Wetlands Mitigation Banking Program

Several departments of the US government have jurisdiction over wetlands from the expected, such as the Environmental Protection Agency, to the seemingly less anticipated like the Department of Defense and US Army Corps of Engineers (USACE). The USACE is a public engineering formation of the US Army and is the dominant regulator of waterways and wetlands throughout the United States. They have the discretion of permitting or denying a development that could cause harm to a wetland environment. If wetland mitigation is deemed to be required due to unavoidable harm to the wetland, then the permit applicant would need to develop their own mitigation plan for their project to be approved by the USACE. This plan often involves wetland banking as a source of compensatory mitigation for authorized impacts on habitat (Votteler & Muir, n.d.).

Wetlands are both invaluable and have little to no market value. While they provide leisure, water purification, and flood protection, these services are not bought and sold and thus the value of wetlands is often obtained through non-market valuation methods such as stated or revealed preferences. Valuations for wetlands have ranged from $0.06 to $22,050 per acre

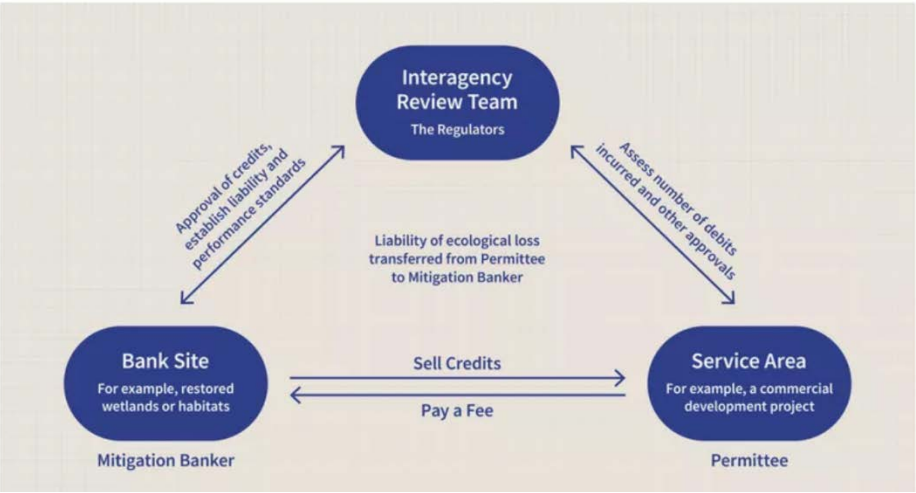
(Woodward & Wui, 2001). However, their biodiversity is irreplaceable and through their rain storage capabilities, they help their surrounding areas recover quickly from natural disasters making them indispensable for disaster-prone areas of the United States.

3.1.1 How does the market work?

The value of each wetland mitigation banking credit varies by state with values ranging from $30,000 to $360,000 per credit (The Mitigation Banking Group, 2022).

The USACE determines both how much a wetland bank is worth in credits and how many credits developers need to buy. They also run a publicly available credit register, the Regulatory in-Lieu Fee Bank Information Tracking System, or RIBITS, to facilitate developer contact with appropriate habitat banks. Developers can check RIBITS to find banks in their state with enough credits to offset their harm to environmental wetlands. RIBITS is consistently updated by the USACE (US Army Corps of Engineers, n.d.). The damage is assessed both on the size and quality of the wetland. developer's plans destroy 10 acres of high-quality wetland, they must purchase 10 full credits. If they are only diminishing in quality by 50% a 10-acre area of mid-quality wetland, they must purchase 2.5 credits. The 10 acres would be given 5 credits due to their average quality and their 50% degradation would further limit the credits they have to purchase to 2.5 (Fenstermaker, 2022).

Figure 3.1 – US wetlands mitigation market operations



Source: Jhawar, 2022

As of 2023, there are over 3,000 wetland habitat banks in 47 out of the 50 US states as well as the Northern Mariana Islands and Puerto Rico. Together, they have a value of over $100 billion (Jhawar, 2022; US Army Corps of Engineers, n.d.).

3.1.2 Lessons for the BNG mandate

The National Research Council of the United States has found that third party mitigation banks often fulfil regulatory requirements more than on-site improvements (US Environmental Protection Agency, 2019). While the BNG mandate is preferring on-site improvements to off-site, developers may not have the necessary expertise or invest the right amount into an ecological consultant team to adequately offset their environmental degradation on the site of their development even in the most earnest of circumstances. Thus, the encouragement of on-site biodiversity enhancements done by the permittee could be detrimental to nature. Through the mitigation banks more than 450K acres of wetlands have been enhanced, improved, or restored each year. This is in large part to how simple it is for the developers to follow the offsetting rules (Hook & Shadle, 2013). With RIBITS helping to facilitate contact between developers and wetlands bankers and nearly all assessment going through the USACE and not multiple third-party firms, the process for developers is straightforward and requires very little initiative on behalf of the developers. The BNG mandate plans to be much less centralized, instead putting a lot of onus on developers and local planning authorities to properly offset biodiversity loss through and monitor the offsetting scheme respectively. This could lead to a more convoluted programme if proper guidance, funding, or assistance is not allocated efficiently, especially in the early days of the nationwide mandate.

3.2 Victoria's Native Vegetation Management

The state of Victoria has undergone the most biodiversity loss in Australia. To combat this, the state put together a framework to reverse the long-term decline of native vegetation and achieve a net gain, administered by the Department of Energy, Environment, and Climate Action (DEECA). It relies on permit controls to encourage developers to protect and enhance

ecological values of native vegetation. The permits are issued by local councils or DEECA depending on the area of the land. (DEECA, 2011).

There are 85 bioregions in Australia and five of these regions have less than a third of the vegetation that existed pre-1750. Of these 5 depleted regions, 4 are in the state of Victoria. Each year, there is a permanent loss of an additional 2,500 hectares and the quality of native vegetation continues to decline (DEECA, 2011).

3.2.1 How does the market work?

Landowners in Victoria can obtain permits for activities that impact native vegetation through their local council or the Department of Energy, Environment, and Climate Action. They must submit a detailed description of their activity as well as the impact on vegetation and their mitigation plan. Native vegetation at a proposed site is assessed by comparing it to a benchmark which represents the average characteristics of a mature and undisturbed plot of the same type of vegetation. The impact is then measured in habitat hectares which combines an assessment of quantity and quality of native vegetation impacted. If ten hectares of habitat will lose 50% of its quality due to development then those 10 hectares are equivalent to 5 habitat hectares that will need to be offset. The permitter assesses the application and takes into account the mitigation measures and chooses whether or not to grant the proposal (DEECA, 2011).

Of the remaining 8.5 million hectares of vegetation in Victoria, 1.1 million hectares are on private land. After an auction-based system pilot program, Victoria currently uses the Native Vegetation Credit Register (NVCR) to monitor credit available. Native vegetation credits are traded in General Habitat Units that combine habitat hectares with landscape-scale mapped information on the NVCR. There are two methods for trading vegetation credits: a bilateral agreement with the offset purchaser or the sale of the credits through an NVCR accredited broker (VAGO, 2022).

The exact amount of credits available on the native vegetation credit register is unknown. According to the Auditor-General of Victoria, there are confusing and inconsistent answers

for the number of sites in the state, the hectares of these sites, and the number of offset credits (VAGO, 2022).

3.2.2 Lessons for the BNG mandate

The Native Vegetation Framework is enacted in an incredibly similar way to the Biodiversity Net Gain Act in that it requires developers to submit planning applications, often to their local councils, that include their mitigation measures for biodiversity loss. The biodiversity impact is done at developer expense and involves their private hire of an ecology consultancy. It is a much less centralized process than the successful US wetlands mitigation banking scheme where nearly every aspect of the process goes through the USACE. This reliance on councils to complete the bulk share of responsibilities for the offsetting scheme leads to a a high degree of variability. The local planning authorities are often undereducated on how to effectively implement this programme. Application approvals are done with a high degree of variability across the state (VAGO, 2022). The state of Victoria embodies the concept that, when offsetting programmes are not managed effectively and with enough guidance for all stakeholders involved, regulators are trading in certain losses for uncertain gains, the opposite of what the BNG mandate in the UK is trying to achieve.

4. THE BIODIVERSITY NET GAIN MANDATE

Maintaining adequate levels of biodiversity is essential to support healthy ecosystem function, natural capital, and life. Alarmingly, biodiversity is declining at rapid rates across the globe. The United Kingdom is among the least biodiverse, most nature-depleted countries in the world. Currently, it has the lowest value of biodiversity out of all G7 countries. Biodiversity preservation and restoration have been prioritised in English national policy, to an extent, in the years leading up to the introduction of the Biodiversity Net Gain Mandate. Policy approaches have evolved over time from minimizing destruction to specific requirements aimed at achieving 'No Net Loss' in biodiversity or even enhancement (The Nature Conservancy, 2021).

The Environmental Act (2021) established a slate of new national environmental standards. A centrepiece of this legislation was the enactment of a "Biodiversity net gain mandate," set to go into effect in November 2023 for new development in England. Biodiversity net gain is an approach to development that requires habitats to be in a measurably improved condition than prior to the development (Defra, 2022). The BNG mandate calls for new development to go beyond offsetting biodiversity losses that result from the development, but to deliver a net gain of 10% compared to the baseline biodiversity value of the proposed development site.

Building off the conceptual framework from Section 2, this section details the relevant legislative history and examines the mechanics of the BNG mandate to establish a foundational understanding of the regulatory context for the Biodiversity Unit market analysis in Section 4.

4.1 Legislative & Regulatory History

The BNG Mandate was established under the Environment Act of 2021, but was preceded by decades of legislation and regulation aimed at halting the decline of biodiversity. Some of these policies and associated scoping studies are detailed in the table below.

Figure 4.1 – Legislative history of BNG in the UK

Policy	Description
Town and Country Planning Act (TCPA), 1990	The Town and Country Planning Act (TCPA) was enacted in 1990 and governs development in both England and Wales. Specifically, the TCPA has served as the overarching regulatory framework for Local Planning Authorities (LPAs)
Natural Environment and Rural Communities Act (NERC Act), 2006	The NERC Act (2006) established Natural England and placed a duty on public authorities and government departments, such as LPAs, in England to "conserve and enhance biodiversity" in their operations.
Defra (2007) "Conserving Biodiversity – The UK Approach"	In this 2007 report, Defra indicated that new policy approaches, such as the creation of biodiversity offset markets, needed to be explored in the wake of UK habitat loss (Defra, 2007).
Defra (2009) "Scoping study for the design and use of biodiversity offsets"	This scoping study examines the potential for establishment of a biodiversity offsetting scheme for England, in helping to achieve "no net loss" (Defra, 2009).
National Planning Policy Framework (NPPF), 2012	The National Planning Policy Framework is issued by the Ministry of Housing, Communities & Local Government and periodically revised to reflect the government's planning policies for England. The 2012 publication reflected a "no net loss" policy for biodiversity.
Biodiversity Metric, 2012	The 2012 NPPF necessitated the implementation of a mechanism for evaluating and creating a standardized measurement for habitat losses and compensation. In 2012, Defra and Natural England released a "metric" to calculate biodiversity offsetting (Treweek, et al., 2010).
Biodiversity Offsetting Pilots, 2012	Two-year pilot program administered by Defra. Developers in Doncaster, Devon, Essex, Greater Norwich, Nottinghamshire, and Warwickshire were required to compensate biodiversity losses

	resulting from development and could do so using biodiversity offsets (Defra, 2012).
25 Year Environment Plan, 2018	This policy paper released by Defra established environmental protection targets for England for the next 25 years and served as an aspirational framework for the Environment Act (2021).

4.2.2 The Mitigation Hierarchy

A foundational framework for mitigating ecological damage in the development process, the mitigation hierarchy is widely accepted by public bodies globally. The mitigation hierarchy asserts that any biodiversity losses resulting from development should be avoided at all costs. If avoidance is not possible, proper measures should be taken to ensure that damage to the environment is minimised. Any unavoidable or residual losses should be adequately mitigated through the enhancement or restoration of habitat on-site of the development. Finally, biodiversity offsets can be used as a last resort, whereby habitats off-site are created or enhanced to compensate for biodiversity losses at the site of development (Post, 2011).

Figure 4.2 – The Mitigation Hierarchy

Source: Adapted from Natural England Joint Publication JP039 (Defra, 2022b)

Employing the principle of the mitigation hierarchy, the 2012 NPPF explicitly set out the requirement that planning projects must "minimise impacts on and provide net gains for biodiversity" in paragraph 174d (MHCLF, 2012). Notably, this explicitly states the intention of the government for "net gains" to be provided, in addition to just no net loss.

4.2.3 Environment Act 2021

The Environment Act 2021 (c.30) was passed by the UK Parliament and received Royal Assent in November 2021 (LGA, 2021). The bill was sponsored by George Eustice in the House of Commons, formerly the Secretary of State for Environment, Food and Rural

Affairs, and by Lord Goldsmith of Richmond Park, formerly the Minister of State of the Department for Environment, Food and Rural Affairs (Defra) (Environment Act, 2021).

Divided into two distinct halves, the Act begins by establishing a new legal framework for environmental regulation and governance and creates the Office for Environmental Protection (OEP). This half was largely borne out of legal obligation following Britain's withdrawal from the European Union, per section 16 of the EU Withdrawal Act (2018). The second half of the legislation provides for the establishment of new environmental standards including measures related to waste and resource efficiency, air and water quality, natural capital and biodiversity, and conservation (Environment Act, 2021). A central component of the second half of the legislation is the establishment of the BNG Mandate.

4.2 Overview of the BNG Mandate

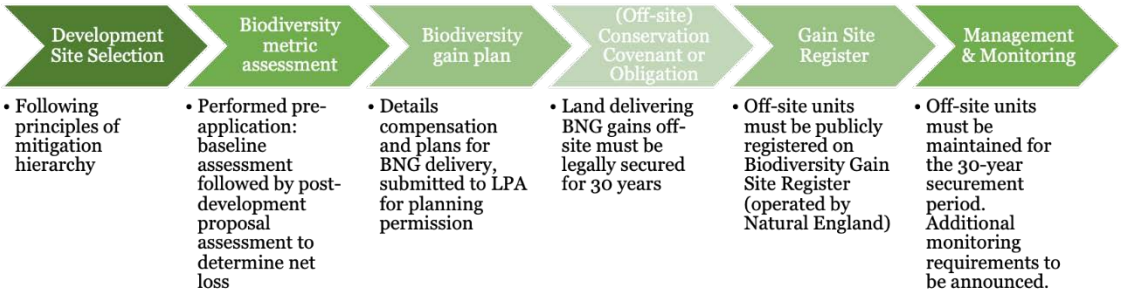
The BNG mandate is outlined in 'Part 6: Nature and Biodiversity' of the Environment Act. Following the mitigation hierarchy detailed above, the mandate requires all biodiversity lost through development to be replaced, and to deliver a net gain of at least 10%. As proposed by Defra (2022a), all important habitat losses must be remunerated by enhancement or creation of another habitat. This does not weaken or change any of the existing legal protections for statutory protected sites, irreplaceable habitats, or protected and important species (Defra, 2022a). The implementation of the mandate will be staggered and will apply to certain new developments in England beginning in November 2023, with other types of development to follow in 2024 and 2025.

The mandate operates through the existing planning system and applies to new development in England (Environment Act, 2021). Specifically, the mandate applies to all development granted planning permission under the TCPA (1990) and imposes a new pre-commencement planning condition of net gain (Defra, 2021). This generally includes most commercial and residential development and applies for all area-based habitats along with linear habitats, like hedgerows.

Under the NPPF, which was revised in 2021 to reflect relevant changes in planning policy imposed under the Environmental Act, developers are required to submit "net gain plans" to

the Local Planning Authority (LPA) that has jurisdiction over the proposed development. A demonstrable net gain of 10% will be a required condition for planning permission, relative to pre-development biodiversity value, prior to the commencement of the development (Environmental Audit Committee, 2021). Required information to satisfy this planning condition will include: the biodiversity value on-site prior to development, the proposed plan to enhance biodiversity on-site, and, if necessary, the proposed off-site biodiversity enhancements (or statutory credit purchase), which must be arranged in advance (Defra, 2022a).

Figure 4.3 – The BNG process for developers



Source: Adapted from Natural England Joint Publication JP039 (Defra, 2022b)

Nationally Significant Infrastructure Projects (NSIPs) will also be subject to the BNG mandate, but the transition period for these larger-scale developments will be extended. NSIPs will be subject to the mandate by November 2025, with Defra releasing additional guidance in the interim (Defra, 2023).

There are three primary mechanisms to achieve net gain delivery: on-site, off-site, or via statutory credit purchase. These three methods are detailed in the next section.

4.3 Mechanisms for Net Gain Delivery

4.3.1 The Biodiversity Metric

The 10% gain will be calculated using the biodiversity metric, a tool developed by Defra that is designed to be administered by ecologists or LPAs, or commissioned by developers (Natural England, 2021a). Broadly, the metric is used to assess the relative value of various

habitat types, where "habitat" is used as a proxy for "biodiversity" (Defra, 2022b). It calculates biodiversity gains and losses, based on a variety of factors, and quantifies these into "biodiversity units."

The metric is first used to provide a baseline assessment of the proposed development site habitat, to calculate pre-development biodiversity units, by considering factors like:

- Size
- Condition
- Distinctiveness, and;
- Strategic significance of the habitat

These criteria are also applied to post-development biodiversity unit assessments, in addition to:

- Delivery risk
- Temporal risk (based on amount of time needed for gain completion)

For off-site gain delivery, there is also a "spatial risk" factor, which considers the distance between the development site and the proposed site for habitat creation or enhancement (Defra, 2022b).

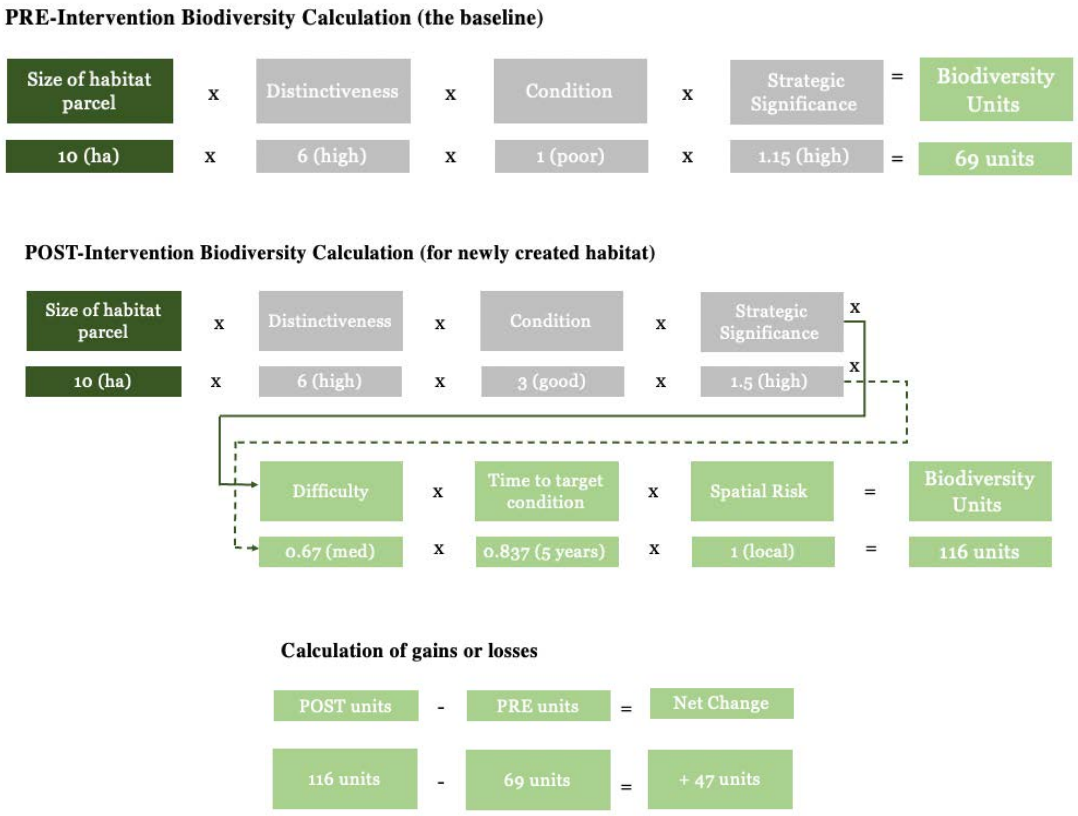
The baseline, or "pre-intervention," biodiversity units are subtracted from projected "post-intervention" units to determine any biodiversity losses. Only environmental impacts that result directly from the development are considered. This is outlined in the net gain plan for the proposed development, submitted to the relevant LPA for planning approval.

Currently, metric version 3.1 is in use, but version 4.0 (the "statutory metric") is expected to be released prior to the implementation of the BNG mandate and will be the version of the metric used to evaluate future planning applications once the mandate goes into effect (Defra, 2023). Defra initiated a technical consultation on the development of the statutory metric in August 2022, where they solicited input from ecologists, developers, LPAs, and other relevant parties (Defra, 2022b). While the government's response to the consultation has not yet been released, Defra indicated in the consultation that it intends to adjust the spatial risk

multiplier, among other things. Defra also intends to release specific guidance regarding minerals developments (Defra, 2022b).

The Environment Act (2021) gives authority to the Secretary of State to "revise or republish the biodiversity metric" (The Environment Act, 2021). The government anticipates making more substantive revisions (those that change biodiversity unit calculation) every 3 to 5 years after initial publication of the statutory metric (Defra, 2022b).

Figure 4.4 – Using the biodiversity metric



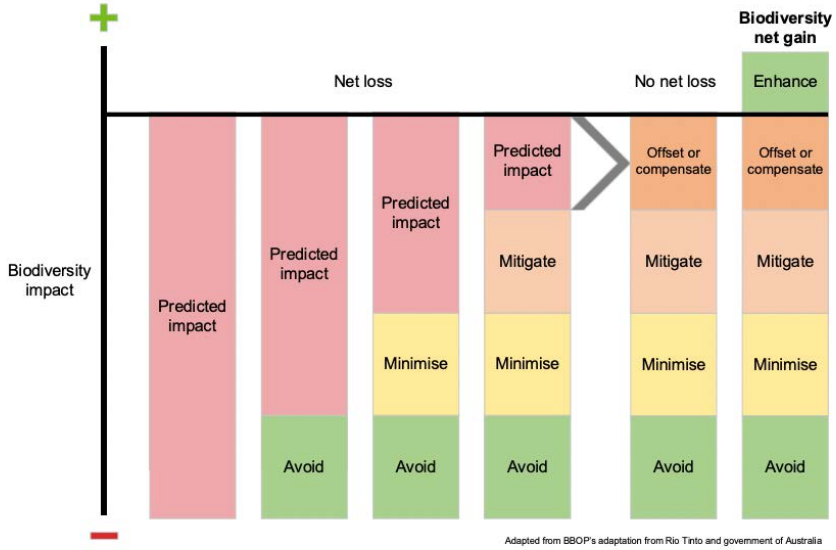
Source: Adapted from Natural England Joint Publication JP039 (Defra, 2022b)

4.3.2 On-Site vs. Off-site Net Gain Delivery

Biodiversity gains can be achieved through habitat creation or enhancement and delivered on- or off-site, calculated using the biodiversity metric, or via statutory credits as a last resort. The metric is applied to proposed environmental remediation plans to calculate the projected biodiversity units once factoring in any losses and proposed plans for restoration and BNG.

The biodiversity metric is designed to apply the principles of the mitigation hierarchy through the use of multipliers, which are included to minimise risk. As detailed above, the mitigation hierarchy dictates that damage or disruption to the habitat should first be avoided or minimised.

Figure 4.5 – The mitigation hierarchy



Source: Department for Environment, Food & Rural Affairs (Defra, 2022a)

Where losses are unavoidable, habitat can be created or enhanced off-site by developers to meet the net gain requirements. On-site restoration is preferred under the theory that it can better assure adequate biodiversity value and composition. There is also a social justification for on-site delivery, arguing that the same communities suffering the consequences of biodiversity loss should be the ones to benefit from the gain. The metric employs a "spatial risk" multiplier, which disincentivizes off-site delivery (where possible) through steeper penalties that make it more difficult to achieve net gains further away from the development site. Simply, there is a positive relationship between distance from development site and cost to deliver net gains off-site. This does not apply to intertidal developments, where on-site delivery of net gain is generally not possible (Defra, 2023). Under the current metric version, the spatial risk multiplier is as follows:

Figure 4.6 – The spatial risk multiplier

Spatial Risk Multiplier	
Score	**Area of habitat**
1.0	Inside LPA
0.75	Neighbouring LPA
0.5	Outside LPA or neighbours

Source: Adapted from Department for Environment, Food & Rural Affairs (Defra, 2022a)

When developers deliver biodiversity compensation and gains off-site, they will be able to do so either through directly enhancing or creating habitat, or through the purchase of biodiversity units through a market. Developers can purchase biodiversity units from other private actors, like private landowners, farmers or estate owners, who choose to undertake enhancements or creation on their own land to sell on the market. The private landowner can then sell the biodiversity units to a developer to compensate for their losses. These transactions can be facilitated by intermediaries, like brokers (Defra, 2022). Alternatively, developers can purchase biodiversity units from local authorities that make improvements on public land, under the same conditions of purchasing biodiversity units from private sellers (Defra, 2022). As of February 2023, Defra also anticipates authorising the sale of "excess" biodiversity units created by developers that meaningfully exceed the 10% net gain requirement (Defra, 2023).

Importantly, when delivering net gains off-site, developers are encouraged to only compensate for losses that is of the same type of habitat being impacted by the development (e.g., damage to grassland can only be compensated for by improvements made to grassland elsewhere), or a "better" habitat type. This is accounted for in the biodiversity metric (Defra, 2022b).

Defra has explicitly stated that there will not be a government-run, centralized platform developed to be used for trading or brokering the sale of biodiversity units (Defra, 2023). Terms of payment are to be agreed upon privately between the buyers and sellers of

biodiversity units, and unit price will be determined by the market. VAT will be applied to the sale of biodiversity units (Defra, 2023).

Under the mandate, off-site net gain delivery must be secured and maintained for a minimum of thirty years, either through conservation covenant or a planning condition or obligation. In instances where private landowners sell biodiversity units to developers, the landowner is generally responsible for maintenance of the units throughout the thirty-year period. It is up to the seller to account for associated maintenance costs in the sale price (Defra, 2023).

4.3.3 Habitat Banking

Private landowners, farmers or estate owners, can preemptively choose to undertake habitat enhancement or creation to generate biodiversity units for sale on the market. In this scenario, the land is evaluated using a baseline biodiversity assessment and then again following enhancement. The metric quantifies the enhancement into a correlated number of biodiversity units. If a buyer is not identified prior to the habitat improvements, then the resulting biodiversity units can be stored in a habitat bank until purchased. The biodiversity units remain in the bank until purchased by a developer to compensate for their losses (Defra, 2022). Defra has allowed habitat enhancements or creation intentionally undertaken after January 30, 2020 for the production of biodiversity units, to be eligible for storage in a habitat bank and eventual sale on the market (Defra, 2023).

4.3.4 Biodiversity Gain Site Register

For monitoring purposes, maintained sites secured via credit purchase will be publicly posted on the Biodiversity Gain Site Register, which will be administered by Natural England. The register is also designed to prevent gaming the system and ensure that multiple development sites cannot claim the same plot of land for net gain. The gain site register will not operate as a trading platform for biodiversity units (Defra, 2023).

4.3.4 Statutory Credits

As a last resort, statutory credits will be available for purchase from Natural England, on behalf of the Secretary of State. These credits will amount to a cash payment to the government, to compensate for any biodiversity losses, in the event that this cannot be

delivered through habitat creation or enhancement on- or off-site. To disincentivize the purchase of these credits, they will be priced at a level above the market value for private biodiversity units. Revenue collected from the statutory credits will be used to support government ecological and environmental initiatives, such as strategic habitat creation or enhancement (Environment Act, 2021).

4.3.5 Environmental Services Payment Stacking

The biodiversity unit market will be operating alongside already existing environmental markets in the UK, like nutrient trading under the nutrient mitigation scheme (Hughes, 2022). The government will allow land managers to create or enhance habitat on the same parcel, to sell both biodiversity units and other credits (like nutrient credits). This does not apply to other ecosystem services like carbon credits (Defra, 2023).

4.4 Exemptions to the BNG Mandate

According to consultation guidance released by Defra, permitted development and urgent crown development will be exempt from the mandate. Defra has stated that it intends to exempt development impacting the habitat of an aerial size below the threshold of 25 metres squared. The BNG requirements will still apply to: previously developed land, change of use and temporary applications and developments that would have been permitted development (but are not due to their location) (Defra, 2023).

The provisions of the BNG mandate will go into full effect for all non-exempted development in England in November 2023. The only exception is for "small sites," where the transition period will be extended until April 2024 (Defra, 2023).

4.5 Monitoring & Compliance

In the case of off-site BNG deliver, it is the responsibility of the landowner to maintain and monitor the land for the 30-year period. In terms of government monitoring, there is the concern of LPA capacity to effectively monitor all off-site biodiversity units within their jurisdiction. Additional guidance, along with a "monitoring and evaluation framework" is expected from the government prior to implementation of the mandate (Defra, 2023).

5. BNG Market Analysis

A key goal of the BNG mandate is to harness private markets and financial flows to improve biodiversity. The smooth functioning, efficiency, and development of the 'BNG market' will be important determinants of the mandate's success. This will be a 'regulatory market', where the regulatory landscape explained in the previous section both creates the market and shapes the incentives of market participants.

This section analyses the dynamics of this market. The purpose is to understand what the market will look like, how that will shape the delivery of biodiversity improvements, what business and financing opportunities there are in this market, and what are the risks to smooth market functioning and development.

First, this section analyses the dynamics of six key components of the BNG market: demand, supply, prices, intermediation, delivery, and financing. We analyse how key incentives and regulatory structures will shape these components and what that means for the BNG market's functioning and delivery of biodiversity improvements. One important feature of the stylised model of the BNG market we describe is that most of these components are somewhat endogenous – for example, the extent of intermediation and financing will help to shape prices, and prevailing prices will help to determine whether there are profitable intermediation and financing opportunities. One purpose of this section is to convey that the systemic interaction of these six components is deeply complex and uncertain, and that this generates risks for the smooth functioning and development of the market. Second, this section looks at risks generated by price uncertainty, compliance uncertainty, and policy uncertainty. Section 7 of this report provides further policy analysis and recommendations to address some of these risks.

5.1 Demand

This subsection looks at two key dynamics that will shape demand for BUs: the inelasticity of total demand for BUs, and the split between on-site and off-site demand.

5.1.1 Demand for BUs will be relatively inelastic

First, it is likely that total annual demand for BUs will be relatively price inelastic. Developers are required by the BNG mandate to 'demand' BUs equal to a 10% increase of the BU stock of the land they are developing. Annual demand for BUs will be somewhat (though not entirely) exogenously determined by the annual level of development and the existing stock of BUs on the land to be developed.

We say 'not entirely' as the level of development is very likely to be impacted by the price of BUs at some margin, and developers are likely to reduce their demand for BUs by shifting to less-biodiverse land (with a lower current stock of BUs) that requires fewer BUs to achieve a 10% improvement. It is difficult to say exactly how big these effects will be, but clearly, increasing the cost of development is very likely to have some marginal effect on the level of development.

Without better data on the current stock of BUs in England, it is hard to know what capacity developers will have to shift onto less-biodiverse land. The mandate is likely to push development away from uncommon high-quality habitat types, given that Rule 3 of the metric requires habitat losses to be offset on the same or better habitat type, which could prove costly. But different parcels of land are not entirely substitutable – a new housing development will fetch a substantially lower price if it is further away from the city centre – and so once again, the impact on annual demand for BUs might not be that large even though development is likely, at some margin, to be pushed toward relatively less-biodiverse land (Environmental Audit Committee, 2021).

5.1.2 On-site or off-site demand

Second, one of the key uncertainties of the BNG market is how demand will be split between BUs delivered on-site, off-site, or through the statutory credit scheme. As section 4.3.2 detailed, developers can either make biodiversity improvements on the site of the development, purchase BUs delivered off-site, or purchase statutory BU credits from the government as a last resort. The two most important factors shaping this demand split are the

relative cost of making biodiversity improvements on-site or off-site, and the biodiversity metric's spatial risk multiplier.

Ultimately, developers will minimise their costs by 'consuming' the cheapest mixture of on-site and off-site BUs available to them. Developers are likely to prefer on-site BUs, all else equal, due to transaction costs in finding off-site BUs and the mitigation hierarchy's on-site bias. The result is that off-site BUs will have to cost less than the marginal on-site BU. The cost of supplying BUs is discussed in the next subsection, but costs for both on- and off-site improvements are likely to vary depending on locally available habitat types, making it difficult to estimate how marginal costs will influence the split in demand.

The second important dynamic shaping demand for off-site BUs is how the biodiversity metric's spatial risk multiplier requires developers to purchase more BUs if they are delivered in a different LPA to the development. As section 4.3.2 discussed, to enforce the mitigation hierarchy, the metric multiplies BUs purchased from a neighbouring LPA by 0.75 and BUs purchased from LPAs further afield by 0.5. So, to meet their obligations under the mandate, a development will have to purchase twice as many BUs from the 'national market' as BUs delivered on-site or in the same LPA. Or, put another way, developers will only buy BUs from non-local LPAs if they cost less than half the cost of the marginal BU in their own LPA or they are forced to because of local supply constraints.

The result is that demand for off-site BUs is likely to strongly prefer locally supplied BUs and demand on the national market will mostly come from LPAs with supply constraints.

5.1.3 The dynamics of demand are uncertain

As an indication of how complex and uncertain this issue is, estimates of the demand split between on-site and off-site BUs vary widely. Defra's 2019 Impact Assessment predicted that only 25 per cent of BUs will be delivered off-site, while the 2021 Market Analysis performed for Defra projected that off-site BUs would compose between 50-100 per cent of the total annual demand for BUs. International biodiversity markets also vary widely, with off-site BUs delivered in the US wetland scheme rising from 50 to 80 per cent between 2010 and 2017 (Hough & Harrington, 2019). In stark contrast, in 'early adopter' councils in

England that have already implemented BNG-like schemes, on average only about 4.5 per cent of improvements are delivered off-site each year (though, of course, under different market conditions) (Environmental Audit Committee, 2021, p. 67).

5.2 Supply

This subsection looks at three factors that will shape the supply of BUs: the cost of supply and public supply.

First, the cost of supplying both on-site and off-site BUs will be shaped by the direct cost of improvements and maintenance, the opportunity cost of locking up land for 30 years in BU supply, and the 'productivity' of supply. An efficient market should maximise productivity – supplying enough BUs to meet demand at the least cost. Section 6 gives numerical estimates for the cost of improvements and maintenance and opportunity costs. One point to note is the likely variability and uncertainty of these costs depending on local conditions, which may make BU prices and local supply less certain.

Figure 5.1 – Land available for habitat enhancement and creation

Habitat	Area (ha)	Area (percent)
Land already developed (total area of urban areas)	**1,583,745**	**11**
Land excluded from BNG market for biodiversity reasons (e.g., designated sites)	**1,773,902**	**13**
Land available for habitat creation	**8,634,923**	**62**
Cropland	5,320,698	38
Grassland	3,125,945	23
Woodland and forest	188,281	1
Land for habitat enhancement	**577,872**	4
Cropland	38,846	<1
Grassland	135,454	1
Heathland and shrub	96,100	1
Sparsely vegetated land	5,228	<1
Woodland and forest	302,245	2
Other land	**1,303,007**	**9**
England total	**13,873,451**	**100**

Source: The Nature Conservancy, 2021

The ‘productivity’ of supply – the number of BUs produced for a given cost – will also be shaped by the biodiversity metric. Creation of new habitats is rewarded more highly by the metric than enhancement, and some habitat types are valued much more highly than others (Natural England, 2021b). Whether supply in any given LPA is delivered through enhancement or creation and on what kinds of habitat type will be shaped by the availability of habitat types in that LPA and the relative cost of enhancement and creation. As in Figure 5.1, The Nature Conservancy (2021) has estimated that only about 4% of land is suitable for habitat enhancement, while 62% is suitable for habitat creation – this will clearly push supply to come from the creation of new habitat.

Second, some BUs will be publicly supplied by the central government and others by LPAs. Our stakeholder interviews indicated that most early adopter LPAs had run statutory credit-like schemes as a last resort for developers in their LPAs, and that some of them were investigating the possibility of continuing those schemes under LPA-managed habitat banks. The statutory credit scheme is only meant to be used by developers as a ‘last resort’, but in practice it will put a ceiling on the price of BUs. As section 4.3.4 discussed, the government is obliged to ensure the price of statutory credits is sufficiently high not to deter private BU supply, but in practice it will be difficult to determine what that price should be – it is not clear how to distinguish between a market failure that justifies public supply and a situation where the cost of private supply is just higher than developers are willing to pay and so the government has to step in if they want to prevent a loss of development.

5.3 Prices

Given those demand and supply dynamics, what will happen to BU prices in this market? The wide variety of BU price estimates reviewed in section 6.1 indicates the difficulty of estimating what the outcome will be from the interaction of the demand and supply dynamics discussed above. But, as with the above dynamics, we can provide some stylised facts about the factors that will shape prices.

The statutory credit scheme and any habitat banks run by LPAs will provide a ceiling on BU prices. To be competitive, off-site BUs will have to be supplied at a cost below that price

ceiling, below the cost of the marginal on-site BU, and less than double the cost of the cheapest marginal BU supplied anywhere in England (due to the spatial risk multiplier applied by the metric). The cost of supplying BUs will vary depending on the habitat types available in any given LPA, and in the face of relatively inelastic demand, be a key factor shaping BU prices. Given the steep discounts the spatial risk multiplier applies to the value of BUs purchased outside a development's own LPA, there will be strong incentives for developers to 'buy local' unless there are local supply constraints, which could steeply increase some developers' costs of meeting the mandate. Transaction costs are also likely to increase prices, particularly if there is an absence of effective intermediation in the early operation of the market.

5.4 Intermediation

Intermediaries like brokers, banks, and stock markets, help solve coordination problems and make markets more efficient by collating information on prices and potential buyers and sellers to make processes such as price discovery and matching less costly (Fernandez & Karp, 1998). For example, for a farmer interested in supplying BUs, figuring out prevailing costs and prices and matching with a developer willing to buy their BUs could be very costly without intermediaries able to provide that information.

Consistent with our conceptual framework's depiction of new markets in section 0, we expect less and smaller-scale intermediation in the short term as market participants 'learn by doing'. Direct bilateral deals between individual developers and suppliers are likely. Our stakeholder interviews revealed that some LPAs are anticipating these coordination problems and intend to help connect developers and potential suppliers as the market gets going. As the market develops, there is a likely to be an opportunity for specialised brokers to connect developers and suppliers. This would represent an intermediate stage of market development, with brokers unwilling to intermediate risk by holding BUs themselves, but able to intermediate information (Robertson, 2009). In a more mature market, habitat banks are likely to buy and store BUs in anticipation of demand, helping to intermediate financing, risk, market information, and matching demand and supply (Simpson et al., 2021; The Nature

Conservancy, 2021). The US wetlands market discussed in section 3 provides an example of a market with a mature stage of intermediation provided by an established ecosystem of habitat banks.

The BNG market could move through these stages quite quickly. Already, there are examples of habitat banks financing the supply of BUs in England in expectation of the BNG mandate's commencement (The Nature Conservancy, 2021, p. 16). On the other hand, the speed at which intermediation matures will depend on the ease with which intermediaries are able to collate information, which will itself partly depend on the transparency and predictability of costs and prices in the market (Simpson et al., 2021). In that regard, the uncertainty about costs and prices that is likely to prevail when the BNG mandate commences could hinder the development of more efficient and mature intermediation services in the short term.

5.5 Delivery

There will be business opportunities created for ecological consultants and landscapers in the actual delivery of the BNG mandate. Consultants will be required by developers to perform baseline and outcome BU surveys and by LPAs to assess the BNG sections of planning proposals and perform monitoring and compliance over the 30-year window. Defra (2019) estimated an ongoing annual cost to LPAs of £9.5 million and the cost to developers of £900 per hectare for site surveys (in 2019 pounds) of over 6,000 hectares per year (£5.4 million total per year). Taken together, this gives an estimate of the value of the opportunity in that segment of the BNG market.

The other key aspect of delivery will be the opportunities created for landscapers to actually perform the required biodiversity improvements and maintain them for 30 years. As the BNG market matures, we would expect to see specialisation in this field, particularly for the creation of higher-value habitat types requiring more specialised technical knowledge and skills.

5.6 Financing

Financing will also play a key role in ensuring smooth market functioning and the delivery of the BNG mandate's policy goals. We see three key opportunities for financing to support the BNG market by financing the supply of BUs, financing on-site BUs, and through financial management of risks.

First, as in the US wetlands market, there could be a significant opportunity for banks and other financial providers to provide the upfront capital required to make biodiversity improvements to earn BUs for sale in the off-site market (The Nature Conservancy, 2021). As the BNG market matures, and particularly if the provision of off-site BUs increases as habitat banks develop as in the US market, this opportunity is likely to grow as well.

This kind of financing supports market functioning by bridging the timing mismatch between costs and revenue for BU suppliers and allowing suppliers to anticipate demand. It also more directly supports improved biodiversity by helping to match the timing of BU gains (supply) and losses (demand). A perennial concern with offset schemes like the BNG mandate is that they trade certain biodiversity losses now for uncertain biodiversity gains in the future. By providing the upfront capital for suppliers to anticipate demand, financing helps to bridge this timing mismatch and provides better biodiversity outcomes.

Second, developers who make biodiversity improvements above and beyond the mandated 10% improvement will be able to earn and sell BUs corresponding to the level of intentional additional improvement they make (Natural England, 2021b). This additional revenue stream for 'green' developers could help to secure additional financing. The benefit here is subtly different from financing off-site BU supply – here, there is also a benefit to market functioning and biodiversity from the creation of additional BUs, but it is the most-desired kind of BU supply according to the mitigation hierarchy's on-site prioritisation and developers face less compliance risk that they will not actually meet their required net BU gain.

Third, in the longer term as the market matures, more specialised financial products designed to help the sector manage bespoke risks could emerge. The US wetlands market again

provides an example of what this might look like. A key risk to both market functioning and policy delivery is that developers and BU suppliers fail to actually deliver or maintain the BU gains required. Two financial products available in the US market to manage this risk are biodiversity funds management and biodiversity insurance products. Funds management addresses another key timing mismatch in the market – suppliers must ensure that the funds received from the sale of BUs are appropriately managed to ensure maintenance costs can be met over 30 years. Mismanagement could lead to a failure to upkeep the biodiversity improvements and/or monetary losses for BU suppliers (The Nature Conservancy, 2021). In the event that suppliers do fail to deliver required BU gains, developers and land managers are likely to face fines from LPAs and a legal requirement to make the improvements at a loss. Biodiversity insurance helps participants to manage this monetary risk and ensures biodiversity improvements are actually delivered (Hough & Harrington, 2019).

5.7 **Risks**

We now discuss key risks to the market's functioning and development arising from price uncertainty, compliance uncertainty, and policy uncertainty.

5.7.1 Price uncertainty

Given the complexity of the factors shaping supply and demand dynamics, there remains significant uncertainty about what the level, predictability, and transparency of prices will be in the BNG market. During interviews, stakeholders gave a range of estimates for the likely price of one BU from £15,000 to £30,000. In a new market without significant intermediation or mechanisms to ensure efficient price discovery and matching of demand and supply, high transaction costs are also likely to contribute to fragmented and unstable prices. To the extent that markets are relatively more local, smaller markets are also likely to be shallower and more prone to price instability depending on the levels of local supply and demand at any given time (McKenney & Kiesecker, 2010).

While it is important not to overstate the impact of this uncertainty, there is a real risk that price uncertainty in some LPAs will deter some private suppliers in the short term. If prices are less certain and less stable, the financial returns and viability of private BU supply are

also less certain, which is likely to deter financing for suppliers and deter some suppliers from entering the market. This risks a feedback loop, where uncertainty hinders deeper markets from forming, which in turn perpetuates price instability and uncertainty.

In the longer term, we expect there will be more certainty around prices as intermediation develops and market participants discover and become more used to the range and drivers of costs and prices. As in the US market, the development of mature intermediation through habitat banks, who are also better able to collate experience across the market negotiating costs and prices, will help to increase the efficiency of price discovery and provide more stable prices to the market (The Nature Conservancy, 2021).

5.7.2 Compliance uncertainty

Suppliers (and developers for on-site improvements) will be obliged by covenants and other legal instruments to maintain biodiversity improvements for 30 years. This creates a kind of maturity mismatch – suppliers will receive payment upfront for biodiversity improvements they must maintain for three decades. The cost of maintenance is likely to vary depending on whether BUs were earned through creation or enhancement and on what kind of habitat type. The variability of these costs both over time and over habitats and the risk posed by the need to manage funds for an extended period to ensure maintenance creates a degree of uncertainty as to the profitability of supplying BUs, which could deter private supply. Particularly in a less mature market, when there may not yet be some of the financing vehicles discussed earlier to manage compliance risk, this could be a particular deterrent.

5.7.3 Policy uncertainty

The two sources of policy uncertainty come from public supply and changes to the metric. As mentioned, stakeholders in our interviews indicated an interest from some LPAs in running their own habitat banks to provide BUs derived from public land. While this would mitigate uncertainty for developers, if the price is competitive with or set below the price available from private suppliers, these public habitat banks risk deterring private supply of off-site BUs. Public suppliers will also need to be very careful that they are accurately and

competitively assessing the cost of supplying BUs – supplying BUs under their cost price would subsidise the destruction of biodiversity.

Finally, Defra has committed to substantially review the metric every 3-5 years. This is useful but will need to be carefully approached – with the lifespan of BU improvements lasting 30 years, there is a risk that uncertainty as to future policy changes, particularly around the time of the updates, could distort or deter supply from entering the market as participants 'wait and see' what the new regulations will involve.

6. QUANTITATIVE ANALYSIS

This section provides a quantitative assessment of the BNG market. We costs, supply, demand, the likely price of BUs, and market size, and estimate an annual monetary value for the biodiversity improvements delivered by the mandate. Additionally, we analyse how these prices might develop in the short and long-term. There are some key limitations modelling the market, including the complexity of the metric, a lack of access to some relevant data due to confidentiality, and the unknowability of some important data such as the current stock of BUs.

6.1 The cost of a Biodiversity Unit

The cost of a BU refers to the amount of money required to generate one unit of biodiversity value through conservation or restoration efforts, which could be one factor of the market price. This cost includes expenses related to the creating or enhancing habitat, management such as planning, implementing, and transaction costs, and monitoring the conservation or restoration project, as well as the opportunity cost of foregoing other potential land uses.

6.1.1 The cost of creating or enhancing habitats

The cost of BUs can vary in each LPA depending on several factors, such as the type of habitat, the size of the area, and the level of restoration or enhancement required. According to Defra (2021), there was a study which had been supplemented by cost data shared by land managers. The cost is presented over 30 years per hectare and covers a combination of creation, enhancement, management and monitoring costs. After excluding outliers, the average nominal cost is £34,746 per hectare or £15,594 per BU, according to figures from 2020.

6.1.2 The opportunity cost for market price

Opportunity cost is a factor in setting prices, which refers to the cost of producing a product or providing a service, including the cost of resources that could be used for other purposes. What could the land be sold for if it was not made into a habitat bank? A recent market review of English estates and farmland found that the average price of arable land sold in 2020 is

£23,227 per hectare. For pastureland, the average selling price is £18,038 per hectare (Defra, 2021).

6.2 The size of the biodiversity market

Estimating the size of the biodiversity market is challenging, but various reports have attempted to estimate the market size in England and its likely growth based (Salzman et al., 2018; OECD, 2020). To estimate the market size, we can look at the total possible supply, annual demand, and the price of BUs using existing data from Defra (2021).

6.2.1 Total possible supply

Total possible supply of BUs is the potential increase in biodiversity units that can be created on non-distinct land such as cropland, modified grassland, and coniferous woodland in each LPA. The figure is calculated by converting this land into BUs using the metric and summing the supply across these habitat types for each LPA. According to Defra (2021), total supply for England is 17,362,551 BUs in 9.2 million hectares (1.89 BU per ha), as shown in Figure 5.1, across the 317 LPAs.

6.2.2 Annual demand

The annual demand of BUs is based on developers offsetting their impacts on biodiversity through buying credits and affects the price and availability of biodiversity credits. This demand is mainly driven by target mandate rate by the regulator under the BNG mandate.

To estimate demand for BUs, we need to know how much area is developed each year. With the OS development data for the periods 2000-2019, for each LPA, the demand across all habitat types has been summed to arrive at the total annual demand. Based on assumptions of how this habitat will be compensated, such as aiming for the same broad habitat and priority habitat, we can calculate the predicted area required to achieve the required net gain of 10% Assuming 50 per cent off-site offsets, the total predicted annual demand for England is 6,223 BUs (6,330 ha) (Defra, 2021).

6.2.3 Supply scarcity

Supply scarcity occurs when there are not enough BUs to meet demand. In this study, we assume that the scarcity is defined as the aggregate supply potential of biodiversity units being less than 100 times the expected annual demand of biodiversity units. This scarcity is assessed for each LPA by comparing the maximum potential supply on low distinctiveness habitats such as arable land, grassland, and woodland with the estimated demand for BUs.

According to Defra (2021), out of 315 local authorities, 58 LPAs are scarce in supply. Of the 58 LPAs with potential scarcity, 26 of these LPAs are London boroughs (45%). Focusing on London as a region, over a 10-year period, the cumulative demand is 31% of the total available supply capacity, while the average is 0.4% across the nine regions in the UK. Due to such scarcity, some BUs may come from neighbouring LPAs with a spatial risk multiplier of 0.75 in the biodiversity metric. The price of these units will also increase by 33 per cent (1/0.75)

Depending on conditions, the amount of demand and the number of LPAs suffering from scarcity changes, as can be seen in Figure 6.1. The number of LPAs with scarcity decreases as on-site mitigation increases due to reduced demand. If using Defra's 2019 Impact Assessment prediction of only 25 per cent of BUs being delivered off-site, then the number of LPAs with scarcity drops to 46, a 21% reduction.

Figure 6.1 – On-site mitigation sensitivity analysis

On-site Mitigation	Supply (BU)	Demand (BU)	NO. Scarcity LPAs	Insufficient neighbouring
0%	17,362,551	12,446	72	21
25%		9,334	66	19
50%		6,223	58	17
75%		3,111	46	10
100%		0	0	0

Source: Defra, 2021

6.2.4 The price of BUs

The set price of a biodiversity unit is likely to apply cost-based approaches. A cost-based approach looks at the cost of producing the product or service and then adds a markup to

determine the price, while a market-based approach sets the price at a level that balances supply and demand.

- The cost of creating or enhancing habitats including other management

The average costs for generating BUs are £15,594 per BU (£34,746 per ha). This cost covers a combination of creation, enhancement, management and monitoring costs. Under the cost-based approach, the price of the BU must be higher than this cost. In addition, we must consider the opportunity cost with the average selling price of arable farmland and pastureland being £23,227 per hectare and £18,038 per hectare respectively.

- Existing BU prices in England based on current compensation actions.

Some consultants consider prices for BUs between £9,000 to £15,000 to be too low and state that the figure should be above £12,000. One local planning authority cited an average local authority tariff of £19,700. Therefore, as shown in Figure 6.2, Liverpool, Leeds, and Warwickshire set BU prices respectively at £20,000, £20,000, and £30,000~£52,000.

Figure 6.2 – BU prices in select LPAs

Location	Liverpool	Leeds	Warwickshire
Price of BU	£20,000	£20,000	£30,000~£52,000

Source: Defra (2021)

- Stakeholders' surveys

Defra assumed a price per off-site BU of £11,000. In stakeholders' surveys, however, this price is too low. A range of £15,000 - £25,000 is seen as more realistic based on initial calculations. There is also the expectation that prices will exceed the costs of ongoing management due to the need to cover transaction costs and reward suppliers with profit.

Under these conditions, the price of a biodiversity unit will be determined as £20,000. This price is based on actual experience in mandated markets as well as the expectation that prices will be compared to the costs of management actions and the opportunity costs of land reflected in farmland sale prices.

6.2.5 Estimation of Market Size

Defra assumes that 2,193 out of the total demand of 6,223BUs would come from adjacent LPAs due to potential supply scarcity. Under the Biodiversity Metric with a spatial risk multiplier, the price of BUs from neighbouring LPAs is £25,000, in this case there is a 25% higher premium for neighbouring LPA off-site offsets.

- *The estimation of market size = Equilibrium Quantity (BUs) * Price of BU*
  *= (4,030 BUs * £20,000) +(2,193BUs * £25,000) = £135 million*

Assuming 100% off-site delivering, off-site demand doubles and market size increases to £276 million.[1]

Figure 6.3 – BNG market size

Source: The nature conservancy report, 2021

[1] (8,264 BU * £20,000) + (4,461 BU * £25,000) = £276 million

6.3 The value of biodiversity improvements

Estimating biodiversity improvements requires the quantification of the economic value of the potential or realized benefits of improving biodiversity in a specific area.

6.3.1 Estimation the value with existing numbers

To find the value of biodiversity improvements, we need data on the area of developed land each year, the current stock of biodiversity of that land area, and the average cost of biodiversity units. The multiplication equation is below.

- *The estimate of the potential value of biodiversity improvement in a year (£) = (A) the developed land area * (B) current stock of BUs * (C) average cost of BU * 10%*

(A) The land area developed in a year (ha)

According to the land use statistics from 2018 and 2022, the average annual land area going from non-developed to developed is 7,065 ha as shown in Figure 6.4.[2]

Figure 6.4 – Land use change in England, 2018-22

Year	Sum (ha)	Residential(ha)	Utilities(ha)	Industry(ha)	others(ha)
2022(Oct)	1,137,361	164,212	573,316	48,654	351,179
2018(Apr)	1,105,570	152,380	567,230	48,551	337,409
Average change	7,065	2,629	1,352	23	3,060

Source: The Land use statistic (2022)

(B) Current stock of biodiversity (BUs per ha)

To find the current stock of BUs we need to measure how many BUs are currently on developed land. The total potential supply of BUs for England is 17,362,551 BUs, covering

[2] There are various results of annual land use change from other materials. (1) Average annual change of developed use 15,900ha (Defra, Impact assessment report, 2019) (2) Potential annual requiring land demand of 6,330ha (Defra, BNG market analysis evidence, 2021)

9.2m ha of land, or 1.84 BU/ha. Therefore, we can estimate that the current stock is also 1.84 BUs/ha and the total lost BUs by the development in a year is 13,000 BUs.

- *The estimated current stock of BUs = 17,362,065 BUs ÷ 9.2m ha = 1.84BUs/ha*
- *Total BUs lost due to development = 7,065 ha x 1.84BUs per ha = 13,000BUs*

(C) Average cost of one biodiversity unit improvement (£ per BU)

The BNG would generally have low-cost implications for developers. It also showed that the costs of biodiversity offsets are generally significant compared to other actions in the mitigation hierarchy designed to achieve BNG at a site level. Further there is evidence that shows on-site action being cheaper than off-site (Defra, 2021).

The average cost of a BU is £15,594 per BU for terrestrial habitat creation. The costs are presented over a 30-year period per hectare and cover a combination of creation, enhancement, management and monitoring costs. Therefore, we can get the value of biodiversity improvement £22.3 million under the 10% BNG mandate. However, the real value is likely less that this figure because the equation assumes all BUs come from off-site sources and the on-site BUs are often than off-site measures (Defra, 2021).

- *The value of biodiversity improvement = {7,065*1.84*£15,594} *10% = £20.2 million*

Similar values can be found via a different method, which is expressed by total demand (off-site BUs + on-site BUs + statutory BUs) *10%. Under same assumptions and Figure 6.3, the value is (12,466* *£15,594} *10% = £19.4 million*

6.4 Market development in the short and long-term

6.4.1 Short-term

Until now, we have analysed the short-term market on the current cost and condition basis. The Defra report has estimations for market conditions up to 5 years. The demand for each LPA has been increased by 20% to reflect the expected increase in the short term. Demand for BUs will be higher than the available supply. Therefore, the price and quantity might increase in the short-term (Defra, 2021)

6.4.2 Long-term

In the long-term, supply increases but the price is uncertain and depends on how much supply increases. As we discussed at the previous chapter, the demand curve becomes more inelastic than the supply curve. Under this market condition, the causes of change in the price are cost factors and government regulations, respectively supply side and demand side.

First, if the cost increases, transaction cost and intermediation services which we already looked at are directly affects the final price, there will be result in lower traded quantity, and higher prices (Kangas, 2022). Next, increasing the target[3] net gain may lead to an increase in demand, which in turn can increase Q, P, and market size. However, Simpson et al. (2021) discovered that when the net gain target is raised, the quantity of offsets traded decreases, and the price required for market clearing also drops. In their empirical research, they discovered that in the absence of net loss, the offset price is £16,433, and 232 transactions are completed. When the net gain is 50%, the offset price is £14,137, and 169 trades are executed. As the mandatory net gain increases, the demand decreases.

[3] The nature conservancy(2021) recommends raising the goal for net gains over time from 10% in 2023 to 30% in 2030.

7. POLICY RECOMMENDATIONS

This section will conclude the report by discussing potential barriers created by the current regulatory design that could either prevent the biodiversity unit market from functioning efficiently or prevent the BNG mandate from achieving real biodiversity net gains.

Drawing from previous sections, we explore what reforms might support the growth of the primary market for biodiversity improvements and the secondary market for biodiversity units. We conclude by recommending some policy reforms that could alleviate the identified barriers, promote the development and smooth functioning of the market, and help the BNG mandate to better achieve its biodiversity improvement goals.

One headline finding is that the estimated ongoing cost of administering the scheme for LPAs of £9.5 million is about half our estimate of the annual monetary value of the additional biodiversity improvements that will be delivered by the scheme, of around £20 million. Given some of the risks discussed below to the scheme actually delivering those improvements, policymakers will have to monitor these barriers and risks closely to ensure the mandate actually delivers cost-efficient biodiversity gains.

7.1 Market Barriers

7.1.1 Short-term market constraints

A primary concern identified by our policy and market analysis is whether there will be a sufficient supply of BUs in the short-term. Several factors could limit off-site BU supply from private suppliers. If the price of public BU supply is set incorrectly by LPA habitat banks or in the statutory credit scheme, private suppliers will be deterred from entering the market. While Defra has stated in the response to the 2022 BNG consultation that local authorities should not be 'directing' developers to purchase their public BUs, it is unclear what regulatory protections will be in place to prevent publicly created BUs from undercutting the market for private BUs (Defra, 2023). Another key risk factor to private supply in the short-term is a lack of financing as lenders figure out how the system works.

To some extent, this constraint should ease as participants 'learn by doing', but there is also a role for government to support market functioning, which we discuss below.

Additionally, with only eight months until the BNG mandate will take effect, there is still considerable guidance (including secondary legislation and details on changes to the statutory metric) that are yet to be released by Defra. This is a source of high uncertainty regarding the regulations, expected costs and obligations that will be imposed on developers, and questions surrounding the new responsibilities of already financially constrained LPAs. This regulatory uncertainty translates into an uncertain market landscape that also is likely to deter private supply of BUs and could increase costs for developers as they have less time to learn the new system before implementation.

Given this uncertainty and the likely lack of mature intermediaries in the early market to enable more efficient price discovery and matching of buyers and sellers, transaction costs for suppliers and developers are likely to be relatively high in the short-term. This extra cost will deter some suppliers at the margin, lower the efficiency of the mandate, and could result in localised distortions as buyers and sellers of BUs do not know what the market's prevailing prices and cost structures are.

7.1.2 Long-term market constraints

Supply scarcity is also a concern in the long-term. Some LPAs will be more supply-constrained than others given variations in geographical size and landscape. Development taking place in those LPAs will likely be more dependent on off-site BUs located further away from development sites to reach their target net gains. Given the steep discounts applied by the spatial risk multiplier in the biodiversity metric, developers in supply-constrained LPAs could pay significantly higher costs to meet their BNG requirement. While this can arise even under 'efficient' market structures, the government will have to monitor this constraint, particularly in inner-city LPAs who are most likely to be supply-constrained, to balance their dual objectives of enabling sufficient development for economic purposes while enhancing biodiversity.

Further, the lack of guidance surrounding monitoring requirements and LPA responsibility in oversight of off-site BU land management could significantly undermine compliance in the long-term. If oversight is not equally applied to on-site and off-site BNG delivery, it could result in a market distortion where developers prefer one option over the other as they can 'get away' with higher non-compliance and lower costs (The Nature Conservancy, 2021).

7.2 Biodiversity Improvement Constraints

There could be several constraints on the delivery of real biodiversity net gains. First, as mentioned in Section 4, the biodiversity metric uses 'habitat type' as a proxy for real-world biodiversity. While the metric has been rigorously tested by Defra, Natural England, and other ecological stakeholders, it is only a proxy – it might not map all that well onto real-world biodiversity and actual plant and wildlife loss or gain (Panks et al., 2021). Further, only biodiversity impacts resulting directly from development are measured, which likely underestimates total value lost as it does not capture systemic effects from, for example, habitat fragmentation (The Nature Conservancy, 2021). There are also likely to be seasonal discrepancies in applying the metric (CIEEM, CIRIA and IEMA, 2016). For example, the same plot of land could appear to have a lower biodiversity value in winter months than in warmer months – while this seems trivial, it creates extra difficulties for regulators assessing planning proposals and ensuring compliance in the long-term.

Another key limitation on the actual biodiversity net gain delivered by the mandate regards ensuring additionality. This is the idea that only improvements that are additional to what would have been made in the absence of the scheme should count toward the positive impact of the mandate (The Nature Conservancy, 2021). For example, in the UK's pilot program for offset markets in 2012-14, developers delivered a net biodiversity gain of around 20% across the lifespan of the scheme, which was higher than that required (Baker et al., 2016). This suggests that many of those improvements would have been even in the absence of the scheme. The BNG mandate is likely to be too large and too broadly applied to have no additional impact, but we should be wary of ascribing all of the gains delivered by developers to the mandate. Likewise, developers have been authorized by Defra to sell excess gains on

the BU market if developments exceed the required 10% net gain (Defra, 2023). This could unintentionally lower the gains achieved to a maximum of 10% where they otherwise would have been higher.

Finally, a common issue raised in our stakeholder interviews was the lack of adequate LPA capacity to manage the increased workload associated with administering the program. The government is providing a one-off payment of £16.71 million to LPAs (Defra, 2023), but Defra's own forecast (2019) was for a £9.5 million recurring cost to LPAs to administer the scheme. Many LPAs do not have enough ecologists on staff and do not have the resources to fully process the new mandate requirements as part of the planning process. This could severely threaten the validity of compliance and monitoring that will be crucial to ensure the mandate actually delivers efficient and real-world biodiversity improvements.

7.3 Policy Recommendations

7.3.1 Gain Site Register expansion

The Government should consider expanding the Gains Sites Register to operate as a centralised marketplace to match buyers and sellers of off-site BUs, to overcome the coordination and price discovery problems. Drawing on the success of the US Wetlands Mitigation Scheme discussed in Section 3, this would make the Gain Site Register function more similarly to RIBITS.

7.3.2 Supporting LPA capacity

There will be a considerable long-term funding gap for LPAs due to the cost of administering the scheme. Additional funding will need to be provided to ensure local authorities have the necessary support and staffing levels to effectively administer the program and ensure compliance (The Nature Conservancy, 2021).

7.3.3 Demand guarantees

To offset uncertainty in the market and encourage private supply in the short-term, the government could guarantee to buy a set number of BUs distributed across LPAs in the early years of the market's operation. The Nature Conservancy (2021) identifies several options

for the government to do with the purchased units: the government could take on the role of a broker and re-sell the BUs (at market value) immediately to buyers, store the units in a habitat bank to ensure long-term supply, or protect the land to help achieve national biodiversity goals.

7.4 Conclusion

As England progresses with the implementation of the BNG mandate, there will be many obstacles to overcome to ensure efficient market functioning and secure biodiversity gains. The BNG mandate has come a long way since it was first floated in a 2007 Defra report. Forecasted to spawn a £135 million market, it will be a significant environmental services market. However, with such opportunity comes many constraints. Providing proper support for all stakeholders will facilitate success and ensure that the England of tomorrow is more biodiverse than the England of today, at least by 10%.

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APPENDIX A: COUNCIL INTERVIEW QUESTIONS: EARLY ADOPTERS OF BNG MANDATES

Interview Questions	
Category	**Question**
Policy Process	Can you walk us through the designing process of the mandate and essentially, the key trade-offs made during this process?
Market Scoping/Valuation	With the regard to the Impact Assessment Report (2019), can you run us through the methodology used to arrive at the estimates of the market's size (example, cost and size of habitat created)?
	Are there any specific high-level assumptions made when estimating any values in such a market?
	We're trying to develop a relatively simple model to predict the value of biodiversity improvements and the price and quantity of off-site credits under the new scheme by looking at the experience of early adopters of BNG-like policies –

	i) Do you think there are any problems in scaling up/extrapolating the estimates from early adopter councils to make a national-level estimate of the size of the market? ii) Since there are multiple factors which influence and shape the valuation of of the current stock of biodiversity units per hectare, is there any specific methodology to derive this estimate? iii) We are also trying to derive the value of the off-site biodiversity credit market and estimate the demand and supply of these credits - do you have any advice on what should be kept in mind while deriving these estimates?
International cases	Were any other international cases of similar biodiversity markets considered when developing the mandate?
Implementation	Going forward, what is the role of Defra in implementing the mandate, in conjunction with the role of local councils and national delivery bodies like Natural England?

	Are they potential constraints/challenges that Defra foresees with the implementation of the mandate?
	With regard to the secondary legislation that is yet to be published, what elements of implementation of the scheme will it cover?
Long-Term Strategy	What are the going to be the next steps/long-term operational plan towards a more high functioning market?
	To what extent will BNG provide an efficient market for trade in environmental services and remove barriers to private investment in biodiversity improvements or nature-based solutions in general?
Council-specific questions	Can you walk us through the specifics of your mandate? (Development type, net gain requirement, etc.)

	How much net gain does your council require? If larger than 10%, will development within your municipal jurisdiction be subject to the stricter mandate?
	Can you walk us through the process of using the biodiversity metric to determine biodiversity units?
	How do companies decide what improvements to make to achieve the required BD improvement?
	On average, are people just meeting targets or going over?
	Percent on-site vs. off-site (if option under your mandate)?
	Do developers prefer on-site/off-site improvements? What factors (within their control) influence this decision?

	What were the implementation challenges/experiences with the mandate?
	Has the introduction of a BNG mandate in your council dissuaded development in your jurisdiction? Was it a significant change from under the no net loss policy?
	Has there been any potentially new business opportunities out of the creation of a market for environmental services?
Relation to national BNG Mandate	How do you view your council as being representative (or not) of the national landscape, as it pertains to the impending biodiversity credits market?
	Is there anything specific to your council that would affect the scalability of your results?
	Have you seen pre-emptive habitat improvement or creation by

	landowners/managers in anticipation of the credit market? To what extent?
	Communication/guidance from gov't? What are your thoughts on the coming credit market? Do you think it will be more effective or less effective than your mandate?
	Do you think there are any policy or financing barriers which could affect the development and growth of this market at a national level?
	Is there anything specific to the regulatory design of the national mandate that concerns you, either locally for your district or on a national scale?
	Have other councils sought advice from you as they plan for implementation of the national mandate?
Leeds-Specific Question	As a metropolitan council, how do you see implementation of the BNG mandate developing in other more densely-populated areas?

APPENDIX B: CEPA CAPSTONE TERMS OF REFERENCE 2022-23

CEPA CAPSTONE TERMS OF REFERENCE, 2022-23

1. BACKGROUND TO CEPA

CEPA is an economic and financial policy consulting business. We advise both private and public-sector clients on economics and public policy issues. Our work spans the energy, water, transport, health, agriculture, communications, and international infrastructure sectors. We have recently completed a number of assignments that have touched on the incorporation of biodiversity considerations into the development of infrastructure and on investment into natural capital improvements. For CEPA, this is a growing area of interest and one where we think economics and finance can provide valuable input into furthering investment into natural capital.

2. NATURAL CAPITAL AND BIODIVERSITY: CONTEXT

Natural capital refers to the stock of renewable and non-renewable natural resources, both living and non-living, that provide value to society, e.g. plants, animals, air, water, soils, minerals.[1] Biodiversity can be considered the living component of the stock of natural capital.[2] In this document, we use the term 'environmental services' to refer to any activity that is designed to improve our natural capital – for example, planting of woodlands to improve air quality or to offset carbon, activities to rehabilitate rivers, turning farmland into semi-managed land to improve biodiversity etc.

In recent years, there have been a number of developments within the UK and elsewhere that have taken tentative steps towards reorienting the relationship between economics and nature. The Dasgupta Review was an in-depth look at how economic thinking needed to be adapted to take nature into consideration.[3] Since then, the UK Government has published guidance on how to enable a natural capital approach to decision-making.[4] And most recently, the UK Parliament passed the Environment Act 2021, which among other things has introduced a Biodiversity Net Gain (BNG) mandate. The BNG mandate requires those undertaking a new development to replace any lost biodiversity from the development plus the creation of (at least) 10% more in biodiverse habitat.

There have been numerous discussions about the potential role of private financing in enabling improvements in the stock of natural capital and biodiversity.[5] We expect the use of private financing will be contingent on the creation of markets for environmental services, or other potential revenue streams that provide investors with financial returns alongside the beneficial environmental impact. Such payments can potentially be categorised in the following way:

- Direct revenue opportunities (e.g. increased tourism revenue from natural capital improvements to an area, or investments in biodiversity to enhance farming productivity).
- Bilateral arrangements (e.g. payments from a firm looking to offset its carbon impact, or public sector grant funding for an environmental service).
- Markets for environmental improvements (e.g. markets for carbon credits or biodiversity credits).

[1] https://www.gov.uk/government/publications/enabling-a-natural-capital-approach-enca-guidance/enabling-a-natural-capital-approach-guidance

[2] https://www.cambridgeconservation.org/wp-content/uploads/2016/07/CCI-Natural-Capital-Paper-July-2016_web-version.pdf

[3] https://www.gov.uk/government/publications/final-report-the-economics-of-biodiversity-the-dasgupta-review

[4] https://www.gov.uk/guidance/enabling-a-natural-capital-approach-enca

[5] https://www.oecd.org/environment/resources/biodiversity/report-a-comprehensive-overview-of-global-biodiversity-finance.pdf

While it is common to find examples of the development of direct revenue opportunities and bilateral arrangements for natural capital improvements, there have only been isolated attempts at creating markets for specific environmental services (e.g. carbon credits). It is rarer still to find examples of large-scale attempts to create widespread markets for environmental services.

To tackle this within the UK, the Financing Nature Recovery coalition has produced a roadmap to scale up 'high-integrity' markets for nature.[6] It has also developed a framework for the introduction of high-integrity markets for nature, shown in the diagram below:

Figure 2.1: Framework for high-integrity environmental markets

Source: Financing Nature Recovery UK (2022) Scaling up high-integrity environmental markets across the UK. Available at https://www.financingnaturerecovery.uk/recommendations-and-roadmap

3. QUESTION AND OBJECTIVES

Students should seek to answer some or all of the following questions regarding the development of markets for environmental services and the financing of natural capital improvements related to the UK's BNG mandate:

- What is a realistic roadmap for the development of markets for environmental services related to the BNG mandate in the UK?
  - How can we categorise the different types of environmental services?
  - Can we develop a framework for thinking about how you develop markets and revenue streams for environmental services?

[6] https://www.financingnaturerecovery.uk/recommendations-and-roadmap

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  - Given the likely 'buyers' of environmental services (e.g. charities, water companies, governments, tourists etc.) and the regulatory landscape of the BNG mandate, which ecosystem services are more likely to have an associated market in the shorter term? And which are more likely to have an associated market in the longer term?
  - What policies are needed to further the development of markets for environmental services?
  - What can we learn from previous attempts to develop markets for environmental services (e.g. EU ETS, carbon credits, biodiversity offsets, etc.)?
- Looking specifically at the funding and financing of biodiversity improvements:
  - What is the potential addressable market for biodiversity improvements given the introduction of the BNG mandate?
    - In other words, given the scale of development within the UK, at a high level, how much biodiversity improvement can be expected in any given year?
    - What considerations would there be when deciding between meeting the biodiversity mandate through on-site improvements versus off-site improvements?
    - And finally, given the potential scale and value of off-site improvements, what is the potential size of the market for biodiversity offsets?
  - What role could private finance play? What risks exist in the financing of biodiversity improvements?

4. KEY ACTIVITIES

We have set out some of the key activities that we expect the project team will undertake to answer these questions. We recognise that the volume of activities may be too large for a single project. As such, we are happy for students to tackle only some of the activities listed below. We also expect the students to identify other useful activities that could help to respond to the project scope in the initial stages of the project.

- A preliminary review of the literature to understand the existing landscape for the funding and financing of natural capital improvements. This should include consideration of:
  - What attempts have been made across the world to create new markets or revenue streams for environmental services?
  - What constitutes a high-quality market for environmental services? And what has experience taught us around the creation of such markets?
- Policy analysis around the development of natural capital markets
  - Analysis of challenges in policy design and implementation of the BNG mandate and opportunities to support the development of high-quality markets associated with the mandate.
  - Categorisation of different types of environmental services.
  - Putting together a theoretical framework that establishes different phases for market development in the context of environmental services (e.g. mature market with lots of liquidity, emerging market reliant on bilateral trades, etc.).

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  - Given the above theoretical framework, assess the likely development of market maturity related to the BNG mandate in the short and long term.
  - Development of 2-3 case studies of markets at different levels of maturity.
  - (Potential) Interview with stakeholders to understand roadmap for future market development.
  - Analysing the experience of other attempts at market development, to identify potential pitfalls and mitigations.
- Quantitative analysis of total addressable market for biodiversity improvements.
  - Estimate the value of biodiversity improvements and markets related to the UK's BNG mandate.
- Policy analysis around the financing of biodiversity improvements and opportunities for revenue streams derived from the markets created by the BNG mandate.
  - Articulation of barriers to the development of biodiversity improvements, and the potential of financing to address those barriers.
  - Analysis of the business opportunities and revenue streams likely to be created by the BNG mandate, and challenges to their development.

In terms of outputs, we would propose development of an inception report that sets out the initial literature review and proposed approach within the first month of the project.

The project team should develop their own thinking about how best to respond to the brief and develop analysis which supports the overall outcome.

5. AUDIENCE

We expect the analysis and policy recommendations to be presented as if being provided to UK Government departments, regulators, and competition authorities. However, this should not limit the scope of the literature review and analysis, which should be informed by a broad range of relevant literature.

6. SOURCES

We have set out below some initial sources to support your literature review, in addition to those included in footnotes elsewhere. This is by no means a comprehensive list of all sources, but a preliminary guide from which to explore the literature in more detail:

- European Commission (undated) Biodiversity strategy for 2030. https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en
- European Investment Bank (undated) Investing in Nature: Financing conservation and nature-based solutions. https://www.eib.org/attachments/pj/ncff-invest-nature-report-en.pdf
- Financing Nature Recovery UK (2022) Recommendations and Roadmap. https://www.financingnaturerecovery.uk/recommendations-and-roadmap

[7] https://www.environment.vic.gov.au/native-vegetation/native-vegetation/offsets-for-the-removal-of-native-vegetation/i-need-to-secure-an-offset

- OECD (2020) A Comprehensive Overview of Global Biodiversity Finance. https://www.oecd.org/environment/resources/biodiversity/report-a-comprehensive-overview-of-global-biodiversity-finance.pdf
- WSP (undated) Biodiversity Net Gain: A new role for infrastructure and development in improving Britain's wildlife. https://www.wsp.com/-/media/Insights/Global/Documents/WSP-Biodiversity-whitepaper.pdf
- Unisféra International Centre (2004) Payments for Environmental Services: A Survey and Assessment of Current Schemes. https://www.cbd.int/financial/doc/cec-pes.pdf

7. HOW WILL CEPA INTERACT WITH LSE STUDENTS?

CEPA will interact with students to provide support and guidance where needed. Shafiq Pandor (Managing Consultant) and Paul de Jong (Economist) will be available to respond to queries and meet with the students to provide informal guidance during the delivery of the assignment.

The project involves a high degree of flexibility for the students to demonstrate their creativity and to have autonomy over the framework they develop for evaluation. The shaping of the project is very much driven by the project team. However, our staff will be available to meet with the project team on a c. monthly basis to discuss ideas and progress.

In terms of milestones, we would suggest:

- Inception and project kick-off meeting (first month of the project)
- Discussion of initial literature review and thoughts around the evaluation framework (following inception report) (c. month 2)
- Discussion of final methodology (c. month 3)
- Catch up on progress (c. month 5)
- Discussion of emerging conclusions (c. month 6)
- Feedback on the draft report (c. month 7)

Shafiq and Paul will be available to provide a small amount of ad hoc support as needed outside of these meeting over the project lifecycle.

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