

SESSIONAL PAPER

Natural capital: an actuarial perspective

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Abstract

This paper introduces the concept of Natural Capital and explores the implications for actuarial work by way of case studies. It is part of a wider series of IFoA papers focussing on the risks from global biodiversity loss and how these risks can be mitigated.

Keywords: Natural Capital; Biodiversity; Nature

Summary

This paper explores the concept of “natural capital.” Its intended readership is actuaries with no prior knowledge of the topic and its purpose is to educate and raise awareness. It covers in turn:

- Introduction to the concept
- Valuing natural capital
- Strengths and limitations
- Case studies (Reef credits; Forestry scheme)
- Implications for actuaries
- Conclusion and next steps

This paper explores the concept (the “what” and the “why”). The companion paper “Introduction to biodiversity valuation tools” by Allison et al. covers the methods to calculate a monetary value of natural capital (the “how”) in more depth.

1. Introduction

Many aspects of our lives rely on the natural world. We need healthy, well-functioning ecosystems and thriving biodiversity to breathe clean air, grow our food, and even produce resources to build our homes.

However, we are overusing our world’s natural resources. We are consuming more than the planet can provide us – the UK’s current consumption of natural resources is 3.1 times what is available (Global Footprint Network, [n.d.](#)). This continued overuse of natural resources has caused huge damage to our natural world and our ability to produce goods and services that meet the needs of our global populations. The negative impacts of humanity’s demands on natural resources have never been more apparent:

- Record high global temperatures;
- 75% of productive land per person could be lost by 2050 (Henley, [2019](#); Arsenault, [2014](#)); and
- Wildlife populations have declined by 60% since 1970 (WWF, [2018](#)).

Awareness of the damage caused by our overuse of resources is growing and more attention is being given to how we can start to protect and enhance our natural world. Recognising nature as a form of capital is a way of identifying it as an asset and beginning to value the benefits it offers humans.

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Valuing an asset and managing it responsibly can create new value, and in this case protect and enhance our natural world. In contrast, overuse of the asset can cause damage that prevents it from producing any future value. This is the situation we are now facing with our natural world, as overuse of the goods and services it provides has caused huge negative impacts that we are now trying to correct, e.g. limiting carbon emissions. To ensure we can continue to produce goods and services from our natural world to support humans’ way of life, we need to carefully manage the use of its resources and mitigate damage we cause.

The concept of “natural capital” therefore aims to recognise nature as an asset and aims to ensure that the goods and services offered by nature become a part of decision-making by governments, businesses, and individuals regarding resource allocation, growth and development. This paper explores the concept of natural capital and how monetary values can be applied to parts of an ecosystem.

Natural Capital

Natural capital is defined by the Natural Capital Protocol as “the stock of renewable and non-renewable natural resources that combine to yield a flow of benefits to people” (Capitals Coalition, n.d.). It includes soil, air, water, and all living things, which can be categorised into four core *ecosystem services* (see below).

Ecosystem Services

Ecosystem services can be categorised into four main types:

1. **Provisioning services** – “goods” produced by ecosystems for personal use and include tangible outputs like food, timber, pure water, energy (hydropower or biomass fuels)
2. **Regulating services** – processes that keep the natural world in balance, such as carbon sequestration, waste decomposition, and predation regulating prey populations
3. **Supporting services** – activities that support the other parts of ecosystems, such as pollination, photosynthesis, nutrient recycling, flood defences, and water purification
4. **Cultural services** – the “non-material” services which make the natural world important to people either through spiritual, historical, therapeutic, or recreational experiences.

A healthy level of biodiversity is necessary for the proper functioning of ecosystems and the provision of these services. Biodiversity (i.e. the existence of a variety of plant and animal species in the world or in a particular habitat) also has an intrinsic value that is separate from its contribution to services for humans. This intrinsic value should be considered (but may be difficult to quantify in a meaningful way) in any natural capital approach.

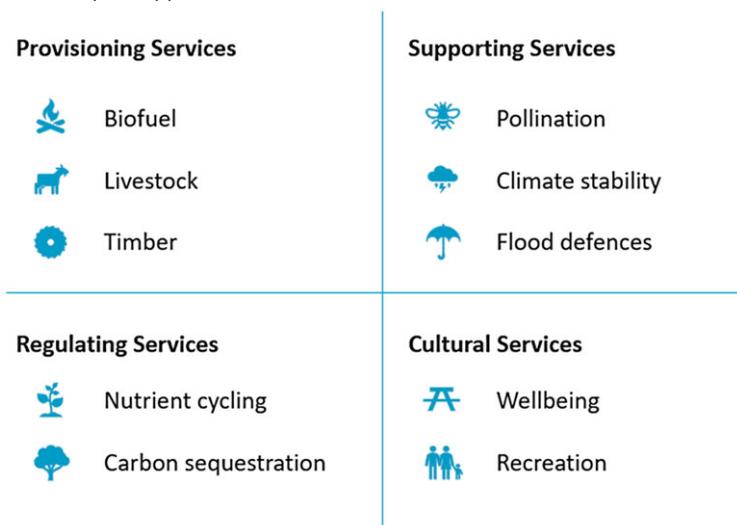


Image 1: Key ecosystem services offered by a forest.

2. Valuing Natural Capital, Including Ecosystem Services

In general, by taking the quantified values of each ecosystem service and adding them together, it is possible (in theory) to place a monetary value on a whole ecosystem. This would provide a natural capital valuation on an ecosystem and allow governments, business and individuals to incorporate this valuation into their decision-making.

Valuing natural capital is complex as there are no widely agreed valuation methodologies for every ecosystem service and consequently data availability is limited. It involves placing a monetary value on various ecosystem services, which is easier for some, than others. For example, it is straightforward to place a value of the timber produced by a forest as this can be sold into the market, but it is extremely difficult to place a value on the benefits of walking in the forest on wellbeing. Placing a value on the cultural services offered by an ecosystem is one of the hardest aspects of natural capital to value, as it is not possible to put a value on how people feel about a place.

Any natural capital valuations should, therefore, be carefully assessed to understand which parts of the ecosystems have been included in the calculations and which areas have been omitted due to data availability. In addition, valuations of natural capital may fail to take account of all the benefits offered by an ecosystem as we cannot assume that we have all the information about all ecosystems which are intricate and complex. Our understanding of what benefits human life changes over time, therefore our valuations of natural capital may also change as our knowledge grows.

Case studies: Valuing natural capital of the World and an elephant

\$125tr

Is the value of the world's natural capital as calculated by economist Robert Costanza in 2014 (Costanza et al., 2014). This valuation is equivalent to 1.4x global gross domestic product in 2019.

Costanza and colleagues used a "natural capital approach" to put a monetary value on several key "ecosystem services" which are crucial to our continued life on earth, i.e. water supply, soil formation, pollination.

\$1.75m

is the estimated value of an African elephant based on their contribution to carbon sequestration (Chami et al., 2020).

The way elephants graze results in more large trees which take up more carbon dioxide than ungrazed shrubland. The authors of a recent study calculated exactly how much more and multiplied the difference by a carbon price of \$25.

The authors suggest a benefit of this approach is that, by publishing a large and eye-catching figure, this should raise awareness of elephants' value to the ecosystem, and hence stimulate conservation actions.

The ability to measure natural capital is improving and a range of techniques are being developed, including the Natural Capital Protocol and the biodiversity valuation tools referenced by the Department for Environment and Rural Affairs (DEFRA) in its publication "Enabling a Natural Capital Approach Guidance" (DEFRA, 2020). These methodologies are explored further in the companion IFOA paper "Introduction to biodiversity valuation tools."

3. Strengths and Limitations

One key strength of a natural capital approach is that it converts different ecosystem services and benefits into common units (i.e. a monetary value, where a monetary approach is used). This allows better communication across different disciplines and allows a comparison of natural assets with other types of capital.

Simplified example: A wooded area on the edge of town is being considered for a housing development. The local council has an acute need for extra housing and needs to decide whether to approve the development.

As houses, the land will have a high monetary value and so it is easy to demonstrate the argument in favour of the development. But the benefits provided by the woodland (e.g. recreation, flood prevention) are more intangible. A monetary valuation of this natural capital allows an objective comparison and should improve the decision-making.

However, the concept of natural capital is somewhat controversial – some observers disagree with the whole premise, perhaps even finding it distasteful. They argue that nature is priceless, so no monetary value can ever capture its true worth. The table below summarises some arguments for and against the concept.

<i>In favour of the concept</i>	<i>Objections to the concept</i>
<ul style="list-style-type: none"> • Provides a common language to compare nature with other services and assets • Ensures nature is considered on an equal footing with competing demands • Reframes nature positively as a capital asset • Encourages rigour and an evidence-based approach • Encourages a longer-term mindset • Builds an understanding of dependencies on nature (e.g. for a company). This repositions nature from an external or “CSR” issue to an internal strategic issue • Aims to protect and enhance nature by bringing it into decision-makers considerations for resource planning, growth and development 	<ul style="list-style-type: none"> • Nature has an inherent value that cannot be measured, so monetary valuation is inappropriate (similar to a human life) • We cannot live without nature, so trying to assign a monetary value is meaningless • It is anthropocentric – focus on “ecosystem services” or “what nature can do for us,” rather than its inherent worth • Valuations will rarely account for all aspects of natural capital and some value will be omitted due to lacking data availability • No widely agreed frameworks on how certain ecosystem services should be valued and therefore comparability is a challenge

Beginning to use valuations of natural capital as part of development, resource planning and growth requires enhancements in data and metrics to allow comparability across different regions, countries and decision type (e.g. different construction sites).

There also needs to be a mindset shift such that there is a better understanding across governments, businesses, and individuals, that the protection of biodiversity and our ecosystem services is vital to protect long term value and prevent further damage to our natural world.

Despite its many strengths and uses, there is a risk that monetary valuation could lead to perverse or unintended consequences.

Simplified example: The council from the case above commissions a valuation of the natural capital in the woodland, leading to an estimate of £5 million. The housing developer agrees to donate £5m to a local conservation charity to secure approval for the development.

This means that the development goes ahead and the ecosystems in this area are lost immediately but the donated money will take time to create benefits elsewhere. Hence there is imbalance in the timings of the benefits offered by the housing developer's donation.

In addition, it is later discovered that the woodland was home to an endangered species of bat. This aspect was difficult to value and thus was not included in the natural capital valuation. If this aspect had been fully considered a different decision would have been reached.

This example is deliberately simplified and idealised, but is intended to highlight a key limitation – that monetary valuations will usually be “**partial**” (i.e. not capture the full range of values). Where a natural capital approach is adopted, it is crucial that such limitations are properly understood and clearly communicated. This approach should also complement, rather than replace, other type of analysis and evidence. Natural capital should therefore be considered a support tool, not a decision-making tool.

The table below summarises some key opportunities and risks of a natural capital approach.

<i>Opportunities</i>	<i>Risks and limitations</i>
<ul style="list-style-type: none"> • Tracking the state of the natural environment year-on-year in a consistent way (“natural capital Accounting”) • An educational tool to raise the profile of nature (as in elephant example above) • Facilitating clear numerical targets, and policies to meet those targets (consider the Paris agreement 1.5°C target driving decarbonisation policies) • Setting up payments or incentives to preserve nature (“Payment for Ecosystem Services”/PES) • Imposing a fair level of fines for pollution, commensurate with the damage done • Creating investible assets – which can stimulate private investment in preserving nature (see Reef credits example below) 	<ul style="list-style-type: none"> • Can legitimise the destruction of nature (e.g. if the equivalent payment is made) • Certain features (e.g. biodiversity, cultural or spiritual values) are not amenable to monetary valuation – so can get missed or overlooked • Valuations are misunderstood by the user (e.g. a partial valuation is treated as comprehensive, as in the housing example above) • The value of an ecosystem can differ depending on the user of community in question. • Monetisation can change behaviours – risk of unintended consequences

Case Study 1 – Reef credits

Coral reefs harbour some of the most biodiverse ecosystems on the planet, earning them the moniker “rainforests of the sea.”

The Great Barrier Reef

The largest coral reef system is the Great Barrier Reef, covering an area of 344,400 km² – so large that it is visible from space. Deloitte Access Economics (2017) estimated that over 2015 to 2016, the Reef contributed **AU\$6.4bn** to Australia’s economy and supported 64,000 jobs.

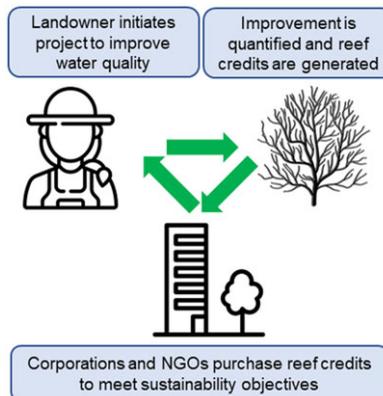
This valuation only included the measured economy (mainly tourism, fishing and scientific activities), which represents a just subset of the total ecosystem services provided by the Reef. This highlights that the assumptions used in natural capital calculations should be carefully assessed to understand which aspects of an ecosystem have been included and ascertain if there are aspects that have been missed and therefore resulted in the ecosystem being undervalued.

Effects of Climate Change

The Great Barrier Reef, like all coral reefs, is under threat from climate change. A rise in the atmospheric concentration of CO₂ increases the frequency and severity of coral bleaching events – where coral polyps expel the symbiotic algae that live inside their tissues – accelerating ocean acidification, which has a deleterious effect on coral and other calcifying organisms. However, the Reef is also under threat from a localised issue – pollution, particularly agricultural run-off.

Valuing the Natural Capital

A natural capital approach has been used in a novel market-based solution to water pollution called the **Reef Credit Scheme**¹.



Reef Credits are tradable and audited units that quantify and value the work undertaken by landholders to improve water quality flowing into the Reef. The price of credits is driven by market forces, but is underpinned by government pollution reduction targets. In December 2020, HSBC became the first private buyer of Reef Credits (Klein, 2020), lending scale and credibility to the scheme.

The Reef Credits scheme is similar to carbon offset markets, but is focussed on protecting the biodiversity of a local ecosystem rather than reducing CO₂. It provides an example of how a natural capital approach and market forces can contribute to innovative solutions to reverse biodiversity loss.

¹<https://www.reefcredit.org/>

Case study 2 – Forest creation scheme

This case study covers the UK's first application of the Natural Capital Protocol's Forest Products Sector Guide (Natural Capital Coalition, 2018). The assessment examined a forest creation scheme managed by Gresham House on a former sheep farm and aimed to assess the natural capital of the forest to ensure it was incorporated into the forest design.

Assessment approach

Both private and wider societal benefits from the forest creation were considered over a 50-year time horizon and three major parts of the value chain were studied:

1. **Upstream** – inputs into forest creation such as plants, soil, fertilisers and labour.
2. **Direct operations** – the productive forest itself
3. **Downstream** – impacts on wider society and uses of timber harvested

The assessment was driven by data availability as many aspects of natural capital do not yet have established measurement frameworks. For example, it is unlikely that valuers will be able to assign a monetary value to how much a forest benefits the aesthetics of the local area.

Valuation approach

The study covered six material services provided by the forest's natural capital. The table below shows the valuation approach taken for each service:

Service	Valuation approach
Timber	Market valuation of timber production based on sale price
Carbon sequestration	Cost-based using Woodland Carbon Code calculations and the non-traded carbon price from the Department for Business, Energy & Industrial Strategy
Flood risk protection	Replacement cost of flood storage based on cost of constructing a flood storage reservoir
Biodiversity	Stated preference (contingent ranking) ²
Recreation	Not assessed due to limited visitor data
Aesthetics	Not assessed due to lack of economic valuation evidence

The modelling relied on various assumptions and results were discounted to provide a present-day valuation.

The analysis found that of these six areas, the ones that had better data availability and agreed valuation approaches had a larger focus in the forest design. This implies that as better data becomes available on other natural capital factors, creation of new natural capital sites, such as forests, could start to consider a wider range of services in their design, creation and management.

²Biodiversity is assessed in terms of its non-use value which is the value associated with knowing that biodiversity exists rather than from engaging with it in some way. The contingent ranking method involves respondents ranking a number of scenarios that are presented to them individually.

Valuation Results

The chart below summarises the value of each service over a 50 year period and whether the benefits are to the forest owner or to wider society:



The analysis found that most of the natural capital value was held in biodiversity (£13m), followed by the forest’s ability to sequester carbon (£9m). The remaining value came from timber production and reducing flood risks.

The valuation approach was bespoke and involved some judgement, as there is no widely accepted framework or market for natural capital valuation.

Benefits of Using a Natural Capital Valuation

The use of a natural capital approach and the associated modelling:

- informed project design and options appraisal;
- identified investible opportunities, e.g. payments for ecosystem services schemes;
- demonstrated social, economic and environmental investment returns in natural capital;
- provided a monitoring framework and lessons learnt for future interventions; and
- provided a basis for engaging with stakeholders about impacts and dependencies on natural capital.

Key Findings

1. Woodland creation can bring very significant benefits to a forest owner and wider society.
2. It is difficult to quantify and assign monetary figures to the benefits.
3. Accepting the limitations of the methodology, most of the benefits accrue to wider society, rather than the forest owner.
4. Sensitivity or scenario analysis is a beneficial tool in project design and option appraisal

4. Implications For Actuaries

As governments and organisations increasingly adopt a natural capital approach, the IFoA will have a role to position the profession to meet these demands. As illustrated in the examples above, the actuarial skill set is well matched to this field of work and so it represents an exciting opportunity for actuaries wishing to explore a non-traditional role.

To value natural capital, there is a need for skilled professionals who are technically experienced with modelling and who are able to interpret and communicate results to enable informed decision-making. Actuaries are well placed to provide these skills.

It’s possible to re-frame the business needs met by actuaries in traditional roles, for example those in life or general insurance roles, to the needs of a company required to calculate additional information related to natural capital.

Example

Actuaries in life and general insurance reporting roles are familiar with the requirements for the calculation of the technical reserves of an insurer, and the need to communicate uncertainty in the results via sensitivity and scenario testing.

A similar skill set could be used by actuaries to place a monetary value on the environmental impact of a company. Analogous to reserving, there is no single “correct” value but a range of possible values that depend on the underlying assumptions. There is a need to illustrate this uncertainty by providing sensitivities to the results and to communicating the results effectively to different stakeholders.

Further examples of where the actuarial skill set is relevant in the context of natural capital include, but are by no means limited to, the following:

- Developing complex models to enable monetary valuation of natural capital.
- Performing bridging exercises between different calculation approaches.
- Analysis of large datasets to inform natural capital valuations (for example the forestry case study above used discrete datasets to value the different services).
- Projecting monetary flows many years into the future and discounting to give present values.
- Communicating the results of complex models in plain English.
- Developing reporting frameworks for businesses with particular focus on environmental impacts and dependencies.
- Designing and calculating new metrics on direct and indirect environmental impacts of business practices.
- Including natural capital in asset valuations and risk/return analysis for liability projections for pension schemes

5. Conclusion And Next Steps

This paper seeks to illustrate the range of uses of a natural capital approach. This is a topic that is likely to become more prominent as business and society places increasing focus on sustainability and the protection of our natural world for humans’ benefit.

With increasing use comes increased risk that results may be misinterpreted, or systems poorly designed leading to perverse consequences. Actuaries, with their skill set of communicating uncertainty, have a key role to play in developing this approach for the benefit of all.

We hope this paper provides a flavour and interesting introduction to the topic of natural capital, and we would encourage all actuaries to build their knowledge in this area – the resources in the further reading section provide an excellent starting point. This paper only scratches the surface of what is a broad and complex topic; in the time available we have not been able to do justice to certain issues, nuances and controversies. The authors feel the following areas would merit further study:

- The plurality of valuation, i.e. that the value depends on who is measuring it, or to whom the benefits accrue.
- The recommendations of the Dasgupta Review (HM Treasury, 2021) and links with natural capital.
- A wider range of real-life examples.

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Further Reading and Resources – Links

Natural Capital Committee (NCC), Natural Capital Terminology (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/909202/ncc-terminology.pdf) – an introductory guide to natural capital concepts and terminology.

- Enabling a Natural Capital Approach (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/869801/natural-capital-enca-guidance_2_March.pdf) – comprehensive guidance by DEFRA on natural capital and environmental valuation.
- Natural Capital Protocol (<https://capitalscoalition.org/capitals-approach/natural-capital-protocol/>) – a decision-making framework that aims to help organisations to identify, measure and value their direct and indirect impacts and dependencies on natural capital.
- Natural Capital Protocol, Financial Sector Supplement (https://capitalscoalition.org/guide_supplement/finance-sector-supplement/) – a supplement to the above protocol for financial institutions.
- Exploring Natural Capital Opportunities, Risks and Exposure (<https://naturalcapital.finance/wp-content/uploads/2018/11/Exploring-Natural-Capital-Opportunities-Risks-and-Exposure.pdf>) – a practical guide by the Natural Capital Finance Alliance (NCFA) to assist financial institutions with natural capital assessments.
- NCFA ENCORE Tool (<https://encore.naturalcapital.finance/en>) – an interactive visualisation tool that is designed to complement the above paper.
- SHIFT Natural Capital Toolkit (<https://shift.tools/contributors/551>) – a database of open source tools to measure and value natural capital.
- The Economics of Biodiversity: The Dasgupta Review (<https://www.gov.uk/government/news/nature-is-a-blind-spot-in-economics-that-we-ignore-at-our-peril-says-dasgupta-review>) – an independent, global review on the economics of biodiversity led by Professor Sir Partha Dasgupta. The review calls for new measure of economic success “inclusive wealth” which incorporates the value of natural capital.
- Into the Wild: Integrating nature into investment strategies (https://wwfeu.awsassets.panda.org/downloads/report_wwf_france__axa_into_the_wild_may_2019__dv_1.pdf) – A report by AXA and WWF that reviews existing initiatives on the analysis of nature-related impacts, risks, and opportunities for financial institutions.
- Greening Sovereign Debt: Building a Nature and Climate Sovereign Bond Facility (https://a1be08a4-d8fb-4c22-9e4a-2b2f4cb7e41d.filesusr.com/ugd/643e85_021432a338a34c3e92237ffdd128404c.pdf) – a report by the *Finance 4 Biodiversity Initiative*, which sets out a proposal to accelerate the integration of nature and climate into sovereign debt markets.
- Taskforce on Nature-related Financial Disclosures (<https://tnfd.info/>) – an initiative that seeks to provide a framework for corporates and financial institutions to assess, manage and report on their dependencies and impacts on nature. This initiative is akin to the biodiversity equivalent of Taskforce on Carbon-related Financial (TCDF).
- Science-Based Targets for Nature (<https://sciencebasedtargetsnetwork.org/wp-content/uploads/2020/09/SBTN-initial-guidance-for-business.pdf>) – initial guidance for business on setting nature-oriented targets. Natural capital assessments underpin the framework.
- The Little Book of Investing in Nature (<https://globalcanopy.org/insights/publication/the-little-book-of-investing-in-nature-2/>) – an overview of the area of biodiversity finance.

Glossary

Anthropocentric

Considering human beings as the most significant entity of the universe. Interpreting or regarding the world in terms of human values and experiences.

Biodiversity

Biodiversity is “the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.” (CBD, 2006)

Carbon offset markets

Marketplaces that enable individuals, organisations, governments etc. to invest in environmental projects in order to balance out their carbon footprints. An example of this would be the forest carbon offset market where common projects would be reforestation and improved forest management to enable carbon offsetting.

Carbon sequestration

A natural or artificial process by which carbon dioxide is removed from the atmosphere and held in solid or liquid form.

Ecological economics

Ecological economics is both a transdisciplinary and an interdisciplinary field of academic research addressing the interdependence and co-evolution of human economies and natural ecosystems (Xepapadeas, 2008).

Ecosystem services

Flows from natural capital assets (e.g. land, oceans, minerals) that enable living things to provide services such as crops, pollination, water filtration and recreation, which serve to benefit humans (POST, 2016).

Environmental accounts

The product of environmental accounting, which is defined as a statistical system bringing together economic and environmental information in a common framework to measure the contribution of the environment to the economy and the impact of the economy on the environment (Eurostat, 2020).

Natural Capital Accounts

A set of accounts that record the total stocks and flows of natural resources and services in a given ecosystem or region, e.g. forest accounts, land accounts, water accounts.

Natural Capital Approach

A natural capital approach integrates the concept of natural capital into decision-making. Thinking in “capital” terms enables comparison of many changes and decisions at the same time. The natural capital approach uses information from, and provides input to, many existing environmental management and analytical approaches (Natural Capital Coalition, 2019).

Natural Capital Protocol

The Natural Capital Protocol is a framework designed to help generate trusted, credible, and actionable information that business managers need to inform decisions. The Protocol aims to support better decisions by including how we interact with nature, or more specifically natural capital, in decision-making (Natural Capital Coalition, 2016).

Payments for ecosystem services schemes

Incentives offered to farmers or landowners in exchange for managing their land to provide some sort of ecological service. For example, in the South West of England, there’s an incentive called Upstream Thinking co-developed between South West Water and the Westcountry Rivers Trust to encourage and/or incentivise farmers to implement land management actions to improve raw water quality, with many management measures locked into 10 or 25 year covenants (DEFRA, 2013).

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