

Governing high-integrity nature markets

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Abstract

There is growing interest in the potential for ecosystem markets to facilitate climate and nature recovery, but there are concerns that poorly designed and operated markets may be used in corporate “greenwashing” and lead to negative unintended consequences for nature and local communities.

To date, there has been no systematic analysis of market governance principles, which have typically been designed to apply at international scales or within single markets; nor has there been any consideration of the governance needed to implement these principles at a national scales across multiple ecosystem markets. 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. UK domestic markets are among the most developed internationally, and both Scottish and English governments are actively exploring options for governing these markets.

This paper therefore:

1. Provides an overview of compliance and voluntary carbon and other ecosystem markets and systematically analyses relevant market actors in the UK, a country with well-developed and rapidly proliferating domestic markets that is actively seeking to increase their integrity;
2. Conducts a comparative analysis of existing national and international principles and synthesises a list of 14 core principles pertaining to the governance, measurement, reporting and verification, and wider benefits of high-integrity ecosystem markets; and
3. Develops an ecosystem markets governance hierarchy, showing the various policy, governance and market mechanisms and infrastructure that are being explored to implement the proposed principles in the UK.

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.

1 Introduction

There are growing concerns that climate change and the degradation of ecosystems around the world are bringing us to the point of ecosystem collapse (Rockström et al., 2009; Steffen et al., 2015; Nash et al., 2017), leading to increasingly dangerous impacts for humans and nature, which are likely to be felt disproportionately by those who have contributed least to climate change (IPCC, 2023). To keep global warming within 1.5°C of pre-industrial levels (Article 2, Paris Agreement, 2015; IPCC, 2018) will require social, economic and technological transformations on a scale not previously seen. In addition to reducing emissions at source, nature-based solutions to climate change have been proposed, which 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, which may need 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), concerns have been raised about the integrity of these ecosystem markets (e.g., Committee on Climate Change, 2022).

Criticisms have tended to focus on carbon markets, but typically apply more widely across other ecosystem markets, and include concerns about: the use of low-integrity ecosystem market units by companies to make net zero and other claims that cannot be substantiated; 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; and allowing companies to invest in offsets to meet net zero targets 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. In addition to this, there are 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.

There is therefore an urgent need to identify 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 markets are among the most developed internationally, 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 will create a set of independent standards against which codes and standards can be evaluated, to be administered by arms-length body, the British Standards Institute. 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:

- Provides an overview of compliance and voluntary carbon and other ecosystem markets and systematically analyses relevant market actors in the UK, a country with well-developed and rapidly proliferating domestic markets that is actively seeking to increase their integrity;
- Conducts a comparative analysis of existing national and international principles and synthesises a list of 14 core principles pertaining to the governance, measurement, reporting and verification, and wider benefits of high-integrity ecosystem markets; and
- Develops an ecosystem markets governance hierarchy, showing the various policy, governance and market mechanisms and infrastructure that are being explored to implement the proposed principles in the UK.

The prioritisation and refinement of principles, and the design of policy, governance and market mechanisms to implement these principles is ongoing in the UK, and this paper will draw on this experience as it unfolds to provide a more critical discussion

of the proposed principles and governance hierarchy prior to submission to a peer-reviewed journal.

2 Methods

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 Market overview

A narrative review of grey literature was conducted to identify compliance and voluntary carbon markets, and other ecosystem markets currently operating in the UK. Narrative reviews are better suited to reviews in which it is not possible to identify specific interventions or outcomes (Greenhalgh et al. 2018). Moreover, it is difficult to conduct a systematic review of peer-reviewed literature on ecosystem markets as they have been proliferating rapidly in recent years and are currently under-represented in the literature.

2.2 Analysis of market actors

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. Participants then continued to input to the analysis online, filling gaps where possible, completing the data collection phase within two weeks of the workshop.

The analysis used Reed et al's (in prep.) interest-influence-impact method for analysing relevant parties. For each market actor identified, participants could also add additional information they felt might be relevant. Participants were asked specifically to consider 'hard-to-reach' groups that may have been missed from the analysis. They were also 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. Although the initial focus of the analysis was

Scotland, national and international market actors were also included, given that ecosystem markets operate across the UK.

2.3 Comparative analysis of national and international ecosystem market principles

National and international initiatives to identify ecosystem market principles were compiled in collaboration with policy officials in Scotland and England, and drew on work by the British Standards Institute. Principles were extracted from the following sources, after screening for relevance to the UK context:

- Defra's Nature Markets Policy Framework (Defra, 2023);
- Scottish Government's Interim Principles for Responsible Investment in Natural Capital (Scottish Government, 2022a);
- 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); and
- An international comparative analysis of 12 agricultural soil carbon codes and standards (Black et al., 2022).

The principles were also informed by:

- 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);
- 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.

3 Results

3.1 UK ecosystem markets overview

The UK has a compliance carbon market, the UK Emissions Trading Scheme, regulated by law that requires participants to comply with emissions reduction requirements. 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). England operates a number of other compliance markets for biodiversity and water pollution (Figure 1). Although compliance carbon markets are reserved, Scottish Government and the UK's two other nations, can develop their own compliance biodiversity markets and have jurisdiction over voluntary carbon and other voluntary ecosystem markets operating in their jurisdictions. However, although regulatory oversight of these markets is devolved, requiring projects to be developed in line with regulations in each UK jurisdiction, they operate as national markets accepting investment from companies based anywhere in the UK (some of the emerging markets also accept overseas investment).

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).

The majority of voluntary carbon market transactions in the UK take place via the Woodland Carbon Code and the Peatland Code. Version 2.0 of the Peatland Code extends operation to lowland fens and wetland agriculture on lowland peats, and projects funded by NatureScot's Investment Ready Nature Scotland fund are currently exploring the integration of biodiversity and community benefits with the Peatland Code (NatureScot, 2022b). In addition to this, a number of initiatives are underway to develop new carbon codes to expand the domestic voluntary carbon market in the UK, including:

- The Wilder Carbon Standards were developed by Kent Wildlife Trust to enable the generation of carbon credits from rewilding activities including woodland creation via natural regeneration, peatland restoration, pond

creation and saltmarsh creation. Funded by the Environment Agency's Natural Environment Investment Readiness Fund (NEIRF), the standards contain no standardised approach to measurement, reporting and verification (MRV), with MRV for individual projects reviewed on a case-by-case basis, and requiring the collection of biodiversity data using Defra's biodiversity offsetting metric. In contrast to other UK domestic carbon markets, Wilder Carbon requires buyer checks to ensure those investing in projects have done everything possible to reduce emissions at source before offsetting their residual emissions. It also has unusually long minimum contract lengths of 100 years, or 50 years with conservation covenants that would ensure projects are effectively permanent;

- Recommendations for a UK Saltmarsh Code were made by a recent NEIRF funded project. An initial feasibility study assessed whether Verra's VM0033 Methodology for Tidal Wetland and Seagrass Restoration could be applied in the UK. This concluded that although VM0033 could be applied to saltmarsh restoration via managed realignment in the UK, it would not be commercially viable due to high upfront costs compared to the costs of developing projects under existing UK Codes for peatlands and woodlands. For this reason, the project made detailed recommendations for a UK Saltmarsh Code, focussed purely on managed realignment and aligned with existing domestic voluntary carbon markets and forthcoming UK market principles and governance;
- The development of a Hedgerow Code is being led by the Game and Wildlife Conservation Trust's Allerton Project, funded by NEIRF. While its initial development will focus on carbon in above ground biomass and soils, projects will also monitor biodiversity benefits;
- An Agroforestry Code is being developed by the Soil Association in collaboration with the Woodland Carbon Code and others, funded by NEIRF, for integration with the Woodland Carbon Code. It will include both above and below-ground carbon sequestration. Given that hedgerows are a form of agroforestry and the existing market penetration of the Woodland Carbon Code, this may also be an important route to market for hedgerow carbon;
- Adur District & Worthing Borough Councils were also awarded NEIRF funding to explore carbon market opportunities for sea kelp restoration and Plymouth City Council are exploring carbon markets for sea grass, which may lead to the development new domestic market blue carbon markets;
- There are a number of carbon capture technologies now coming to market, with the European Biochar Certificate available for UK projects and new biochar and enhanced weathering credits being developed by Puro Earth;
- Although not immediately identifiable as Codes, there are a number of new companies now competing with the two established Codes for woodland and peatland carbon. Each of these 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;

- Finally, there are a large number of companies now offering agricultural soil carbon credits. These too are not always full transparent and sometimes integrate functions that are traditionally separated to avoid conflicts of interest. However, a number of these companies are planning to use Verra's VM0042 Methodology for Improved Agricultural Land Management. Another NEIRF project proposed minimum requirements for agricultural soil carbon codes, which if adopted by BSI could bring more consistency and rigour to the agricultural soil carbon market.

In addition to the voluntary carbon market, there are a number of other ecosystem markets at different stages of development in the UK, for example:

- Biodiversity net gain is a compliance market that mandates a 10% net gain in biodiversity from development under the Town and Country Planning Act 1990 in England (Defra, 2023b). Developers must first try to avoid habitat loss, but if this is not possible then they must create habitat either on-site or off-site. If neither of these options are possible, they must purchase statutory credits from the government, generated from habitat creation elsewhere in England. There are plans for a similar system in Scotland and Defra are also developing Marine Net Gain that will work in a similar way to Biodiversity Net Gain, and require all in-scope developments to leave the environment in a better state than before (Defra, 2022);
- 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);
- Plan Vivo are a UK-based company operating in the voluntary biodiversity market, and consulting on the introduction of a biodiversity standard, "PV Nature" that could operate in the UK (Plan Vivo, 2023a). They have already piloted the code in seven sites, including one in the UK to restore and improve management of saltmarsh, seagrass, oyster habitat and seabird nesting habitat. There are a number of other companies offering voluntary biodiversity credits in the UK, but without transparent standards;
- The Forestry Commission is exploring the potential to introduce a Woodland Water Code, which would provide a standard and new market for water-related benefits from woodland creation, including pollution mitigation, reducing flood risk and maintaining river flows (Defra, 2023a);
- Water quality markets tend to be regional rather than focus, 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. For example, EnTrade is a Wessex Water business that pays for catchment management solutions that provide biodiversity gain,

carbon sequestration and natural flood management, alongside nutrient mitigation (EnTrade, 2023);

- Landscape Enterprise Networks (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. 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).

3.2 UK ecosystem market actors

Over 200 stakeholder organisations and groups were identified across 11 main categories in the analysis (Figure 2). Table 1 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 1 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 2 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. As such, the principles are aimed at:

- Governments and their agencies;
- Other governance bodies and mechanisms such as the UK Accreditation Service and the British Standards Institute;
- Codes and standards operating across multiple nature markets, including carbon, biodiversity, water quality and flood risk among others;
- Project owners and developers; and
- Investors.

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

Table 1: 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 Scottish Government responsible for aspects of natural capital and ecosystem markets policy and regulation	<ul style="list-style-type: none"> ● Natural Capital Co-ordination Group ● Land Use Transformation Portfolio/Board ● Rural and Environment Science and Analytical Services Division 	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 ● National Park Authorities ● Scottish Forestry/Forestry & Land Scotland 	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 	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 (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"> ● Woodland Carbon Code ● Peatland Code 	Both Codes 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.

Emerging voluntary carbon markets that could operate in the UK	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	<ul style="list-style-type: none"> • Wilder Carbon (Kent Wildlife Trust) • Companies applying Verra's VM0042 methodology to create new agricultural soil carbon markets • Agroforestry and Hedgerow Codes 	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.
Biodiversity and other single service markets	Codes, standards and schemes are being developed for biodiversity and other single ecosystem services	<ul style="list-style-type: none"> • Nature Restoration Fund (Scottish Government) • Plan Vivo • Blue Impact Fund 	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.
Cross-cutting ecosystem markets	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	<ul style="list-style-type: none"> • Landscape Enterprise Networks • Riverwoods • Highlands Rewilding 	Interested in how policy frameworks might facilitate or limit their current activities, and enable them to expand their currently limited operations.
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 • Trinity Agtech • Farm Advisory Service 	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"> • Forest Carbon Ltd • The Habitat People • BX Group 	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 	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 	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 for Scotland • Investment firms 	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.
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 	Interested in potential increase in demand for their products and services arising from ecosystem markets.
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 Scotland • Community Land Scotland • Scottish Land and Estates 	Keen to enable their landowning members to benefit from natural capital and ecosystem markets, and build knowledge and skills amongst members based on findings from the research.
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 • 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.
Natural capital and ecosystem markets networks			

Natural capital and 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 • Ecosystem Knowledge Network 	Keen to enable their members to learn new insights from the research, and help shape and facilitate the work through their networks where relevant.
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 	Concerned about potential negative unintended consequences of ecosystem markets and keen to ensure communities receive direct benefits.
Recreation			
Recreation	Groups that pursue recreational activities in the natural environment	<ul style="list-style-type: none"> • Shooting associations • Cycling clubs • Hiking clubs 	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).
Research			
Peatland natural capital and ecosystem markets	Research institutes and universities with strong research capabilities in peatland natural capital and ecosystem markets	<ul style="list-style-type: none"> • University of Leeds • Aberystwyth University • UKCEH 	Interest in contributing evidence and insights to the development of high-integrity ecosystem markets.

Woodland natural capital and ecosystem markets	Research institutes and universities with strong research capabilities in woodland natural capital and ecosystem markets	<ul style="list-style-type: none"> • Bangor University • University of Aberdeen • Forest Research 	As above
Natural capital and ecosystem markets for other habitats and land uses	Research institutes and universities with strong research capabilities in natural capital and ecosystem markets for other habitats and land uses	<ul style="list-style-type: none"> • Rothamstead Research • James Hutton Institute 	As above
Ecosystem markets (cross-cutting)	Research institutes and universities with strong cross-cutting ecosystem markets research capabilities	<ul style="list-style-type: none"> • University of Edinburgh • Thriving Natural Capital Challenge Centre (SRUC) • University of the Highlands and Islands 	As above

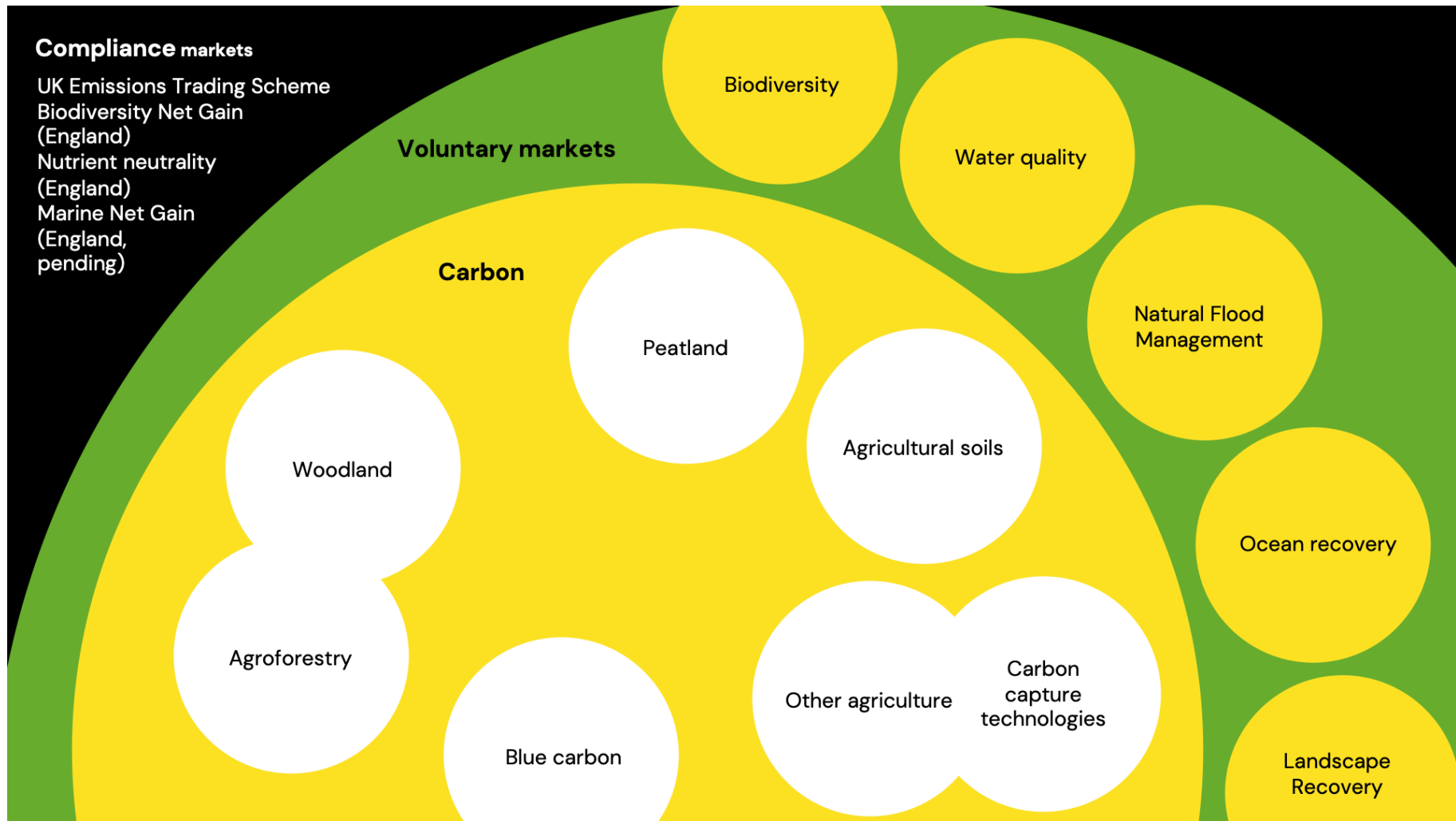


Figure 2: Types of ecosystem market operating or under development in the UK

Table 2. 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 and transparent

Summary: Robust and transparent governance structures and procedures are needed around the ownership, management and operation of codes and standards, and the claims that buyers of units can make.

Details:

- Codes and standards should establish robust governance structures, including bodies to oversee the generation of units and the rigour with which the code is being applied in practice, review changes required in response to accreditation bodies or new evidence, and should include a complaints procedure to deal with conflicts between buyers, sellers and intermediaries, and to deal with complaints about projects. 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 stakeholders (including buyers, sellers and intermediaries as well as policy and other stakeholders), 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.
- Codes and standards should align with relevant national and international legislative and regulatory frameworks. Projects funded under any code or standard should 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
- 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

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

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
- 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
- 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.

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

**Outcomes
should be
permanent**

Summary: Mechanisms should be in place to ensure that outcomes are effectively permanent.

Details:

- 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.
- While there may not be legal frameworks that 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 changes are effectively permanent. 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.

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

<p>Damaging activities should not be moved elsewhere as a result of the project</p>	<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: Leakage may be avoided by:</p> <ul style="list-style-type: none"> • Restricting eligible changes in land use and practices to those with low risk of leakage; • 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. 	<p>Black et al. (2022), ICVCM (2022)</p>
<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>

There should be clear rules about the transferability of units via secondary markets

Summary: Codes and standards need to establish rules around the resale of units on secondary markets.

Details:

- Resale of units on secondary markets is not possible via the Woodland Carbon Code or the Peatland Code, but a number of emerging markets allow this.
- A principle could be agreed in favour or against transferability of units.
 - Arguments in favour of transferability tend to centre on utility and returns for markets, and the potential to increase unit prices which could incentivise greater supply of projects into the market;
 - On the other hand, arguments against tend to focus on the fact that investment in secondary markets does not deliver additional nature benefits, and the danger that secondary markets create a “bubble” which could be counterproductive to market growth in the long-term.

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

Measurement, reporting and verification principles

Assessment of likely and actual outcomes should be evidence-based

Summary: The selection of eligible practice and assessment of likely and actual outcomes from projects needs to be evidence-based.

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 sequester carbon or reduce emissions, to avoid the promotion of practices 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 peer-reviewed models, internationally recognised default values or peer-reviewed datasets or meta-analysis of studies, to avoid over-claiming of likely benefits leading to underperformance of projects and/or over-selling of Pending Issuance Units
- Units sold in nature markets should be based on robust assessment of the benefit delivered (for example carbon captured, nutrient concentrations reduced or increases in habitat extent and condition, or the number of individuals, indicator species or priority species). 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 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
- Baselines should be established at year zero (and may be established prior to the start of a project) against which to measure carbon sequestration gains or emission reductions. 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)

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

- 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, projects should be verified by a qualified, independent expert or body.
- 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 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 (2022) 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 (2022) 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: As part of the validation process, projects should actively engage all relevant parties to ensure they have an opportunity to comment on and shape projects.

Details:

- Engagement 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.

Defra (2023),
Scottish
Government (2022),
ICVCM (2022)

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 provide clarity around interaction with regulatory frameworks, tax and public payments for ecosystem services
- They 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)
- They should also consider extending financial regulatory oversight 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)

Markets should be open to innovation	<p>Summary: Codes, standards and owners and operators of market infrastructure should be open to innovation and invest in new technologies where appropriate.</p> <p>Details: This may include, for example, technologies:</p> <ul style="list-style-type: none">● To better implement the principles above to increase integrity;● Reduce costs to project developers or verification bodies whilst maintaining integrity;● Improve the accuracy of MRV; or● Facilitate new market activities.	Defra (2023)
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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 will require policy, governance and market mechanisms and infrastructure. 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. In addition to roles for accreditation services and regulators to oversee the operation of codes and standards, there is also a need to coordinate these oversight functions, 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.

Starting from the bottom of the hierarchy proposed in Figure 3, it is possible to identify a number of governance mechanisms. First and ultimately, the goal of ecosystem markets is to fund projects that can generate real and effectively permanent flows of new ecosystem services, for example helping tackle the climate crisis and facilitate nature recovery. Projects are typically geographically constrained, often focussing on habitat creation, restoration or interventions designed to sequester and store carbon, and/or reduce or avoid emissions. In the UK there are no restrictions on who can take funding to create a project that generates ecosystem services, as long as care is taken about what the investor claims as a result of the project. This includes corporate social sustainability projects and initiatives to reduce corporate risk from climate change, that often have limited measurement, verification or reporting of outcomes, but it may also include payments for carbon, water, biodiversity and other ecosystem services. However, there is a risk that these projects do not deliver their intended outcomes, leading to a risk of greenwashing, even despite the limitations around claims that can be made for projects of this nature.

	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	Standards framework
	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 Partnerships (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	Assurance framework
	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 3: Governance hierarchy showing mechanisms that may increase the integrity of ecosystem markets.

Market infrastructure can help manage some of these risks, for example ensuring that there are robust contracts in place and offering 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.

This raises the need for financial regulation in ecosystem markets, for example extending the jurisdiction of the Financial Conduct Authority in the UK to include ecosystem markets. However, this would not be sufficient to protect the integrity of these markets, because regulators only step in once things have gone wrong. 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.

Assurance may also 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 are 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. While this has already been done in the UK for peatlands and woodlands, and is now proceeding for other land uses and habitats (see above), 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 in everything but name. However, these codes are of variable quality, so it is necessary to devise mechanisms to evaluate the integrity of codes, to direct buyers and sellers to the most robust codes.

This is being done in the UK through the development of a set of minimum requirements for high-integrity codes across a range of land uses and habitats, and ecosystem services, 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 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 3, 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. 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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