Benefits from nature

Human well-being depends on a wide range of resources and processes that are supplied by natural ecosystems.

Summary

Through working together, natural resources provide fundamental 'ecosystem services' to people, many of which are vital for social, economic, physical and emotional well-being. Monetary values for ecosystem services are impossible to determine as some, such as providing oxygen to breathe, have infinite value, but those that can be valued are estimated to be worth between £21 and £23.5 billion per year to Scotland. Taking account of ecosystem services in decision-making allows inter-relationships between different natural resources to be considered. More interdisciplinary work is required, particularly to understand how changes in stocks of natural resources impact on ecosystem services.

Introduction

Human well-being depends on a wide range of resources and processes that are supplied by natural resources. Collectively, these benefits are known as 'ecosystem services' and they include 'products', such as food and clean drinking water, and 'processes', such as waste decomposition and climate regulation. As human populations grow and develop, they demand more ecosystem services; however, natural resources are not never-ending or unaffected by these demands.

Considering ecosystem services helps us to understand the full range of benefits that we get from our environment and the impacts that environmental changes have on them. Our environment needs to be managed to maximise the provision of ecosystem services and minimise the damage to them.

Changes that clearly impact on one part of the environment can have knock-on impacts on the ability of other parts of the environment to provide ecosystem services. The ecosystem services concept allows the impacts of environmental change as a whole to be taken into account, rather than considering individual environmental changes.

The United Nations 2004 Millennium Ecosystem Assessment (see also the Scottish Environment Protection Agency's (SEPA) Biodiversity Position Statement) grouped ecosystem services into four broad categories. These are summarised and explained in Table 1.

Table 1: Ecosystem service categories and examples from the Scottish environment

Ecosystem Service Category	Definition	Examples from the Scottish Environment
Provisioning	The products that people obtain from ecosystems, most of which generate economic benefits	Food Timber Drinking water Tourism Minerals
Regulating	The benefits obtained by regulating ecosystem processes and human impacts on them	Climate regulation Coastal protection Waste management Flood regulation Regulation of pests and diseases
Supporting Services	The benefits necessary for the production of all other ecosystem services	Habitat provision (for biodiversity) Water cycling Nutrient cycling Soil formation and retention Atmospheric oxygen provision

Cultural	The non-material benefits that people obtain from ecosystems	Spiritual benefits and happiness Physical and mental health and well-being Recreation Aesthetic experience Education

Measuring the significance of ecosystem services, or impacts on them, is not easy as many are not generally 'bought' or 'sold' and therefore have no value in money. Only 'provisioning' ecosystem services, which are clearly linked to the production of goods that are bought and sold, are relatively easy to assign monetary values. Some ecosystem services, for example providing oxygen to breathe, are fundamental to the continued existence of people, so their value is infinite. Many 'non-provisioning' ecosystem services, for example aesthetic experiences, are not used up when people benefit from them and, as such, they are often available whether or not people pay for them. These features mean that it is very difficult to assign monetary values to them and, as they are not generally paid for when people make use of them, their maintenance and production has often been neglected in favour of 'provisioning' ecosystem (and other) services.

In spite of the difficulties associated with valuing ecosystem services, estimates of their value in Scotland have been made. The benefits provided by Scotland's natural resources have been valued at between £21.5 and £23 billion per year in 2009[1]. Research is ongoing to both develop and improve techniques to assign monetary values to ecosystem services, and to understand what ecosystem services values are for Scotland.

The ecosystem services framework allows a comprehensive assessment of the relationships between people and their environment to be made. Other work is currently underway to improve our understanding of the ecosystem services that different aspects of our environment provide. So far, this has been carried out through the UK National Ecosystems Assessment (NEA), but work is also being undertaken by Scottish Natural Heritage (SNH) through its development of a Natural Capital Asset index and is also being planned by the Scottish Government. The UK NEA reports published on 2 June 2011 provide strong evidence of the importance of ecosystem services to people.

They link ecosystem service provision to eight broad habitat types, examine how ecosystem service provision has changed in the last 60 years and predict how it will change in the future. At this time, however, our understanding of ecosystem service provision, the impacts that environmental changes have on it, and the values of these impacts, particularly for Scotland, is still not complete. Therefore, this topic highlights examples and case studies to illustrate the issues and concepts associated with ecosystem services, rather than comprehensively report on them. Over time, it is anticipated that work carried out as part of Scotland's Environment web will help us to gather the information we need to better understand Scotland's ecosystem services.

Reference

[1] *Williams E (2009) Preliminary exploration of the use of ecosystem services values in a regulatory context.* Environmental and Resource Economics Project Report for the Scottish Environment Protection Agency (SEPA).

Description of benefits from nature

This section describes, in turn, the different categories of ecosystem service: provisioning, regulating, supporting and cultural. Many of the topics could be associated with multiple ecosystem services. For clarity, topics appear under the ecosystem services with which they are most associated.

Provisioning services

Provisioning services are those that give rise to the production of goods that have a clear economic value. The economic value usually depends on the ecosystem service being combined with 'inputs', such as human labour or other manufactured inputs, so it can be difficult to be clear about the extent to which the ecosystem service contributes to the final 'product' value. Nonetheless, these provisioning ecosystem services are relatively straightforward to value in financial terms. Goods that are clearly related to provisioning ecosystem services include food, fibre, energy, tourism and timber. A study by Scottish Natural Heritage (SNH) carried out in 2008 estimated the total economic value associated with sustainable use of the natural environment by industry to be £17.2 million per year and associated with one in seven jobs in Scotland. The study only focussed on the sustainable use of the environment and provisioning services associated with extracting non-renewable things from our natural environment were excluded (e.g. quarrying, mining, oil production).

The production of many of these provisioning goods is impacted both by changes in the quality of our environment and impacts upon the quality of it. Changes in water quantity and quality, and air and land quality and availability all impact on the ability of our environment to deliver provisioning services. Conversely, if not carried out appropriately, the use of our environment to deliver provisioning services (by agriculture, forestry, fisheries or mining, for example) can adversely affect the quality of the environment and its ability to deliver other ecosystem services in the long term. Our knowledge of the provisioning services associated with our natural environment is not complete, although work is underway to improve this (see also the Natural Capital Asset Index).

Reference to provisioning services is made throughout Scotland's Environment website. The following are key provisioning services that are associated with our environment:

- land use and management;
- crops and livestock;
- fisheries and fish farming;
- fossil fuels and minerals;
- Timber and forestry products;
- energy;
- tourism;
- drinking water.

Regulating services

Regulating ecosystem services are the benefits that people obtain from the regulation of ecosystem processes. They include services such as flood and coastal protection, climate regulation and waste breakdown and detoxification. Some of these regulating services have very clear financial implications. For example, natural flood management will reduce costs associated with flooding or overcome the need for artificial flood defences. However, many regulating services, such as climate regulation, are much more difficult to assign monetary values to. Even where monetary values are available, as for natural flood management, it is likely that difficult-to-value aspects of this as a service (such as an improvement in wildlife habitat) could be neglected.

Regulating ecosystem services are described elsewhere in this report:

- waste;
- climate regulation;
- biodiversity;
- natural flood defence.

Supporting services

Supporting services are necessary to ensure the provision of all the other ecosystem services. They include the provision of the fundamental components of our environment, such as clean air, water, soil and geodiversity (the variety of rocks, minerals, fossils, landforms, sediments and soils, together with the natural processes which form and alter them). Any changes to the availability of these supporting services will impact on the provision of other ecosystem services.

Supporting ecosystem services, the pressures that they are under and the consequences of any changes in their provision are covered elsewhere:

- air quality;
- clean and sufficient water;
- soils;
- rocks and landforms;
- biodiversity.

Cultural services

Cultural services are those that give rise to spiritual enjoyment, increased knowledge, quality of life and happiness. Some of these benefits are not associated with direct use of the environment and they can be delivered without people actually having direct experience of the environment. For example, many people value the existence of habitats and wildlife, such as the remote mountains of Scotland, Scottish wildcats or capercaillie, even though they may never actually see them. Some of these benefits are very difficult to value in monetary terms as markets do not generally exist for them and, even where values are available, they can underestimate the total value of these services. However, just because they are difficult to value, these ecosystem services should not be neglected in decision-making as they are extremely important.

Many cultural ecosystem services are described elsewhere:

- wildlife;
- health and well-being;
- recreation and amenity;
- cities, towns and greenspaces;
- historic environment;
- landscape.

Pressures affecting benefits from nature

Everything that causes changes to the state and condition of the environment impacts on the provision of ecosystem services. Comparing the impacts that different environmental changes have on ecosystem service provision can help us to prioritise action to protect and improve the state of our environment.

Consequences of a change in benefits from nature

Changes in ecosystem service provision will impact on:

- human well-being as a consequence of their potential impacts on the economy;
- the ability of the environment to regulate and control other impacts;
- the ability of the environment to provide other ecosystem services;
- the ability of the environment to provide direct, non-material benefits to people.

The combined impact of several individual environmental impacts can, over time, have serious consequences for the provision of ecosystem services to people.

Response by society

To ensure that ecosystem services continue to be provided, we must take the delivery of ecosystem services into account in all decision-making. Responses should include:

- multi-benefit responses that work across a wide range of ecosystem services (e.g. waste reduction measures);
- sustainable solutions that weigh-up the positive and negative impacts on ecosystem services to make decisions and prioritise what work should be carried out.

For these types of responses and solutions to be developed, we need to improve our understanding of the full range of ecosystem services that are associated with the Scottish environment. Alongside this, we also need to develop approaches that allow us to assign values (possibly monetary values) to these ecosystem services so that different options can be compared and their positive and negative impacts on ecosystem service delivery identified.

Finally, making sustainable decisions means that we need to understand the consequences of changes in the stocks of natural resources on the provision of ecosystem services. Currently, our understanding of ecosystem services provision is developing but further work is necessary to improve our understanding of the ability of natural resources (e.g. soil stocks) to deliver these services (e.g. climate regulation) if their levels decline. There is a chance that, if levels of natural resources fall beyond certain levels, it may be impossible to sustain the provision of ecosystem services, or recover stocks of natural resources. Work in this area requires cross-disciplinary thinking by natural scientists, social scientists, economists and risk- analysts.