

Governing high-integrity ecosystem markets

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Abstract

There is growing global interest in the potential for ecosystem markets to facilitate climate and nature recovery. Yet, poorly designed and operated markets are prone to corporate “greenwashing” and negative consequences for nature and local communities.

With the rapid emergence of ecosystem markets around the world, there is a need to systematically analyse ecosystem market governance principles, and identify the practical steps needed to implement these principles at national scales across multiple high-integrity ecosystem markets. Markets are considered high integrity when they are governed by clear and consistent principles that address governance, measurement, reporting and verification, and wider benefits. The majority of principles published to date are designed to be applied at international scales or within single markets. However, national policy oversight is essential to ensure emerging ecosystem markets deliver natural capital outcomes and wider public benefits appropriate to the jurisdictions in which they operate. Relying on international voluntary initiatives alone is unlikely to prevent the operation of low-integrity schemes.

This paper therefore analyses principles for the development and operation of high-integrity ecosystem markets, proposing how these could be operationalised to in the UK, where governments in Scotland and England are actively developing new governance regimes for rapidly proliferating domestic ecosystem markets. To do this, the paper:

1. Provides the first comprehensive overview of compliance and voluntary carbon and other ecosystem markets alongside the first analysis of relevant ecosystem market actors in the UK ;
2. Conducts a comparative analysis of existing national and international principles, identifying 14 core principles for governance, measurement, reporting and verification, and delivering wider benefits of high-integrity ecosystem markets that could be applied by relevant market actors to the range of ecosystem markets identified in the UK; and
3. Proposes how these principles could be applied in an ecosystem markets governance hierarchy, showing policy, governance and market mechanisms and infrastructure that are being developed to implement the proposed principles in the UK.

Taken together, the proposed core market principles and governance hierarchy could be used to ensure the development of high-integrity ecosystem markets across the UK and internationally, helping national governments to responsibly build and scale these markets.

1 Introduction

Climate change and the degradation of global ecosystems are taking us to the brink of ecosystem collapse (Rockström et al., 2009; Steffen et al., 2015; Nash et al., 2017). The increasingly dangerous impacts of these changes for humans and nature disproportionately affect those who have contributed least to climate change (IPCC, 2023). Keeping global warming within 1.5°C of pre-industrial levels (Article 2, Paris Agreement, 2015; IPCC, 2018) requires social, economic and technological transformations on an unprecedented scale. More than half of global GDP is highly dependent on nature, according to the World Economic Forum (WEF, 2020). However, at COP15 of the UN Convention on Biological Diversity, 195 nations agreed that our world must not only become net zero, but also nature-positive (Convention on Biological Diversity, 2022). There is no pathway to limit global warming to 1.5°C to halt devastating effects of climate change on people and planet, without addressing nature loss.

Nature-based solutions to climate change have been proposed as one approach to achieving a nature-positive transition to net zero emission. These sequester and store carbon or reduce emissions, whilst facilitating nature recovery and reducing risks from climate change for vulnerable communities. Such solutions can also reduce climate risks for companies, providing a rationale for private investment. Such private investment is needed to supplement limited public funding in many countries. The United Nations Environment Programme (UNEP) estimates that finance for nature-based solutions is currently USD133 billion per year, but needs to at least triple by 2030 and increase fourfold by 2050 to meet international climate, biodiversity and land degradation targets (UNEP, 2021; Deutz et al., 2020). However, as compliance and voluntary carbon markets grow rapidly (Ecosystem Marketplace, 2022), and markets for biodiversity, water quality, water supply, flood risk alleviation and ocean recovery begin to proliferate (Reed et al., 2021), the integrity of these ecosystem markets is an increasingly urgent concern (e.g., Committee on Climate Change, 2022).

Critiques have tended to focus on carbon markets, but often apply more widely across other ecosystem markets (Committee on Climate Change, 2022; Reed et al., 2021). These include:

- The concern that companies will use low-integrity ecosystem market units to make unsubstantiated claims to green credentials or achievement such as achieving 'net zero';
- Selling of units that are not robustly verified and so may not represent real climate or other benefits from nature; double-counting and selling of units or the sale of units from projects that would have happened anyway, and so are not additional;
- Challenges securing or demonstrating the permanence of nature-based solutions, which if reversed may not be reported or compensated for;

- Allowing companies to invest in offsets without first avoiding and minimizing impacts, e.g., without first cutting their avoidable emissions or having long-term net zero commitments consistent with limiting global temperature increases to 1.5 degrees Celsius above pre-industrial levels; and
- Concerns that projects that focus on single outcomes, such as carbon, may have negative unintended outcomes for other ecosystem services or local communities, for example in some cases leading to their displacement.

As such, there are now calls for ecosystem markets to go beyond ensuring that there is “no net harm”, to delivering net benefits for local communities and/or other ecosystem services (Scottish Government, 2022a). As investment in nature-based solutions grows, alongside the potential climate and nature benefits, there is a growing risk of greenwashing and negative unintended consequences that could harm the climate, nature and local communities. As a result, the UK’s Committee on Climate Change (CCC, 2022) recommended that any expansion of carbon markets into new land uses and habitats should be limited until carbon credit integrity and the integrity of claims could be ensured.

Each market includes market actors, governance structures and infrastructure to support the development of individual projects, but as the range ecosystem markets expands, the marketplace becomes more complex and there is an urgent need to identify universal policy and governance options that could facilitate the design and operation of high-integrity ecosystem markets that generate real, verifiable, additional and effectively permanent nature and societal benefits. The International Council for Voluntary Carbon Markets have proposed core carbon principles (ICVCM, 2023), alongside a range of other international initiatives to increase the integrity of ecosystem markets (e.g. high level biodiversity principles proposed by Plan Vivo, 2022). These are now being implemented on a voluntary basis by a number of international voluntary market players, but it is not clear how national governments can ensure such guidance is used within domestic markets.

UK domestic ecosystem markets are proliferating rapidly, and both Scottish and English governments are actively exploring options for governing these markets. Scottish Government published Interim Principles for Responsible Investment in Natural Capital Markets (Scottish Government, 2022a) and Defra published a nature markets policy framework (Defra, 2023), which initiated work with the British Standards Institute (BSI) to create a set of independent standards against which codes and standards can be evaluated. Both of these initiatives contain market governance principles, but neither go as far as many of the international initiatives upon which they build. To date, there has been no systematic analysis of market governance principles that have been proposed, nor is there has been any consideration of the wider policy and governance needed to implement these principles at a national scale. This is important, because without national policy

oversight, international voluntary initiatives alone are unlikely to prevent the operation of low-integrity schemes, or ensure these markets deliver wider public benefits appropriate to the jurisdictions in which they operate. This paper therefore:

1. Provides the first comprehensive overview of compliance and voluntary carbon and other ecosystem markets alongside the first analysis of relevant ecosystem market actors in the UK;
2. Conducts a comparative analysis of existing national and international principles, identifying 14 core principles for governance, measurement, reporting and verification, and delivering wider benefits of high-integrity ecosystem markets that could be applied by relevant market actors to the range of ecosystem markets identified in the UK; and
3. Proposes how these principles could be applied in an ecosystem markets governance hierarchy, showing policy, governance and market mechanisms and infrastructure that are being developed to implement the proposed principles in the UK.

2 Methods

Research was conducted over a two-year period from 2021-2023 to evaluate ecosystem markets policy development across the UK, using a mixed methods approach that combined comparative analysis of ecosystem market documentation and a professionally facilitated workshop to collect primary data on market actors. The research started with a narrative review of ecosystem markets currently operating in the UK, to provide an overview of the market context, prior to identifying and analysing relevant market actors. This context is then used to discuss a comparative analysis of international and national market principles, and how they could be applied to develop high-integrity ecosystem markets in the UK and similar countries.

2.1 Identifying UK ecosystem markets

A review was conducted to identify literature on ecosystem markets in the UK. For the purposes of this review, ecosystem markets were defined after Wunder (2015) as codes, standards or schemes where ecosystem services are bought and sold in voluntary transactions, providing assurance of the delivery of services. Ecosystem markets do not include nature investments or trades made for corporate social responsibility, or impact investment, where the transaction does not involve receiving specific and/or measurable credits in return for investment.

Peer-reviewed literature on UK ecosystem markets was sought via the following searches, performed via Google Scholar, sorting for relevance: "ecosystem market*" AND UK; "nature market*" AND UK; "natural capital market*" AND UK; "payment* for ecosystem services" AND UK; "carbon market*" AND UK; and "biodiversity market*"

AND UK. However, other than our former work on UK ecosystem markets (Reed et al., 2022), there were no other peer-reviewed papers about voluntary carbon, biodiversity or other ecosystem markets operating in the UK. Instead, papers tended to be general or global in scope and did not contain information specific to UK ecosystem markets (e.g. Kroeger and Casey, 2007; Hein et al., 2013; Teytelboym, 2019), about privatisation of ecosystem services rather than ecosystem markets (e.g. Bakker, 2005), or about pilot programmes and feasibility studies rather than operational markets (e.g. Ferreira, 2017; van den Burg et al., 2022). The exception was peer-reviewed literature on the compliance market for Biodiversity Net Gain in England; this literature was included in the review.

A narrative review of grey literature was conducted to identify compliance and voluntary carbon markets, and other compliance and voluntary ecosystem markets currently operating or in development in the UK. Narrative reviews are scholarly summaries that combine interpretation and critique (Petticrew et al., 2013; Greenhalgh et al., 2018). Narrative reviews are better suited than systematic reviews for topics or questions where it is not possible to identify specific interventions or outcomes (Greenhalgh et al. 2018).

Grey literature and literature from Google Scholar searches were supplemented with literature from projects funded in two investment readiness schemes by the English (the Environment Agency's Natural Environment Investment Readiness Fund) and Scottish Governments (NatureScot's Investment Ready Nature Scotland fund), as these were designed to stimulate the development of new markets across the UK. A "snowball sampling" method was then used to identify missing markets from investment readiness project teams and relevant policy teams in Scotland and England, until no new markets were found. Despite reaching this saturation point, it is however possible that some markets may have been missed.

2.2 Analysis of UK ecosystem market actors

Building from the UK ecosystem markets identified in the first stage of the review, relevant market actors were identified. For purposes of this research, market actors were defined as UK ecosystem market entities and organizations who are involved in various aspects of these markets.

An online workshop was facilitated in May 2022 to collect data with Scottish Government officials and researchers familiar with the range of interested actors interacting with ecosystem markets in Scotland and across the UK. The workshop lasted for one hour, with participants writing comments simultaneously into a shared spreadsheet. It started with an introduction to the method by the facilitator, followed by a discussion to establish the boundaries of the analysis. This included the range of ecosystem markets to be included (based on the analysis in 2.1 above) and the

geographical focus. The geographical focus was the whole of the UK, given the scale that these markets operate at, despite the fact that the workshop was funded by Scottish Government (hence the inclusion of only Scottish policy officials). To correct this bias, the four officials were supplemented with four researchers from Scottish institutions who had experience working across UK ecosystem markets. Following the workshop, participants were able to continue adding input to the analysis online, filling gaps where possible, and completing the data collection phase within two weeks of the workshop.

For each market actor identified, participants could add additional information they felt might be relevant using Reed et al's (in prep.) interest-influence-impact method for analysing relevant parties. Participants were invited to check each other's work, filling gaps in knowledge and offering alternative perspectives where relevant. They were also asked specifically to consider 'hard-to-reach' groups that may have been missed from the analysis and invited to suggest categories within which individual organisations could be grouped. Where organisations had more than one interest in high-integrity ecosystem markets, their primary interest was used. For example, RSPB develops nature-based solutions projects, some of which supply carbon offsets, but given the breadth of their interests across the natural capital policy agenda and their primary functions, they were classified as an environmental NGO rather than a project developer/offset provider.

2.3 Identifying ecosystem market principles relevant to the UK

Building on the analysis of UK ecosystem markets and market actors, we sought to identify principles for the development and operation of high-integrity ecosystem markets that could be applied to the UK to help guide the development of policy and governance mechanisms. Previously published UK and international ecosystem market principles were identified using a "snowball" sampling method with policy officials in Scotland and England and the British Standards Institute, until saturation was reached and no new documents containing market principles could be identified. For purposes of this search, international encompassed documents developed for globally recognized markets; this did not include documents that pertain to markets operating in specific countries outside the UK. The following sources were identified as being relevant to the UK:

- UK sources:
 - Defra's Nature Markets Policy Framework (Defra, 2023)
 - Scottish Government's Interim Principles for Responsible Investment in Natural Capital (Scottish Government, 2022a)
 - The design of the UK's two most mature voluntary carbon markets, the Peatland Code version 2.0 (IUCN UK Peatland Programme, 2023) and the Woodland Carbon Code version 2.2 (Scottish Forestry, 2022)
- International sources:

- Integrity Council for the Voluntary Carbon Market (ICVCM)'s Core carbon principles consultation document (ICVCM, 2022);
- Voluntary Carbon Markets Integrity (VCMI) Initiative's Provisional Claims Code of Conduct (VCMI, 2022);
- Science-Based Targets Initiative (SBTi)'s Corporate Net-Zero Standard Version 1.0 (SBTi, 2021);
- Greenhouse Gas Protocol's Corporate Accounting and Reporting Standard (GHG Protocol, 2023);
- An international comparative analysis of 12 agricultural soil carbon codes and standards (Black et al., 2022);
- Unpublished international comparative analyses (based on Black et al's (2022) analytical framework) of three agroforestry and six saltmarsh codes and standards, funded by the Environment Agency's Natural Environment Investment Readiness Fund; and
- An unpublished international comparative analysis of approaches to measuring biodiversity in 25 biodiversity codes and standards, funded by NatureScot's Investment Readiness for Nature Scotland scheme.

The analysis was conducted by the lead author and proceeded via the following steps:

1. Principles were extracted from each document and analysed thematically, grouping similar principles together;
2. Principles were screened for relevance to the UK context, removing principles that were not applicable in terms of their biophysical or cultural context e.g. around working with first nations or indigenous groups;
3. Thematically grouped principles were then assessed qualitatively to identify each of the different concepts they contained, creating one point per concept (the bullet lists in Table 3). These individual points were then aggregated into a single summary point, which was then further condensed to form a single principle per thematic group, in the left-hand column of Table 3.

Following this analysis, the co-authors refined the principles to ensure applicability across multiple ecosystem markets and incorporate additional literature references.

3 Results

This section provides the findings of our analysis ecosystem markets and their actors in the UK. This is followed by the results of a comparative analysis of principles for the development and operation of high-integrity ecosystem markets that could be applied by the actors that were identified, to the markets found in the UK.

3.1 UK ecosystem markets overview

Four compliance markets were identified, alongside seven types of voluntary carbon market and five other ecosystem markets. The UK has one compliance carbon market, the UK Emissions Trading Scheme, regulated by law that requires scheme participants to comply with emissions reduction requirements on a 'cap and trade' basis (Table 1). Although compliance carbon markets are reserved for the UK Government, the governments of Scotland, England, Northern Ireland and Wales can develop their own compliance biodiversity markets and have jurisdiction over voluntary carbon and other voluntary ecosystem markets operating in their jurisdictions. The UK can also engage with international voluntary carbon markets to meet its obligations under the Paris Agreement (the rule book for this was agreed under Article 6 at COP26). Although the regulatory oversight of these markets is devolved to the individual countries and projects need to be developed in line with regulations in each jurisdiction, they operate as UK-wide markets accepting investment from companies based anywhere in the UK (some of the emerging markets also accept overseas investment).

England also operates compliance markets for biodiversity and water pollution (Figure 1, Table 1; the other three UK nations do not currently have compliance markets). Under England's Biodiversity Net Gain, developers must follow the mitigation hierarchy by first trying to avoid and minimize habitat loss and then, if this is not possible, they must create habitat either on-site or off-site or purchase statutory credits from the government or credits generated from habitat creation elsewhere in England. The introduction of the scheme was controversial, as it attempted to balance the simplicity and certainty demanded by the market with the complexity of the ecology and the need to ensure the ecological integrity of offsets (Gordon et al., 2015; Lockhard, 2015; Sobkowiak, 2020), leading to multiple revisions of the biodiversity metric in the years since its launch. Nutrient neutrality is another compliance market operating in England in which developers must ensure that any increase in pollution arising from a development is offset by a reduction in pollution in the same area, for example through the creation of new wetlands or woodlands to capture nutrients (Natural England, 2022). Defra are also developing Marine Net Gain in England that will work in a similar way to Biodiversity Net Gain, requiring all in-scope developments to leave the environment in a better state than before (Defra, 2022).

It is therefore important to recognise the potential for regulatory divergence between different nations within the UK, where legislation from each country may make unique demands on these markets. Concerns have been raised about the potential for new taxes on ecosystem markets to distort the market (e.g. favouring investment in parts of the UK with lower taxes), and discussions are ongoing with HMRC and UK Treasury on taxes that may apply to landowners, project developers and retail aggregators who buy and sell on carbon credits, as well as companies who 'hold' credits on their books and how this is viewed in tax terms. Market distorting effects may also arise from mechanisms being considered to protect or share benefits with communities from natural capital markets in Scotland, if not adopted elsewhere in the UK. These are outlined in the recent "land reform in a net zero nation" consultation paper, in preparation for a future Land Reform Bill and a Community Wealth Building Bill, and include public interest tests for transfers of large-scale land holdings and community wealth funds (Scottish Government, 2022b).

There are numerous voluntary markets, either established or in development, in the UK. The majority of these codes and standards focus on voluntary carbon markets, including woodland, peatland, agroforestry, carbon capture technologies, agricultural soils and blue carbon, although voluntary markets are also in development for biodiversity, freshwater resources, ocean recovery and landscape recovery (Figure 1, Table 1). The most established voluntary carbon markets in the UK are the Woodland Carbon Code and the Peatland Code. Most codes and standards focus on one market type, although there are Landscape Enterprise Networks (LENs) and other catchment management trading schemes that integrate multiple voluntary market mechanisms together to provide a range of benefits and payments, for example, related to biodiversity, natural flood management and nutrient mitigation. Also, Version 2.0 of the Peatland Code addresses the potential for integration of biodiversity and community benefits with the Peatland Code (NatureScot, 2022b).

The codes and standards vary widely in their approach to ensuring market integrity. Some approaches do not have transparent or standardised approaches to measurement, reporting and verification (MRV) or have MRV for individual projects reviewed on a case-by-case basis. Others have the governance and MRV components you would expect to see in a code, although they are not all fully transparent, and some companies combine project development, standards and registries within the same operation instead of using independent verification and registries. For example, there are at least eight companies now offering agricultural soil carbon credits, and some of these approaches integrate functions that are traditionally separated to avoid conflicts of interest. Efforts are underway to standardize methodologies (e.g., using Verra's VM0042 methodology) and establish minimum requirements for agricultural soil carbon codes, which if adopted by BSI, could bring more consistency and rigour to the agricultural soil carbon market. Contract lengths and the use of buyer checks to ensure emissions have been

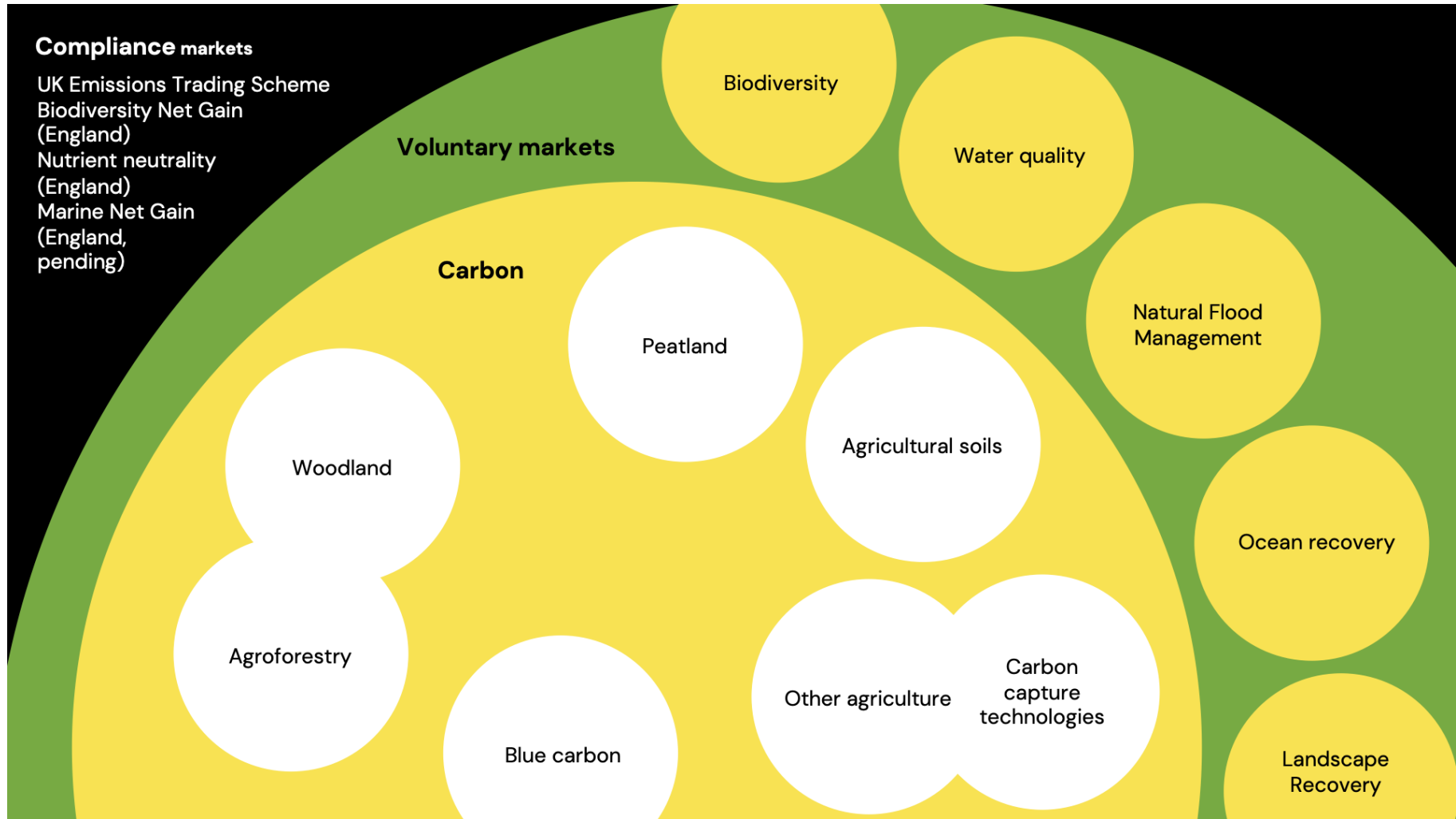


Figure 1: Types of ecosystem market operating or close to market in the UK

Table 1: Codes and standards that are established or in development for UK ecosystem markets.

Ecosystem Market	Standards and Codes	Description	Owner/operator(s) operating in the UK
Compliance Markets			
Carbon	UK Emissions Trading Scheme	(UK wide) Law requires scheme participants to comply with emissions reduction requirements on a 'cap and trade' basis, where a cap is set on the total GHGs that can be emitted by sectors covered by the scheme, which decreases over time. Within the cap, participants receive a free allowance and those who are unable to keep their emissions within this allowance can buy emission allowances at auction or on the secondary market from participants that have not fully used their allowance	BEIS and ESNZ
Biodiversity	Biodiversity Net Gain	(England only) Mandates a 10% net gain in biodiversity from development under the Town and Country Planning Act 1990 in England (Defra, 2023b).	Defra
	Marine Net Gain*	(England only) This will work in a similar way to Biodiversity Net Gain, requiring all in-scope developments to leave the environment in a better state than before.	Defra
Nutrients	Nutrient Neutrality	(England only) Developers must ensure that any increase in pollution arising from a development is offset by a reduction in pollution in the same area, for example through the creation of new wetlands or woodlands to capture nutrients.	Defra
Voluntary Markets			
Carbon - Woodland	Woodland Carbon Code	A voluntary carbon standard for woodland creation projects in the UK, generating independently verified carbon units.	Scottish Forestry
	Wilder Carbon Standards	A voluntary standard for the generation of carbon credits alongside biodiversity uplift from rewilding activities including woodland creation via natural regeneration, peatland restoration and saltmarsh creation.	Kent Wildlife Trust
	CSX Carbon	A supplier of carbon from projects that do not meet the additionality criteria of the Woodland Carbon Code or Peatland Code, including commercial forestry projects, preservation of healthy peatland and management of existing woodland to increase carbon storage	CSX Carbon
Carbon - Peatland	Peatland Code	A voluntary carbon standard for UK peatland projects wishing to market the climate benefits of peatland restoration applicable to blanket bogs, raised bogs, lowland fens and wetland agriculture on lowland peats.	IUCN UK Peatland Programme
	Wilder Carbon Standards	(see above)	
	CSX Carbon	(see above)	
Carbon - Agroforestry	Agroforestry Code*	A voluntary carbon standard for agroforestry projects (including hedgerow planting) that includes both above and below-ground carbon sequestration; applying to be	Development is being led by the Soil Association

		included as a methodology under the Woodland Carbon Code.	
	Hedgerow Code*	A voluntary carbon standard for hedgerow planting that includes carbon in above ground biomass and soils, alongside biodiversity uplift.	Development is being led by the Game and Wildlife Conservation Turst
Carbon capture technologies	European Biochar Certificate	A voluntary carbon standard for biochar application in agriculture.	European Biochar Certificate
	Biochar and Enhanced Weathering Credits*	A voluntary carbon standard for engineered carbon removal and storage, including biochar, enhanced rock weathering, woody biomass burial, and geologically stored carbon.	Puro Earth
Carbon – Agricultural Soils	Agricultural Soil Carbon Schemes (various)	A range of companies are providing agricultural soil carbon credits with their own proprietary measurement, reporting and verification methods, registries and associated governance.	For example, Agreena, BCarbon, Trinity AgTech, Ecometric via Respira International, Interational Future Food Solutions via BCarbon, UK Carbon Code of Conduct, BX Group (insets only), Soil Capital (insets only)
	Verra VM0042 Methodology for Improved Agricultural Land Management*	A methodology using Verra’s voluntary carbon standard to issue credits for GHG emission reductions and soil organic carbon removals resulting from of improved agricultural land management practices such as reductions in fertilizer application and tillage, and improvements in water management, residue management, cash crop and cover crop planting and harvest, and grazing practices.	Operators planning to apply Verra’s VM0042 in the UK include Regenerate Outcomes, Soil Heroes, Ruumi and Sub 51
Carbon - Blue Carbon	UK Saltmarsh Code*	An initial feasibility study assessed the applicability of Verra’s VM0033 Methodology for Tidal Wetland and Seagrass Restoration (Emmer et al. 2021) in the UK and recommended development of a UK Saltmarsh Code focussed solely on managed realignment and aligned with existing domestic voluntary carbon markets and forthcoming UK market principles and governance.	Development is being led by Centre for Ecology and Hydrology
	Wilder Carbon Standards	(see above)	
	Sea Kelp*	Developing a kelp nature certificate to include carbon through an innovation partnership with The Crown Estate. Implementing a “Blue Natural Capital Lab” for developing and testing new models of regulation, seabed leasing and blue natural capital financing.	Development is being led by Sussex Bay hosted at Adur District & Worthing Borough Councils
	Sea Grass*	Developing a financial model and investment case based on actual restoration and	Development is being led by

		management costs, habitat condition and carbon analysis of seagrass in the Plymouth Sound, which could in future be scaled to other sites.	Plymouth City Council
Biodiversity	PV Nature*	Proposed biodiversity standards have been piloted in seven sites, including one in the UK to restore and improve management of saltmarsh, seagrass, oyster habitat and seabird nesting habitat.	Plan Vivo
	Wilder Carbon Standards	(see above)	
	CreditNature	Offers Nature Impact Tokens using metrics that measure and forecast ecosystem recovery linked to land management commitments.	CreditNature
Water quality	Woodland Water Code*	Developing a standard and new market for water-related benefits from woodland creation, including pollution mitigation, reducing flood risk and maintaining river flows	Scottish Forestry
	Regional water quality markets	These are based on payments for catchment management by water companies to farmers to change management to reduce diffuse water pollution, leading to reduced water treatment costs.	Water Utilities
Landscape recovery	EnTrade	A Wessex Water business that pays for catchment management solutions that provide biodiversity gain, carbon sequestration and natural flood management, alongside nutrient mitigation .	EnTrade
	Landscape Enterprise Networks (LENs)	LENs can integrate payments from multiple voluntary ecosystem markets alongside other benefits sought by regional investors, such as reducing climate risks to infrastructure or supply chains, for example via natural flood management or landscape recovery. Existing LENs have included payments for animal welfare and sustainable land management to protect the quality of milk supplies and payments from water companies for catchment management (Reed et al., 2021).	LENs Central
Ocean recovery	Blue Impact Fund	Investing in enterprises producing sustainable seafood and aquatic plants that can generate attractive returns while delivering ocean resilience and recovery.	Finance Earth and WWF
<i>*Codes and standards are in development</i>			

reduced at the source before offsetting also vary. For example, Wilder Carbon Standards have unusually long minimum contract lengths of 100 years, or 50 years with conservation covenants that would ensure projects are effectively permanent.

3.2 UK ecosystem market actors

Over 200 stakeholder organisations and groups were identified across 11 main categories in the analysis (Figure 2). Table 2 provides an overview of each category including examples of organisations and groups in each category and sub-category. Due to the sensitivity of some of the information collected about some stakeholder organisations, only summary information is presented here. The examples in Table 2 reflect the Scottish focus of the analysis (see methods). Categories with significant numbers of different organisations included (in descending order):

- Nature-based solutions project developers and offset/inset providers;
- Environmental/sustainability NGOs, thinktanks and representative organisations; and
- Landowner/manager NGOs, thinktanks and representative organisations.

Although fewer than ten organisations or groups were identified in a number of categories, these included important market actors, for example government departments and agencies (of which only a limited number have direct interests in natural capital and ecosystem markets). Some categories with apparently limited numbers of different actors were groups rather than organisations, where there are a limited number of representative organisations (e.g., tenant farmers).

3.4 Principles for the design and operation of high-integrity nature markets

A range of sources were identified that proposed principles that could be used to define and/or govern high-integrity nature markets. These were systematically analysed to identify themes, which were summarised to generate synthetic principles. Table 3 lists each of the principles that emerged from this analysis in three categories:

1. Governance principles;
2. Measurement, reporting and verification principles; and
3. Wider benefits principles.

In each case, the principle, is followed by a summary of more detailed points drawn from across the sources. Although the majority of the principles apply to the design and operation of codes and standards, a number of them also require engagement from other market actors within the governance hierarchy. As such, the principles are aimed at:

- Governments and their agencies acting within a single market or across multiple markets;
- Other governance bodies and mechanisms such as the UK Accreditation Service and the British Standards Institute;

- Codes and standards operating within single markets or across multiple nature markets, including carbon, biodiversity, water quality and flood risk among others;
- Project owners and developers and others engaged in market infrastructure; and
- Investors and others engaged in market finance mechanisms.

To apply these principles, these different market actors will need to develop a range of policy, governance and market mechanisms, and these are discussed next.



Figure 2: Market actors with interests in the development of high-integrity ecosystem markets.

Table 2: Categories and sub-categories of market actors emerging from the analysis, showing the nature of their interests in high-integrity markets.

Stakeholder Category	Description	Example organisations/groups	Nature of their interest in high-integrity ecosystem markets
Policy			
Government departments and teams	Teams and groups within Government responsible for aspects of natural capital and ecosystem markets policy and regulation	<ul style="list-style-type: none"> • Defra • Environment and Forestry Directorate (Scottish Government) • Department of Agriculture, Environment and Rural Affairs (Northern Ireland Executive) • JNCC 	Interested in ensuring high-integrity markets supplement public funding for climate and nature recovery whilst generating wider public benefits, and avoiding negative unintended consequences.
Government agencies	Government agencies and other bodies with statutory powers responsible for natural capital policy implementation	<ul style="list-style-type: none"> • NatureScot, Natural England, Natural Resources Wales • National Park Authorities • Scottish Forestry, Forestry & Land Scotland, Forestry England 	Each has a more sectoral or location-specific context in which they are likely to engage with high-integrity markets, facilitating their operation through their land and functions.
Local government	Local councils and planning authorities with interests in natural capital	<ul style="list-style-type: none"> • Local Planning Authorities • Local Councils with interests in natural capital • Local Government Association, COSLA 	Interested in harnessing high-integrity ecosystem markets to deliver nature-based solutions that provide wider benefits to the communities in their area.

Other government bodies and initiatives	A range of other cross-UK bodies and Scottish and UK policy initiatives are working on natural capital and ecosystem markets	<ul style="list-style-type: none"> ● UK Ecosystem Markets Policy Oversight Group (connecting Scottish Government, Defra, Welsh and Northern Irish policy teams) ● Committee on Climate Change (CCC) ● Scottish Enterprise, Social Enterprise UK 	Interested in learning from different UK jurisdictions and where possible harmonising policy and governance to avoid market distortions across borders.
International policy community	International organisations and task forces that either engage with or shape policy and ecosystem markets	<ul style="list-style-type: none"> ● Task Force on Nature-Related Financial Disclosures (TNFD) ● The Global Ethical Finance Initiative (GEFI) ● The International Council for Voluntary Carbon Markets (ICVCM), VCMi 	Interested in increasing the integrity of ecosystem markets internationally, with a strong focus on international voluntary markets.
Carbon and other ecosystem markets			
Established domestic voluntary carbon markets	UK carbon offsetting schemes accredited to relevant ISO standards by UKAS	<ul style="list-style-type: none"> ● Scottish Forestry (Secretariat for the Woodland Carbon Code) ● IUCN UK Peatland Programme (Peatland Code) 	Both programmes are interested in the potential for market principles and new governance to further improve their standards, and prevent competition from low integrity codes that could bring the market into disrepute.

<p>Emerging voluntary carbon markets that could operate in the UK</p>	<p>New codes, standards and schemes are being developed or adapted for use in the UK to provide guarantees to buyers and sellers that carbon benefits are additional and verifiable</p>	<ul style="list-style-type: none"> ● Kent Wildlife Trust (Wilder Carbon) ● Companies applying Verra's VM0042 methodology to create new agricultural soil carbon markets ● Agroforestry Code (being proposed as a methodology under the Woodland Carbon Code) and Hedgerow Code (operated by the Game and Wildlife Conservation Trust) 	<p>These groups are interested in the development of policy frameworks that could restrict or facilitate their development and market share, enabling them to learn from international experience as they develop their own products for the UK market.</p>
<p>Biodiversity and other single service markets</p>	<p>Codes, standards and schemes are being developed for biodiversity and other single ecosystem services</p>	<ul style="list-style-type: none"> ● Biodiversity Net Gain ● PV Nature ● Blue Impact Fund 	<p>As above, but with a particular interest in how policy frameworks and other codes and standards might facilitate or limit stacking of payments for multiple services between different codes.</p>
<p>Cross-cutting ecosystem markets</p>	<p>Schemes and companies that are creating markets for multiple services, for example via re-wilding, sometimes integrating projects that use the codes and standards above</p>	<ul style="list-style-type: none"> ● Landscape Enterprise Networks ● Riverwoods ● Highlands Rewilding 	<p>Interested in how policy frameworks might facilitate or limit their current activities, and enable them to expand their currently limited operations.</p>

Advisors and intermediaries

Land agents, advisors and brokers to the land management community	Companies and individuals providing expert advice and diagnostic services to landowners and managers	<ul style="list-style-type: none"> • Savills, Knight Frank • Galbraiths, Bidwells • Trinity Agtech • SAC Consulting 	Interested in gaining market insights and skills that could enable their clients to access ecosystem markets and blended finance mechanisms.
Nature-based solutions project developers and offset/inset providers	Companies that work with landowners to make changes to land use or management that can deliver ecosystem services to the specifications of buyers, often via codes and standards	<ul style="list-style-type: none"> • Soil carbon project developers • The Wildlife Trusts • Forest Carbon Ltd 	Interested in policy frameworks and mechanisms that can increase both supply and demand across ecosystem markets.
Financial advisors and brokers to natural capital investors and policymakers	Companies offering advice to investors and policymakers on the design of new financial products and services, and blended finance mechanisms to de-risk investment and maximise gains for both investors and the environment	<ul style="list-style-type: none"> • Finance Earth • Palladium • Green Finance Institute 	Interested in helping shape policies and regulation, to increase the integrity of markets for their clients.
Nature-based solutions investment community			
Return on investment (including land and commodity value)	Companies interested in investing in natural capital or ecosystem services for return on investment	<ul style="list-style-type: none"> • Federated Hermes International • Aviva • Nature Capital • Lombard Odier • Hamden • Oxygen Conservation 	Interested in policy mechanisms and other innovations that can de-risk investments.

Major voluntary carbon offsetters	Companies with a history of or interest in offsetting their emissions	<ul style="list-style-type: none"> ● Gatwick airport ● Disney ● Sainsbury's 	Interested in mechanisms to increase supply of high quality offsets in UK markets, from both existing and emerging markets.
Major carbon insetters	Companies with a history of or interest in insetting emissions, including decarbonising their loan books	<ul style="list-style-type: none"> ● McDonalds ● Nestle ● Lloyds Bank 	Although interested in carbon codes/standards with registries on which they can retire credits, many of these companies are prepared to do their own monitoring, reporting and verification for their investors/stakeholders internally.
Investors in other ecosystem services	Companies interested in paying for biodiversity, water quality and flood risk alleviation outcomes from land management interventions	<ul style="list-style-type: none"> ● Flood re-insurance industry ● Scottish Water ● We Mean Business Coalition ● Infrastructure and Energy companies 	Interested stacking of payments for multiple ecosystem services, and policy and finance mechanisms that could generate returns from these services or evidence that investment in nature-based solutions can reduce their exposure to risk.
Landowner/manager community and their suppliers			
Landowners	Owner occupier farmers, private estates, environmental NGOs, government/crown and other institutional landowners	<ul style="list-style-type: none"> ● Crown Estate ● National Trust ● Investment firms ● John Muir Trust ● Private landowners ● The Wildlife Trusts ● Community Land Scotland 	Interested in how natural capital and ecosystem markets might affect land values, the value of their natural capital and potential to exploit existing and future ecosystem markets on their holdings. Concerned about losing control of land to new investors.

Tenants and other rights owners	Those with rights to use or manage land owned by others	<ul style="list-style-type: none"> • Tenant farmers • Crofters • Sporting interests 	Interested in benefit sharing arrangements with landowners entering into contracts to deliver natural capital and ecosystem service outcomes, and concerned about potential increases in rental values.
Suppliers to nature-based solutions projects	Companies supplying landowners and managers delivering services to ecosystem markets	<ul style="list-style-type: none"> • Woodland creation/management contractors • Peatland restoration contractors • Producers of organic amendments such as biochar producers • Ecological consultants 	Interested in potential increase in demand for their products and services arising from ecosystem markets. Interested in applying technical expertise, including in project design and implementation, restoration techniques, methods and assessment.
Landowner/manager community and their suppliers			
Landowner/manager NGOs, thinktanks and representative organisations	Organisations representing the interests of landowners and managers	<ul style="list-style-type: none"> • National Farmers Union • Community Land Scotland • Moorland Association • Scottish Land Commission 	Keen to enable their landowning members to benefit from natural capital and ecosystem markets, and build knowledge and skills amongst members to benefit from ecosystem markets. Concerned about the impact that ecosystem markets could have on other core income streams, for example, from food/timber production.
Environmental/sustainability NGOs, thinktanks and representative organisations			
Environmental and sustainability NGOs, thinktanks and representative organisations	Organisations with conservation or climate goals	<ul style="list-style-type: none"> • Rewilding Britain • RSPB, The Woodland Trust • NatureScot, Natural England • Financing UK Nature Recovery (Broadway Initiative) 	Interested in potential to generate new sources of funding to reach their goals but concerned about potential negative unintended consequences of ecosystem markets for the natural environment and greenwashing.

Networks and professional bodies

Ecosystem markets networks	Networks of individuals and organisations with interests in natural capital and ecosystem services	<ul style="list-style-type: none">• Scottish Nature Finance Pioneers• Regional Land Use Partnerships• Ecosystems Knowledge Network• Marine Natural Capital Network• Landscape Enterprise Networks	Keen to enable their members to learn new insights from the research, and help shape and facilitate the work through their networks where relevant.
Professional bodies	Organisations representing professions relevant to ecosystem markets	<ul style="list-style-type: none">• Chartered Institute for Ecology and Environmental Management• Institute for Chartered Foresters• Institute of Environmental Management and Assessment• Royal Institution of Chartered Surveyors	Provide training, professional standards of practice, and engage in policy development.

Rural communities

Rural communities	Organisations representing the interests of rural communities	<ul style="list-style-type: none">• Scottish Rural Action• Scottish Crofters Federation• Rural Youth Project• Action with Communities in Rural England	Concerned about potential negative unintended consequences of ecosystem markets and keen to ensure communities receive direct benefits.
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Recreation

Recreation	Groups that pursue recreational activities in the natural environment	<ul style="list-style-type: none">● Watersports clubs● Shooting associations● Cycling clubs● Climbing and hiking clubs● Fishing clubs● Ecotourism	Limited direct interest in ecosystem markets, but interested in some of the outcomes (e.g. biodiversity) and negative unintended consequences (e.g. aesthetic impact of afforestation).
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Table 3. Principles for the design and operation of high-integrity nature markets

Draft principle	Description	Source
Governance principles		

Market governance structures and procedures should be robust, coherent and transparent

Summary: Robust and transparent governance structures and procedures are needed around the ownership, management and operation of codes and standards; monitoring, validation and enforcement; and the claims that buyers of units can make. High level coordination should occur across markets to ensure policy coherence, effectiveness and alignment across markets and relevant market actors.

Details:

- Codes and standards should establish robust governance structures, including by identifying bodies to oversee the generation of units, the rigour with which the code is being applied in practice, review changes required in response to accreditation bodies or new evidence, and oversee procedures to deal with conflicts between buyers, sellers and intermediaries or complaints about projects. Expectations should be clearly established around who has responsibility to monitor and enforce standards of practice. Documentation covering these processes should be available for public scrutiny and competent individuals should transparently be assigned to relevant roles and responsibilities to manage governance processes, with measures in place to avoid conflicts of interest.
- Codes and standards should be piloted prior to their launch to ensure all the necessary components are fully operational, gain feedback from market actors, assess the likelihood of unintended negative consequences and ensure the code or standard is fit for purpose. Codes should be revised in response to piloting and after the validation and verification of the first projects under the code, to address any challenges encountered.
- High level, strategic coordination should occur between governments and market actors to ensure policy coherence, effectiveness and alignment with other relevant strategies, and legislative and regulatory frameworks. Codes and standards should align with relevant national and international legislative and regulatory frameworks and ensure projects funded under any code or standard also comply with legal and regulatory frameworks in the jurisdiction within which projects are located.
- An assessment should be made of likely interactions with public funding schemes to avoid competition between schemes and ensure public funding supports environmental markets and is targeted towards the provision of public goods that are less likely to be provided by markets

Black et al. (2022), ICVCM (2022), VCMI (2022), SBTi (2021), GHG Protocol (2023), Scottish Government, 2022c

- Codes and standards should include know your customer and anti-money laundering checks, accounting and communications guidelines for claims that can be made, and checks to ensure units are not being purchased to offset avoidable impacts
- For carbon codes and standards, checking the buyer's wider emission reduction strategy to ensure offsets are only purchased after everything possible has been done to reduce their own Scope 1 and Scope 2 emissions at source. VCMI and the Science-Based Targets Initiative go further, suggesting that companies should set science-based targets and provide detailed strategies to reduce emissions in the short term as they progress toward long-term net zero commitments consistent with limiting global temperature increases to 1.5 degrees Celsius above pre-industrial levels
- There should be guidance and monitoring around the legitimacy and accuracy of claims made by buyers of units, showing how units have been purchased, retired and used as part of a mitigation hierarchy to only offset unavoidable impacts as part of a wider strategy with clear targets.
- The owner of the code or standard should have transparent and robust corporate governance to ensure effective performance and promote trust, including high levels of transparency, accountability, board oversight and gender equality in its governance structures, policies and procedures.

Outcomes should not be double counted

Summary: Outcomes from projects should not be double counted and where more than one ecosystem service is being sold from the same activity in the same location (“stacking”), legal and financial additionality criteria should be passed in codes and standards for each ecosystem service.

Details:

- Each unit or credit of a specific type (for example a biodiversity or carbon unit) should only be claimed by one buyer at a time and can only be counted towards one target (the same unit cannot be sold twice, counted towards multiple targets). Measures should be in place to prevent duplicate registration of projects or registration of projects that overlap with and share outcomes with other projects. Note that where units of different ecosystem services are sold from the same project or land area (e.g. biodiversity and carbon), this is not considered double counting, as long as each benefit in the bundle or stack is identifiable and additionality rules have been met for each code or standard that has been used to validate projects
- Regardless of whether units of environmental benefits are issued on their own, in a stack or in a bundle¹, if they are used to meet offsetting requirements or to claim progress against an environmental or climate target, they must be robustly quantified and each should be subject to the same standards of integrity. It should be made clear (on the registry) whether units represent a single ecosystem service, an explicit or implicit bundle, or whether the service is part of a stack of other benefits being generated from the same location.
- To avoid double counting, stacking is only possible when both legal and financial additionality test are passed in codes and standards for each ecosystem service. The need to pass legal additionality tests means that it is not possible to include units from compliance markets in a stack, for example habitat creation under Biodiversity Net Gain is required to meet conditions under the National Planning Policy Framework and because the activity is legally required, any attempt to generate carbon units from the same piece of land would not pass the legal additionality test. On the other hand, where funding from voluntary biodiversity markets is not sufficient to make a project financially viable, additional funding may be sought from voluntary carbon markets, and if both payments together are sufficient to make the project viable, the project would pass the financial (investment) additionality test under both the biodiversity and carbon code (it was also pass the legal test because projects under voluntary biodiversity markets are not legally required)

Defra (2023), Black et al. (2022), ICVCM (2022), the governance hierarchy in this paper (see previous section)

- Note that domestic carbon units may count towards both a company's voluntary internal target and the UK's Carbon Budgets and Nationally Determined Contribution (the UK's international emissions reduction commitment) as these represent the total of domestic emissions regardless of source. The UK has not opted to apply "corresponding adjustments" to its domestic markets at present, but is expected to apply these to projects funded by overseas investors (decisions are pending). Although the Woodland Carbon Code and Peatland Code do not allow overseas investment, some of the emerging markets allow this, and corresponding adjustments will be made in these cases to avoid units being double-counted by the UK and the country of the investor.

Outcomes should be additional

Summary: Ensuring that eligible practices and their expected outcomes are additional is essential to the integrity of nature markets, and high integrity codes and standards typically include legal tests and at least one financial additionality test.

Details:

- These are practices and outcomes that are additional to what would have happened in the absence of a project i.e., these practices and outcomes would not have happened anyway, without the project. For example, would the ecological gains at a biodiversity project site have occurred anyway under existing policies or requirements.
- Additionality is typically evaluated when projects are proposed as part of an initial project validation process, which also checks the eligibility of projects and makes sure projects comply with a code or standard.
- There are four main types of additionality test, and most codes require some combination of these: legal, financial (including both investment tests and contribution to carbon finance tests), common practice and barrier tests.
- As a minimum, high integrity codes and standards typically include legal tests and at least one financial additionality test.
- For biodiversity markets, additionality can be assessed through an evaluation of current conditions and threats, to characterize the expected background rate of loss. This approach to estimating additionality allows for the inclusion of both restoration actions and preservation (protection) of existing ecosystem functions/services, as additionality can be demonstrated for preservation through the prevention of expected background rates of loss (McKenney and Kiesecker, 2010).

Defra (2023), Black et al. (2022), ICVCM (2022), McKenney and Kiesecker (2010), CIEEM, CIRIA and IEMA (2016)

Outcomes should be permanent

Summary: Mechanisms should be in place to ensure that outcomes are effectively permanent. Permanence, or durability, relates to the ability of the target ecosystem functions or services to be maintained in perpetuity.

Details:

- In carbon markets, permanence may be ensured via:
 - Legal frameworks (e.g. the Forestry Act requires forests to be replanted);
 - Minimum permanence periods to ensure long-term maintenance of outcomes, enforced via contractual arrangements;
 - Project or pooled buffers of carbon units that are not sold and can be allocated to projects in the case of unintended and unavoidable reversals; and/or
 - Contractual arrangements or insurance policies to ensure projects generate replacement carbon units or pay back investors in the case of avoidable reversals.
- In other ecosystem markets, while the same legal frameworks may not exist to guarantee the permanence of most land uses, habitats and practices, there are a variety of legal mechanisms that may be used to increase the likelihood that ecological functions or services are maintained in perpetuity. For example:
 - Where practices lead to the improvement of habitats in designated sites, the reversal of these changes would trigger statutory processes.
 - Where required by investors and agreed by project owners, contracts may include conservation covenants/burdens or equivalent to ensure changes are maintained in the long-term.
 - Contractual agreements can be put in place to ensure the durability of a project, for example, by requiring a defined monitoring period followed by long-term management plans and funding. In the US stream and wetland markets, permanence is established through a combination of long-term site protection mechanisms (deed restrictions, conservation easements, etc) and the establishment of a long-term financing and site management (where needed) after ecological success criteria have been achieved (IWR 2015).

Black et al. (2022),
ICVCM (2022)

Damaging activities should not be moved elsewhere as a result of the project	<p>Summary: Damaging activities, such as habitat degradation or GHG emissions, should not be displaced by the project, leading to negative outcomes elsewhere, also known as leakage.</p> <p>Details: Displacement of damaging activities (i.e., leakage) may be avoided by:</p> <ul style="list-style-type: none">• Restricting eligible changes in land use and land management practices;• Requiring the identification and mitigation of leakage risks during project validation;• Monitoring of outcomes (e.g. GHG emissions or biodiversity) in surrounding land where activities have been displaced from the project area and this land is under the same owner; and• Monitoring of yields in the project area to identify if declining yields from the project are compensated for by increasing yields elsewhere in a landholding.• Requiring that buyers adhere to the mitigation hierarchy (i.e., avoid and minimize impacts prior to purchasing offsets).	Black et al. (2022), ICVCM (2022), CIEEM, CIRIA and IEMA (2016)
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<p>Transparent information should be available about validated projects and verified units</p>	<p>Summary: Codes and standards should provide comprehensive and transparent information on all validated projects and units, available online for public scrutiny.</p> <p>Details:</p> <ul style="list-style-type: none"> • Codes and standards should use a recognised, credible, public registry to register, track the resale of units and permanently retire verified credits to avoid double counting, double issuing or double selling. • Registries should provide unique identifiers to units, the activities that generated them and any other attributes associated with the unit (e.g. if it is part of a stack, or the other environmental and social benefits associated with the unit) • Sufficient data should be provided to allow market participants to conduct appropriate due diligence of projects, which may include details of the relevant land/marine parcel, quantification methodology of the relevant code or standard, project documentation, credit ownership and whether the unit is bundled or stacked (with links to registries containing other units from the same location) • Data should be recorded in standardised ways for monitoring and oversight purposes and liability provisions should be in place in the event of incorrect issuance of units, ensuring units are cancelled or compensated. 	<p>Defra (2023), Black et al. (2022), ICVCM (2022)</p>
<p>Units sold within nature markets should be clearly defined and account for ecological equivalency and uncertainty</p>	<p>Summary: Codes, standards and methodologies need to clearly address the loss and gain of ecosystem functions/services and address uncertainties around ecological outcomes.</p> <p>Details:</p> <ul style="list-style-type: none"> • Codes, standards and methodologies need to address ecological equivalency (i.e., both the loss and gain of a particular ecosystem function or service). This can be largely achieved through the selection of appropriate and ecologically relevant units (i.e., informed by quantitative measures or metrics that relate directly to target ecosystem functions/services). However, the units sold within nature markets should also account for differences in when and where losses and gains are occurring (e.g., differences in resource quality, time lags and geographic disparities), potentially through the use of multipliers, trading rules or adjustment factors (e.g. Biodiversity Metric 4.0 includes spatial and temporal multipliers, as well as trading rules for habitat distinctiveness). 	<p>Lave and Doyle, Quetier and Lavorel (2011), McKenney and Kiesecker (2010), Cole (2023), Morgan and Hough (2015), CIEEM, CIRIA and IEMA (2016)</p>

- Methodologies and standards should ensure units sold in nature markets account for ecological uncertainties related to the accrual of units over time. It is important to consider both the probability of success (i.e., the likelihood that ecological outcomes will be achieved) and the time it may take to yield self-sustaining and mature ecological functions/services. These uncertainties can be addressed by incorporating elements to ensure administrative and ecological performance. Examples include the application of structured credit releases (e.g., the availability of units are tied to defined project milestones or ecological outcomes and informed by multiple verification events), release of multiple types of tradeable units (e.g., Pending Issuance Units in the woodland and peatland code), reliance on robust assessment (MRV), application of multipliers (e.g., Biodiversity Metric 4.0 multipliers to address risk associated with creation and enhancement in different habitat types), and through consistent project management elements.

Methodologies and standards underpinning units sold in the marketplace should include robust assessment of and/or requirements for key project management elements that contribute to successful delivery of benefits (e.g., setting clear ecological objectives and related performance or success criteria, and having clear plans for implementation, maintenance, monitoring, adaptive management, and long-term management). For example, in the US regulatory markets, baseline data and landscape context inform the project objectives and a workplan; performance standards, financial assurances, maintenance, monitoring and adaptive management plans are required to ensure a project will deliver the benefits outlined in the objectives (these are tied to the value and release of units); and a site protection instrument and long-term management plan are in place to ensure benefits can be sustained in perpetuity (IWR 2015).

Measurement, reporting and verification principles

Assessment of outcomes leading to the generation of units should be evidence-based

Summary: The selection of eligible practices and assessment of likely and actual outcomes from projects needs to be evidence-based. The assessment of outcomes and calculation of units sold within markets needs to be informed by clearly defined indicator metrics that are relevant to the identified target functions/services, responsive and able to be consistently and efficiently measured.

Details:

- Eligible practices listed in codes, standards and schemes should be evidence-based, drawing on evidence synthesis and (where possible) meta-analysis of peer-reviewed publications that demonstrate practices funded under codes are likely to result in expected ecological outcomes, e.g., carbon sequestration, emissions reductions, biodiversity gain, etc., to avoid the promotion of practices or techniques that are unlikely to deliver the anticipated benefits. Robust processes should be in place for evaluating new practices for inclusion as these emerge.
- Assessment of likely outcomes at project design and validation should also be based on robust evidence, for example, including site-specific data and detailed project designs, peer-reviewed models, internationally recognised default values or peer-reviewed datasets or meta-analysis of studies, to avoid over-estimating project outcomes.
- Units sold in nature markets should be based on appropriate and ecologically relevant measures and/or metrics that are informed by robust assessment of the benefit delivered for the identified target ecosystem functions/services (for example carbon captured, nutrient concentrations reduced, habitat extent and condition increased, or the number of individuals, indicator species or priority species increased). Measurement, reporting and verification (MRV) processes should either be defined in codes and standards or there should be a rigorous process for evaluating and approving MRV methodologies developed by third parties for use within the codes and standards.
- MRV should take place at regular intervals across the project duration and be reported to code owners and/or verification bodies. Verification should use empirical data where possible, and where models are used, these should be calibrated to local conditions and validated using empirical data to ensure their accuracy over the project area. The reliability, repeatability and accuracy of measurement methods should be assessed and uncertainties taken into account, for example by increasing the size of buffers (or unsold carbon credits), purchasing insurance policies or agreeing clawback clauses in contracts in case of measurement error.

Defra (2023), Black et al. (2022), ICVCM (2022), CIEEM, CIRIA and IEMA (2016)

- Baselines used to assess net gains or losses (e.g., carbon sequestration, emissions reductions) should be established at year zero (and may be established prior to the start of a project). In many cases, multi-year (historic) baselines may be necessary to account for natural variability (where variability can be predicted, variable baselines may be established).
- Where codes and standards are open to the creation of new methodologies that can be used to generate credits, there needs to be a robust approval process that includes public stakeholder consultations and reviews by independent experts.

Validation and verification of projects and outcomes should be robust and independent

Summary: The validation of projects and verification of outcomes should be robust and independent.

Details:

- Projects put forward for credit issuance should be validated by a qualified, independent body, to ensure they have a credible project design to deliver a credible estimate of ecosystem service units
- After implementation and monitoring to assess outcomes, projects should be verified by a qualified, independent expert or body.
- Adaptive management measures should be considered where projects have not demonstrated achievement of project milestones or anticipated ecological outcomes.
- Qualifications may be vetted based on curriculum vitae and professional registration, or on the basis that a body is already accredited to a national or international standard such as ISO14065 or ISO17020, as determined by an accreditation body such as the UK Accreditation Service
- The person or organisation doing the verification should have no financial or other conflicts of interest with the project. Units should only be issued on the basis of successful verification.
- There should be procedures for evaluating how verification bodies perform, with sanctions for under-performance.

Defra (2023), Black et al. (2022), ICVCM (2022)

Wider benefits principles

There should be environmental and social safeguards

Summary: Codes and standards should ensure projects do no harm, proactively managing risks and trade-offs with other ecosystem services, local communities and other rights holders.

Details:

- Risks and trade-offs with other ecosystem functions and services, local communities and other rights holders should be identified, assessed and managed proactively, with clear mechanisms through which concerns can be raised, to ensure projects do no harm
- Procedures should be in place to ensure social and environmental risks are correctly identified, assessed and managed. For example, this may include guidance on the identification and protection of heritage sites that could be damaged by project activities. Scottish Government (2022a) suggest positive and negative natural, social, economic and human impacts should be identified
- Where possible, investment in nature markets should not involve land acquisition, and when acquiring land, management agreements and collaboration with tenants, crofters and local communities should be considered to ensure shared benefits. Scottish Government (2022b) have provided guidance on this in their Land Rights and Responsibilities Statement.
- Public bodies should work with market participants to identify negative unintended consequences of markets for individual ecosystem services and interactions between different private markets and private and public payments for ecosystem services, adapting policy and governance mechanisms to manage risks and trade-offs.

Scottish Government (2022a,b), Black et al. (2022), the governance hierarchy in this paper (see previous section)

Environmental and social net positive impacts may also be required

Summary: Codes and standards may require projects to deliver net social and environmental benefits beyond the benefits arising from the generation of units, where possible as part of a wider place-based approach to the coordination of public and private payments for ecosystem services at landscape and catchment scales.

Details:

- The most common wider environmental benefit required by carbon codes and standards is biodiversity uplift. Scottish Government (2022a) go further to suggest that all carbon management should be designed to deliver integrated land use with multiple benefits. Biodiversity codes often seek wider social benefits.
- Social benefits may include improvements to site access (e.g. for recreation), using benefit sharing contracts, or using a proportion of profits to make community wealth funds or fund local development in line with local strategic and development plans through agreement with local communities.
- Scottish Government (2022a) also suggest project should consider resilience to food supply and natural flood management as part of a just transition to net zero.
- Public bodies should, where possible, facilitate the coordination of public funding and private schemes to identify and enable the assessment and management of trade-offs between payments for ecosystem services at landscape and catchment scales.

Scottish Land Commission (2023), ICVCM (2022), Scottish Government (2022a)

Engagement should take place with all relevant parties affected by projects

Summary: All relevant parties should be actively engaged in both the development of governance mechanisms and individual projects to ensure they have an opportunity to comment on and shape both projects and the codes and standards that govern them.

Details:

- Engagement should occur prior to project validation and should include those specifically affected by a project (e.g. neighbouring properties), hard-to-reach groups, as well as conducting a public consultation
- There should be evidence that issues raised during engagement and consultation have been adequately addressed.
- Projects should remain open to feedback from relevant parties for the duration of the project, providing timely responses to feedback.
- Scottish Government (2018) published Guidance on Engaging Communities in Decisions Relating to Land that emphasise early engagement in shaping decisions.
- The development of governance mechanisms should be an inclusive process to engage and empower local and regional institutions.

Defra (2023), Scottish Government (2022a), ICVCM (2022), CIEEM, CIRIA and IEMA (2016)

Markets should be as easy and low risk to access as possible

Summary: Codes and standards should be as simple as possible within the bounds of the rules and systems needed to maintain market integrity, which should be provided by public bodies who should also provide clarity around interactions with regulations, tax and public funding and where possible prioritise public funding to address market failures and de-risk market engagement for buyers, sellers and intermediaries.

Details:

- Codes and standards should make it as easy as possible for project owners and developers to work with them, within the bounds of any rules and systems needed to ensure integrity, avoiding unnecessary complexity in their design (for example, in forms, guidance and MRV rules and field protocols) or operation (for example, in the number or required changes in verification bodies that projects must work with)
- Public and arms-length bodies should provide guidance to enable codes and standards to operate to similar standards of integrity in ways that are interoperable in terms of stacking (where this is possible) for supply-side actors and the ability for buyers to assess the quality of units and invest in mixed portfolios of ecosystem services.
- Public bodies should provide clarity around interaction with regulatory frameworks, tax and public payments for ecosystem services.
- Public bodies should also seek, where possible, to use public funding to reduce risks for buyers, sellers and intermediaries (e.g., blended finance mechanisms like floor price guarantees and contracts for difference), leverage private investment (e.g., via public-private finance vehicles) and address market failures (e.g., by funding ecosystem services and locations for which there are no markets or that are insufficiently attractive to markets, or funding the long-term maintenance of natural capital created by markets to increase permanence).
- Financial regulatory oversight should be extended to nature markets to ensure markets are honest, competitive and fair. This will reduce the barriers to doing business and make it easier for buyers, sellers, investors to take part in markets, whether alone or in partnership with others, allowing more nature projects to be brought forward and investment to scale up.
- It should be easy for suppliers to access different markets simultaneously and individual market design should not unnecessarily impede this.

Defra (2023), the governance hierarchy in this paper (see previous section)

<p>Markets should be open to innovation</p>	<p>Summary: Developers of governance mechanisms, codes and standards, and owners and operators of market infrastructure should be open to innovation as new technologies and advancements in scientific understanding emerge.</p> <p>Details:</p> <p>New advancements in scientific understanding or technology can:</p> <ul style="list-style-type: none"> ● Better implement the principles above to increase integrity; ● Reduce costs to project developers or verification bodies whilst maintaining integrity; ● Improve the accuracy of MRV; ● Enable new assessment approaches; ● Improve administrative and ecological performance; ● Demonstrate the interventions and/or restoration activities that result in successful outcomes; and ● Facilitate new market activities. 	<p>Defra (2023), Scottish Biodiversity Strategy (2022), Morgan and Hough (2015)</p>
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¹ When more than one type of separate credit or unit is issued from the same location this is known as ‘stacking’ – for example if a natural resource owner or manager were to sell both carbon and water quality units from the same woodland. When a single credit is sold that includes several different environmental benefits (for example a wetland unit delivering carbon, biodiversity and water quality benefits), this is termed ‘bundling’. Bundles may be either explicit (in which several different benefits are quantified and communicated to the buyer who may then make claims about each ecosystem service provided) or implicit (in which only one service is quantified but others are assumed to be generated alongside it)

4 Discussion

This paper has provided an overview of ecosystem markets currently operating in the UK, and the range of market actors with an interest in high-integrity ecosystem markets. A comparative analysis of national and international principles for the development and operation of high-integrity markets led to the proposal of 14 principles pertaining to the governance, MRV and wider benefits of well-run ecosystem markets. However, the majority of principles published to date are designed to be applied at international scales or within single markets, and there has been no attempt to develop principles that could be applied at a national scale across multiple ecosystem markets. To apply these principles in this way, relationships between policy, governance, and market mechanisms and infrastructure need to be established in a consistent hierarchy (Figure 3). For example, although codes and standards can play an important role in applying these principles to the projects they facilitate and the buyers, sellers and intermediaries they interact with, there are questions around how the integrity of codes and standards can be assessed, and where necessary improved. A consistent and coordinated approach to the development and operation of codes and standards, as well as their accreditation and regulatory oversight is needed to ensure interactions between ecosystem services are managed at landscape scales and feedback is provided to the policy community where regulatory intervention may be needed to protect the public interest.

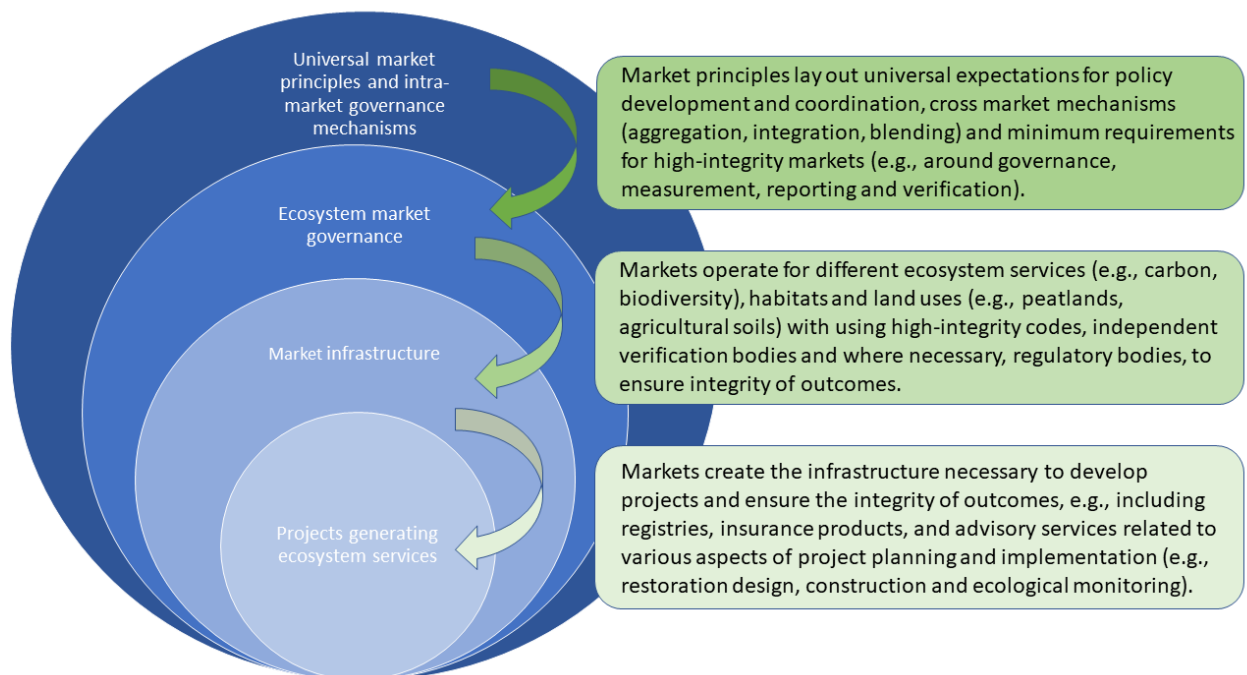


Figure 3: Overview of ecosystem market hierarchy

Within the hierarchy presented in Figure 3 and further outlined in Figure 4, it is possible to identify a number of governance mechanisms where market principles can be applied. First and ultimately, the goal of ecosystem markets is to fund projects that can generate real and effectively permanent flows of new ecosystem functions or services, for example, to help tackle the climate crisis and facilitate nature recovery. Project scopes are typically geographically limited, and they often focus on restoration or interventions targeting one or more ecosystem functions or services, such as biodiversity gains, habitat creation, carbon sequestration and storage, and/or emissions reduction or avoidance. In the UK, there are no restrictions on who can receive funding to create a project that generates ecosystem services, so long as the results of the project appear reasonable. Corporate social sustainability projects and initiatives to reduce corporate risk from climate change often have limited measurement, verification or reporting of outcomes, but may also include payments for carbon, water, biodiversity and other ecosystem services. Without robust, coherent and transparent governance structures, including for monitoring, reporting, and verification, and consideration of wider benefit principles in project planning, there is a risk that projects do not deliver their intended outcomes, leading to a risk of greenwashing and a loss of public trust in funding or investing in projects of this nature.

Principles that support market infrastructure can help manage some of these risks, for example ensuring that there are robust contracts in place, project management elements, or insurance products to protect buyers and/or sellers against non-delivery, typically as a result of factors beyond the control of the project. However, there is also a risk of fraudulent activity in these markets, especially given the intangible nature of the outputs being marketed. For example, demand-side actors may make unsubstantiated claims about the benefits arising from their investment, or supply-side actors might sell the same carbon abatement to multiple buyers. Within this level of the hierarchy, mechanisms should be put in place to ensure accessibility, reduce risk, support innovation and encourage the engagement of all relevant parties in ecosystem markets, from the development of individual projects to broader governance frameworks.

Market principles and governance structures are needed to ensure adequate financial regulation in ecosystem markets. For example, it would be useful to extend the jurisdiction of the Financial Conduct Authority in the UK to include ecosystem markets. However, this alone would not be sufficient to protect the integrity of these markets, because of the reactionary nature of the regulatory processes. The first verification point under many carbon codes is not until year five, and if significant issues were uncovered at this point, in large enough schemes, this could significantly undermine wider market confidence. Early monitoring and reporting, when combined with financial assurances that support adaptive management, can ensure projects are on track to achieve ecological outcomes and allow for timely intervention if targets are not being met.

	Governance mechanism	Description	Example	
Generalisable ↓ Land use or habitat-specific	Market principles and reporting guidelines	Minimum requirements for the design and operation of high-integrity ecosystem markets and corporate reporting in a given jurisdiction (or internationally)	ICVCM Core Carbon Principles could be supplemented with other ecosystem market principles (e.g. stipulating responsible investment principles or essential additionality tests for all codes). UK Environmental Reporting Guidelines and UK Sustainable Finance Taxonomy might allow corporate reporting against codes that meet these principles and minimum requirements (see below).	a
	Policy co-ordination group	Co-ordination between policy and expert groups	Regular meeting between expert group chairs and key policy teams	b
	Aggregation, integration and blending mechanisms	Place-based mechanisms to aggregate supply & demand, co-ordinate ecosystem service delivery in space and stack (private) or blend (public) payments for multiple services at project design	Landscape Enterprise Networks, Wilder Carbon and Rural Land Use Partner-ships (Scot) doing this at regional scales and could be adapted and/or scaled. Stacking and blending is currently via additionality criteria of codes and full stack must be agreed pre-contract. New blending options under development	
	Independent expert groups manage minimum requirements for codes in each habitat, land use and ecosystem service	Expert groups set minimum requirements (e.g. for additionality and permanence), list approved methods (e.g. carbon models and MRV sampling regimes) and evaluate codes, updating requirements as evidence becomes available	An independent soil carbon expert group stipulates a minimum permanence period for all soil carbon codes, states minimum soil sampling depth, approves models to estimate carbon in project design documents, and evaluates soil carbon codes against these requirements e.g. for inclusion in Environmental Reporting Guidelines	c
	Independent accreditation to relevant ISO standards	Individual codes and standards are checked to ensure they comply with relevant ISO standards	UKAS checks the integrity of the Peatland Code and then accredits verification bodies to ISO14065 to work with it	
	Individual codes	A document, or set of documents, that set out the requirements and rules to establish and run a project that aims to generate verifiable carbon or other ecosystem credits	The Woodland Carbon Code and Peatland Code, and other codes under development, e.g., hedgerows, agricultural soils, saltmarsh and agroforestry	c
	Verification bodies	Organisations that validate projects and verify ecosystem service claims of projects against the requirements of individual codes	OF&G is a verification body for the Peatland Code and Woodland Carbon Code which is accredited by UKAS to ISO 14064/3 and 14065	
	Financial regulation	Protection for ecosystem market buyers/sellers from fraud and ensuring healthy competition	Financial Conduct Authority could extend its jurisdiction to ecosystem markets	a
	Market infrastructure	Market registries, online marketplaces, model contracts and legal mechanisms, and insurance	UK Land Carbon Registry and insurance exist with new marketplaces, investment platforms, contractual models and insurance products being developed	
	Project developers, intermediaries and brokers	Organisations that may develop projects under codes, sourcing both buyers (e.g. offsetters) and sellers (e.g. landowners)	Forest Carbon Ltd develops peatland and woodland projects and sells or retires credits via the UK Land Carbon Registry	
	Projects generating ecosystem services	Interventions undertaken in a geographically defined area to sequester carbon, avoid emissions and/or deliver other ecosystem services that adhere to a relevant code	Carrick Peatland (restoration project) developed by Tillhill Forestry	

■ Developed and in operation
■ Under development by a) Defra and Scottish Government; b) JNCC; c) Environment Agency NEIRF and Defra

Figure 4: Governance hierarchy showing mechanisms that may increase the integrity of ecosystem markets.

Within each ecosystem market, governance mechanisms are needed to provide assurances for high integrity codes and standards. Assurance may be provided by accreditation bodies like the International Carbon Reduction and Offset Alliance (ICROA) or the UK Accreditation Service, who can accredit verification bodies to codes and standards, such as ISO standards and domestic voluntary carbon market codes like the Woodland Carbon Code. However, these organisations only do limited checks on the codes themselves, and don't have the expertise to be able to comment on the science underpinning measurement, verification and reporting methods. It is therefore possible that they accredit independent verification bodies to work with codes that may be fundamentally flawed.

As a result, it is important to pay attention to the codes themselves. With sufficient funding and expertise, it may be possible to create a robust set of codes for different ecosystem services, land uses and habitats, that are evidence-based and effectively managed. For peatlands and woodlands, code development has been led in the UK by governmental agencies, and is now proceeding for other land uses and habitats (see above). However, private bodies can devise their own codes, and there are already multiple international programmes like Verra and Gold Standard that are able to operate within any given jurisdiction. In the UK, there are multiple private companies, each with their own proprietary agricultural soil carbon codes. The quality of these codes varies, so it is necessary to devise mechanisms to ensure minimum standards, evaluate the integrity of codes and provide transparency for buyers and sellers to select high integrity markets.

In the UK, a set of minimum requirements for high-integrity codes across a range of land uses and habitats, and ecosystem services, is being developed, which can be operated by an arm's length body like the British Standards Institute. The first set of minimum requirements has been developed for agricultural soil carbon, and once formally adopted by an arms-length body, it will be possible to accredit codes against these minimum standards, providing clear market signals to investors and farmers alike, so that they work with the most reputable codes. Guidance will be given to codes that do not meet the requirements, to help them improve the integrity of their codes. As an incentive to submit codes for accreditation, UK compliance markets will only be able to offset using codes accredited to this standard. However, a BSI standard doesn't auto-update or adapt unless there is a body that can ensure the minimum requirements remain in line with the latest evidence and horizon scan for negative unintended consequences. In this way, sets of minimum requirements for codes can be adapted where necessary or policy teams alerted, in case a regulatory response is needed. However, there is a danger that this leads to the development of a siloed system where each ecosystem service and habitat is managed separately, in contrast to the interdependencies we see in the real-world.

For this reason, it is also important to think about mechanisms for aggregating both supply and demand for ecosystem services; different investors may be looking for contradictory outcomes and land holdings may be highly fragmented and so not investible. These mechanisms need to be place-based because actual landscapes integrate multiple land uses and habitats, and produce many different ecosystem

services. And some interventions will produce one ecosystem service at the expense of another, cancelling out benefits from different schemes and investors. In addition to thinking about how private payments for ecosystem services interact across landscapes, it is also important to think carefully about how private and public payments interact, and avoid situations where public funding outcompetes private investment. It is difficult to justify spending public money on outcomes that the market would have been happy to pay for.

Next, it is important to ensure there is a level of policy coordination within and across ecosystem markets to ensure things work smoothly. In many European countries, ecosystem markets operate at sub-national scales, which is similar to the challenges posed by the UK's four countries, given that voluntary ecosystem markets are devolved to these administrations. Even where policy is national, there is a need to ensure the various government departments and delivery agencies are aligned. But where you have the potential for divergent regulatory constraints, such as a requirement for projects to contribute to community wealth funds, or tax regimes for example, there is the potential for competition between jurisdictions and a race to the bottom. Finally, at the top of the governance hierarchy in Figure 4, to bring consistency across all of these policy and governance mechanisms, there is a need for core principles that can operate across markets for different ecosystem services in different habitats and land uses.

Even with these governance proposals, there are potential issues remaining not yet discussed, which could cause perversities in markets, and therefore unintended negative ecological and social consequences. For example, there are concerns that investment in secondary markets does not deliver additional nature benefits, and may create a "bubble" which could be counterproductive to market growth in the long-term. On the other hand, secondary markets may increase unit prices which could incentivise greater supply of projects into the market. As such, codes and standards need to establish rules around the resale of units on secondary markets, and market principles could be agreed either in favour or against the operation of secondary markets at a national scale across all ecosystem markets (Du et al, 2018). Resale of units on secondary markets is not currently possible via the Woodland Carbon Code or the Peatland Code, but a number of emerging markets in the UK allow this.

The principles proposed in this paper build on international initiatives, creating consistency across global voluntary markets, whilst drawing on national experience in the design and operation of high-integrity codes like the Woodland Carbon Code and the Peatland Code. Taken together, the core market principles and governance hierarchy could be used to ensure the development of high-integrity ecosystem markets across the UK and internationally, as national governments around the world attempt to responsibly build and scale these markets.

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