

Biodiversity, ecosystem services and sustaining food production

Introduction

Recent rapid declines in biodiversity at a global scale have stimulated significant efforts to conserve and protect the natural environment. The focus of conservation efforts has shifted in recent years towards the protection not only of species and habitats, but also the services that our ecosystems provide. This shift has led to substantial interest in the processes that underpin ecosystem service delivery, including through the interaction of biodiversity – the diversity of genes, species and habitats in our natural environment – with the biophysical environment.

Understanding this relationship is extremely challenging, not least because of the huge range of services that we derive from nature, and the many different ways in which the components of natural systems can interact to deliver these services. One way of addressing this complexity is to break down the question into smaller components. Although we can recognise the inter-connected nature of the natural environment, it is reasonable to conclude that some ecosystem services are more relevant than others to particular sectors of society, business and government.

A recent [review](#) has considered the role of biodiversity and biophysical processes in delivery of ecosystem services in Scotland. In particular, the review focusses on “priority ecosystem services” that are considered particularly relevant to four broad policy goals: 1. A low carbon economy; 2. Sustaining food production; 3. Halting biodiversity loss; and 4. Sustainable water management. Here we summarise key information from this review that relates to the broad policy goal of **sustaining food production**.

Key Concepts and Terms

Biodiversity - ‘Biological diversity’ means 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. - Article 2 of the Convention on Biological Diversity

Biophysical processes - potential environmental regulators of ecosystem service delivery other than biodiversity, for example non-organismal soil processes.

Ecosystem services - an “activity or function of an ecosystem that provides benefit (or occasionally disbenefit) to humans” (Mace *et al.* 2012). Final ecosystem services directly underpin or give rise to a ‘good’. In general, **ecosystem functions** are considered to be the processes driven by organisms that support the delivery of services.

Key Points

The review considered the following ecosystem services to be particularly important for the broad policy goal of sustaining food production: crops, livestock, soil formation, and pollination.

- Production of **crops** in Scotland is highly mechanised, with considerable inputs and high intervention. Consequently, although biophysical conditions are a major determinant of

productivity, non-crop biodiversity currently has a limited underpinning role. However, many studies find positive relationships between crop and non-crop biodiversity and relevant ecosystem functions such as crop productivity or pest and disease regulation. These might have increasing relevance in crop production as the availability of chemicals for pest and disease control is restricted. Declining biodiversity could have consequences for ecosystem functions central to crop production, and ultimately for its productivity and sustainability.

- **Livestock** production is the dominant agricultural sector in Scotland, and is particularly important in upland regions. There is a considerable literature on how livestock production affects biodiversity and biophysical processes (both positively and negatively), but rather little information on its underpinning by biodiversity. However, biophysical drivers and processes (e.g. climate, soil and water conditions) clearly can impact livestock directly by influencing grazing quality, and indirectly through regulating disease and pests.
- There is a clear link between **Pollination** services and biodiversity: a reduction in the abundance and diversity of insect pollinators is likely to have a deleterious effect on this ecosystem service. However, a relatively small proportion of current Scottish crop production is dependent on pollination (about 13% of total output value). In addition, since wind-pollinated grasses are the main source of fodder, there is likely to be limited impact of pollinator losses on the production of meat and dairy products or on grain production.
- **Soil formation** is vital for food production. The links between soil formation, biodiversity and biophysical processes are complex. Research on the role of soil biodiversity in ecosystem function has lagged behind corresponding research above-ground, but functional trait approaches (which consider the roles of different organisms) may be useful in addressing research gaps. Soil biodiversity in many areas is clearly in decline and current intensive farming practice frequently impacts negatively on soil biota and soil formation.
- **Overall** it appears that the functional diversity of organisms may be central to sustaining food production in the future. Natural processes, and biodiversity at a range of scales, e.g. between and within plant and animal species, can help to deliver services directly relevant to food production, and can contribute to increased sustainability of agricultural production systems. However, it is clear that we need a better understanding of how to achieve both biodiversity conservation and food production, and to balance the negative (e.g. resource competition, pests and diseases) and positive effects of biodiversity on ecosystem service delivery.

Research Undertaken

The review from which this information is derived has been undertaken as part of the Ecosystem Services Theme of the Scottish Government Strategic Research Programme: Environmental Change. Its aim is to help deliver the request from Scottish Government for:

Increased understanding of the linkages between the primary ecological and evolutionary processes, ecosystem function and ecosystem services, to inform assessment of the consequences of environmental change for the wide range of ecosystem services. (RD 1.1.2).

The approach and terminology adopted throughout the review follows that used in the [UK National Ecosystem Assessment](#). The overall scope, approach and conclusions of the review are described in the [main report](#) and accompanying [Executive Summary](#).

Policy Implications

Food production – particularly intensive food production – can have negative impacts on many components of biodiversity. In many cases, increasing the biodiversity of farming systems can help to promote food production. However, it is unclear whether any declines in productivity needed to

promote biodiversity in farming systems will be off-set by the positive effects on crop yield that result from enhancing natural ecosystem processes. This is a major gap in our understanding and has to be addressed if drives for sustainable intensification – maintaining or increasing yields whilst reducing negative environmental impacts - are to succeed.

Because of our ability to replace natural processes with artificial ones, for example by fertilising crops rather than depending on natural soil processes for nutrient supply or applying chemicals to control pests and disease, it is possible that the flow of ‘goods’ such as food is maintained whilst the ‘health’ of farming ecosystems continues to decline. This means that the amount of food produced is not a good indicator of ecosystem health, particularly in intensively managed farming systems. Continued declines in ecosystem health may have serious consequences for sustaining food production in the long term. A threshold may be reached where the negative impacts of farming on natural processes can no longer be offset by human inputs. Alternatively increased commodity prices might necessitate greater dependency on natural ecosystem functions and biodiversity. Given these possibilities, promoting the maintenance in farming systems of biodiversity and food production seems sensible.

Authors

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Topics

Biodiversity; Ecosystem services; Food production

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Scottish Government Strategic Research Programme: Environmental Change

<http://www.scotland.gov.uk/Topics/Research/About/EBAR/StrategicResearch/future-research-strategy/Themes>

UK National Ecosystem Assessment

<http://uknea.unep-wcmc.org/Home/tabid/38/Default.aspx>