

Chapter 27:

Response Options

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Key Findings

There are three **tiers** of response options for sustainably managing ecosystems and their services:

- 1. Foundational:** the generation and distribution of knowledge and information.
- 2. Enabling:** legislation; policies, institutions and governance; changing social attitudes.
- 3. Instrumental:** markets and incentives; technologies and practices; voluntary actions.

Knowledge (Foundational). The evidence base supporting ecosystems and their services continues to grow, as demonstrated by the richness of the UK National Ecosystem Assessment, and the large underlying literature base. However, there is a need to better understand linkages between biodiversity, ecosystem structure, functions and services. There is also an important need to develop monitoring and reporting frameworks that are better aligned with the ecosystem approach.

Legislation (Enabling). The role of the global and EU context, within which the UK has to frame policy responses, is important and often provides a strong push towards a more integrated and collaborative approach. In the context of environmental policy, external obligations should not necessarily be seen as a constraint, and often enable the adoption of more effective responses, while allowing scope for variation in national models of implementation. Many recent improvements in flows of ecosystem services have been due to effective legislative drivers.

Examples of important legislation include the Habitats Directive and the Birds Directive aimed specifically at the protection and conservation of wild animals, plants and habitats. Legislation from a wide range of sectors can positively impact on biodiversity, e.g. the Natural Environment and Rural Communities (NERC) Act 2006, and the Marine Strategy Framework Directive (MSFD) 2008. Pillar 2 of the Common Agricultural Policy (CAP) has provided an important source of funding for land managers to better align farming practices with the delivery of biodiversity through agri-environment schemes.

Policies, Institutions and Governance (Enabling). The UK Biodiversity Action Plan (UK BAP) led to the development of a framework of BAPs implemented by a broad array of stakeholders, with biodiversity targets expressed at the UK and country levels. The UK BAP contains 1,150 species and 65 habitats for which Species Action Plans and Habitat Action Plans have been published. As part of this national framework, more than 170 Local BAPs have been developed through local partnerships and community engagement for priority habitats and species.

Changing Social Attitudes (Enabling). The importance of the engagement of local communities and the general public in conservation is acknowledged in national biodiversity strategies and policies because public understanding and opinion of the value of biodiversity have strong implications for the acceptance and adoption of measures. While there has been a positive change in environmental attitudes, at present, the terms and concepts of biodiversity, ecosystems, and their services are not meaningful for the vast majority of people. Culturally, the concepts which have most meaning are those of nature, place and landscape.

Markets and Incentives (Instrumental). While incentives (e.g. CAP pillar 1) have long been used as an instrument to increase agricultural production, often degrading natural habitats and resulting in the loss of non-provisioning ecosystem services, recent incentive schemes (e.g. CAP pillar 2) have successfully contributed to the conservation of biodiversity. Agri-environmental schemes, especially the Higher Level Stewardship schemes, have generally led to the maintenance and restoration of existing habitats, with associated biodiversity benefits. Reform of the CAP could further safeguard biodiversity and promote multifunctional land use by rewarding, for example, the provision of carbon stores, promoting integrated pest management, and responding to new disease threats linked to climate change. Other market-based schemes that have proved effective include certification schemes such as the UK Woodland Assurance Standard.

Technologies and Practices (Instrumental). Agricultural production has been greatly increased by the application of technology for breeding, cultivation, management and protection from pests and diseases. The wider negative effects of fertilisers, pesticides and livestock manures have been reduced due to improved storage, new chemicals and more efficient applications. Nevertheless, habitats that are highly productive in terms of food are, inevitably, uniform and species-poor. In some areas, biodiversity is being supported by allocating non-productive areas for its conservation using biodiversity offsetting mechanisms such as agri-environment schemes. This support is occurring on a range of levels from single fields (promoting pollination and biological pest control), to whole catchments (promoting landscape and water quality), and even to higher scales (such as wilderness areas) and has the potential for enhancing biodiversity in the wider countryside. For example, the practice of set-aside (i.e. taking land out of agricultural production) was found to have a wide range of environmental benefits, despite not being explicitly designed for this purpose.

In the Marine environment, seabed trawling technologies have significantly damaged biodiversity. However, new, more environmentally friendly technologies and practices are now being developed, e.g. fishing technology to minimise harm to non-target species and juveniles.

Voluntary Actions, Education and Awareness (Instrumental). Education, at all ages, is essential for increasing public knowledge and understanding of the importance of conserving biodiversity. Statutory requirements stipulate that the science curriculum must include sustainable development, life processes and living things. Awareness creation leads to voluntary and civil society action, which plays an important role in the conservation of biodiversity. A prominent important example of voluntary action is the Campaign for the Farmed Environment.

Evidence shows that managing ecosystems and their services sustainably (economically, environmentally and socially) will be facilitated by employing an appropriate mix of approaches including legislation and regulations supporting attitudinal changes, underpinning markets and incentives, technological innovation, and voluntary compliance. The evidence shows that local initiatives have been invaluable for a range of local conservation activities and improving the delivery of some ecosystem services, but no national, regional or global environmental issue (e.g. air and water quality) has ever been successfully addressed without an appropriate enabling framework using a mix of regulations, technology, financial incentives and behavioural changes.

Evidence also shows that managing ecosystems and their services sustainably will be facilitated through the use of integrated approaches, recognising the scope for a wide range of actors to participate and collaborate, acknowledging the importance of spatial and temporal scales in formulating appropriate response mechanisms, and using flexible adaptive management frameworks.

Broadly, trends suggest that responses are becoming more integrated and reflective of ecosystem thinking, which suggests that the overall direction of change is positive. Moreover, in an international context, EU and UK approaches to ecosystem management reflect more integrated and collaborative modes of intervention. However, considerable challenges remain and should not be underestimated.

Evidence from the regional assessments (England, Northern Ireland, Scotland and Wales) demonstrates some divergence in approaches, which provides useful benchmarks for a comparison of policy options. In many ways, the UK context provides a 'controlled experiment' environment in which policies are differently implemented across the Devolved Administrations, and there is considerable scope for innovation at country level and shared learning from these divergent approaches.

Integrated Approaches. In order to reflect ecosystem thinking in the consideration of policy responses, the evidence suggests that decision-makers need integrated approaches that cut across narrow sectoral boundaries and recognise that the impact of actions in one sector has implications for other sectors and their associated ecosystem services (as well as human well-being). Promoting multifunctionality requires the identification of win-win opportunities which conserve and enhance multiple services (such as through strategies like managed realignment), while also recognising the importance of potential trade-offs between services. Responses that are initiated within a single sector often impact on other sectors and services—a key aspect of ecosystem service-based thinking. For example, agri-environment schemes provide markets and incentives shaped by EU law, albeit with variations in implementation in each region of the UK. The goal is to secure non-production ecosystem services from the farmed landscape to supplement income farmers make from provisioning services, e.g. crop, livestock and dairy production. Agri-environment schemes have been shown to have the following effects on ecosystem services:

- There is growing evidence that there have been considerable biodiversity improvements.
- There is potential to deliver other services, e.g. the prevention of soil erosion, better water quality and improvements to quantity and recharge flood control, and recreation.
- Evidence suggests that working across spatial scales is required to gain full potential, i.e. joint participation schemes for farmers to deliver ecosystem services from spatially connected farms which cannot be accomplished by individual farms.

Actors. There is considerable evidence that in each sector action has been undertaken by actors at every level, suggesting that there is scope for a wide range of actors to participate in the management of ecosystems. Different actors may be differently placed to undertake particular types of responses, but it is important to recognise that responses are not the exclusive domain of official/government actors, and that effective responses have been led by a range of private, non-governmental and community actors. An appropriate policy mix may require a combination of different types of responses (drawing upon the typology of responses that are considered, i.e. foundational, enabling and instrumental, with different actors playing different roles in each of the three tiers). Governments are primarily involved in foundational and enabling activities; the scientific community in foundational activities; the private sector primarily in foundational and instrumental activities, but also in enabling activities, especially in shaping social attitudes; and individuals and communities are mostly

involved in enabling activities by changing social attitudes and values and instrumental activities by responding to incentives and undertaking voluntary activities.

Collaboration Between Actors. In order to be effective and to deliver lasting improvements in ecosystem services and human well-being, responses need to recognise the importance of collaboration between actors. While responses may be typically initiated by particular actors, they are rarely implemented in isolation, and usually require synergistic inputs from other actors to be successful. For example, the Water Framework Directive is an enabling piece of legislation which is implemented at local/regional scales, and necessitates collaboration between actors in order to develop River Basin Management Plans (RBMPs). While the lead stakeholders are competent government authorities in each river basin district (e.g. the Environment Agency, the Scottish Environment Protection Agency and the Northern Ireland Environment Agency), extensive consultations have taken place with stakeholders in the agricultural sector and water industry, and with planning authorities, businesses, environmental organisations, and anglers, boaters and other water users in the development of RBMPs. This engagement has established the foundation for continued collaboration between stakeholders in this context.

Temporal and Spatial Scale. Spatially, institutional mechanisms that link across scales provide opportunities for stakeholder engagement and greater collaboration between actors, and for the involvement of local groups and non-governmental organisations. Strategic spatial planning of habitats (terrestrial, freshwater and marine) is important for ecosystem service delivery, and this is happening in some cases, but needs to be better reflected in future responses. Temporally, recognising potential trade-offs between short-term goals and medium/long-term targets may require the adoption of longer planning horizons.

One example of thinking across spatial scales is marine planning. The Marine and Coastal Access Act is an enabling piece of legislation, which is under implementation in each region. The goal is an overarching framework for marine spatial planning, recognising linkages across scales. Key features include: consistency at the UK level across Devolved Administrations; recognition of competing demands taking an integrated ecosystems approach across scales; and engagement of all stakeholders/actors. Relevant evidence for the effectiveness of such an approach is the enactment of the Belgium Marine Protection Act in 1999, which established a master plan for Belgium's North Sea marine area, making it one of the first countries to develop an operational, multi-use marine spatial planning system with effective engagement of relevant stakeholders.

An example of thinking across temporal scales is Forest Schools, which seek to influence long-term social attitudes (enabling) through education in woodland. The goal is to use woodlands as a learning tool and site for education; there are about 140 Forest Schools in the UK. Evidence shows that outdoor learning environments enhance physical health and mental well-being of participants. There are also positive long-term impacts on the attitudes of participants towards nature and forested landscapes, resulting in greater local involvement in forest stewardship.

Flexible, Adaptive Management Frameworks. Planning responses in the face of uncertainty (such as in the context of climate change) requires the adoption of more flexible, adaptive management frameworks that are implemented within reflexive learning environments and which recognise that mistakes often help to construct more effective future responses. Knowledge frameworks need to support this adaptive approach, and lay and local knowledge needs to be adequately recognised as part of this broader learning environment, especially to get greater involvement of a wide range of stakeholders in response strategies.

27.1 Introduction

The UK National Ecosystem Assessment (UK NEA) has assessed a range of ecosystem types and associated flows of services, and has considered their contributions to human well-being. This chapter considers response options undertaken by a wide range of stakeholders which impact on these habitats, their ecosystem services and ultimately on health and human well-being. The chapter adapts a framework for assessing response options developed for the Millennium Ecosystem Assessment's Manual for Practitioners (Simpson & Vira 2010), and applies it to the UK experience. These responses are considered in the devolved UK context, and the chapter pays particular attention to the regionally diverse experiences within the different countries. The material is presented in a sectorally specific manner, in order to be accessible to readers who are likely to occupy roles in particular areas of ecosystem management. However, the overall message of the chapter is that sectorally focused approaches to responses are unlikely to be effective, given the connectedness of ecosystems and their functions, and the interdependence of different stakeholders. Responses that are initiated in one sector often have impacts in other sectors, and an integrated approach is a key element of ecosystem-based thinking for the delivery of multifunctional habitats. This chapter also emphasises the need for stakeholder collaboration since responses that are initiated by particular actors usually require engagement with others for successful implementation. Furthermore, the chapter highlights the necessity to recognise the need to adopt an appropriate mix of complementary responses, with knowledge, legislation and regulations supporting attitudinal changes, underpinning markets and incentives, driving technological innovation, and creating space for voluntary compliance.

This chapter is limited both by the availability of time for the actual assessment process, and by space, so inevitably falls short of a comprehensive survey of all response options that have been considered in the UK context. The examples that are used in the discussion of sectoral responses are illustrative of a much more complex reality, but have been chosen because of their relative importance and potential for further use. The chapter authors have consulted widely to aid this selection process, and have benefited greatly from the process of peer review and stakeholder engagement, which has widened the range of examples that have been considered, and has also added considerable nuance to their interpretation of the material that is under review.

This chapter needs to be seen as a contribution to the policy debate, being policy relevant, but not policy prescriptive (Ash *et al.* 2010). It does not provide any specific recommendations for policy, but reviews a range of responses and considers the evidence for their impacts. In this sense, the chapter documents a number of responses that have been undertaken in the UK context, by actors at different levels and cutting across a range of sectors, but does not provide prescriptive guidance for decision-makers. The choice among policies cannot be separated from the political context in which alternatives are considered, and

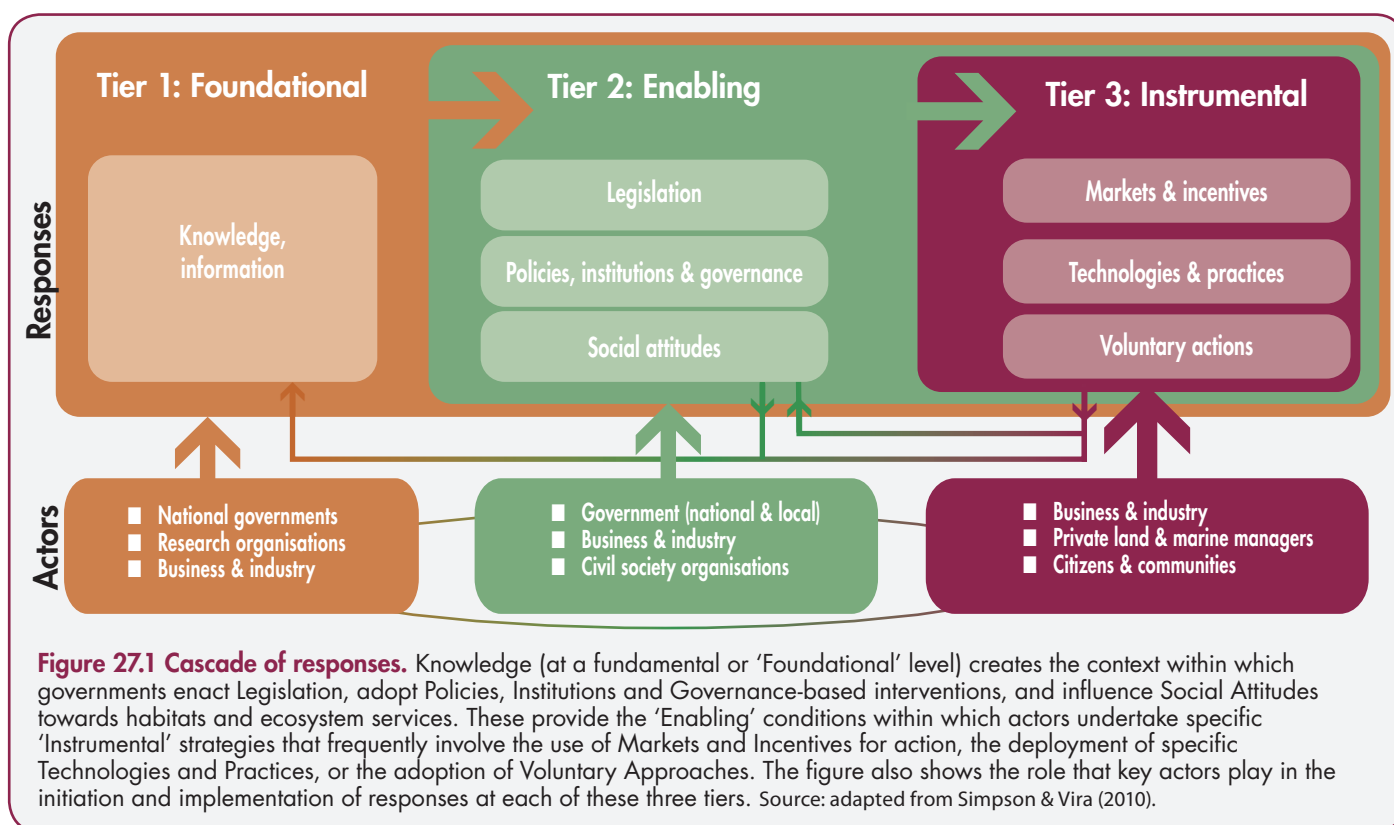
the objectives that are important for the decision-maker. These political choices will determine the intended outcome of any particular intervention, and the metric against which the relative success of a chosen measure is assessed. This chapter helps this process of policy choice by reviewing the evidence for the impacts of different responses, specifically focused on the UK context.

27.1.1 Typology of Response Options and Key Actors

This assessment adapts the typology of response options described in the Millennium Ecosystem Assessment's Manual for Practitioners (Simpson & Vira 2010). **Figure 27.1** presents a cascade, in which knowledge (at a fundamental, or 'foundational' level) creates the context within which governments enact legislation, adopt policies, institutions and governance-based interventions, and influence social attitudes towards habitats and ecosystem services. These provide the 'enabling' conditions within which actors undertake specific 'instrumental' strategies that frequently involve the use of markets and incentives for action, the deployment of specific technologies and practices, or the adoption of voluntary approaches.

Knowledge and information (in Tier 1 of the typology) are fundamental to any response as they provide the context within which a decision-maker recognises the need for intervention. This includes the emergence of new information about the impacts of production systems on natural ecosystems and their potential consequences for human well-being, as well as the monitoring of longer-term trends in habitat change and ecosystem functions and the likely risks that these might pose. An adequate knowledge base for action is a prerequisite for any intervention as it would be impossible to structure meaningful strategies without information about basic ecological and social relationships. Within the context of the UK NEA, the assessment of the status and trends of the UK's ecosystems and the services that they provide, the key drivers that are affecting ecosystem change, and the impacts of these on human well-being all constitute the knowledge base which shapes our consideration of potential responses. Importantly, this emerges from multiple sources; while research within conventional knowledge-producing sectors (such as universities and research organisations) is clearly very influential, there is an increasing role for other sources of information, especially from business and industry, but also from the 'lay' perceptions and experiences of citizens, which often form an important source of disaggregated data that can be effectively harnessed for monitoring purposes.

Tier 2 in the typology of responses provides an important link between the recognition of a problem and the adoption of specific instrumental strategies in response to that problem. This is characterised as a set of enabling mechanisms which provide the basis for particular approaches. Most importantly, perhaps, is the legislative and legal framework within which governments apply explicit policies, create particular institutional mechanisms and adopt specific strategies for governance. These are clearly influenced by a wider set of stakeholders, including businesses and industry, and the concerns of citizens and civil society organisations.



Apart from the official adoption of these specific aspects of policy, it is also important to recognise the role of social attitudes, which shape the wider societal context within which responses are enacted. Attitudes to nature, the environment and to different components of human well-being are fundamental to the ways in which societies react to ecosystem change, and influence the range of interventions that can be implemented. These attitudes vary over time and space and are subject to a range of influences, including the crucial role of education as well as the persuasive power of advertisers and businesses, which shape social aspirations and attitudes to consumption.

Tier 3 in the typology describes specific actions that attempt to achieve particular outcomes; these include the use of markets and incentives to shape individual choices; the adoption of particular technological choices and everyday practices; and voluntary acts. While the enabling structures shape the opportunities and constraints that confront individual actors, much of the activity at this instrumental level is undertaken by businesses and industry, individual land and marine managers, and by citizens and communities. The role of governments at this level is to provide the conditions within which certain activities are rewarded and others are restricted, and to guide the actions of stakeholders towards improving the condition of ecosystems and enhancing the services that they provide.

Figure 27.1 shows the typology of response options, as well as the key stakeholders who exert a significant influence at each tier of the typology. While the role of governments at national and local levels is clearly important, the framework emphasises the need to recognise a wider range of stakeholders who shape responses including businesses and industry, private land and marine managers, civil society organisations (including non-governmental

organisations: NGOs), research organisations, and citizens and communities. Each of these actors has a particular domain within which they are able to exert an influence, but effective responses inevitably require interaction between the three tiers, and collaboration across actors. **Figure 27.1** also illustrates the importance of feedbacks between the three tiers. For example, the emergence of new technologies can lead to the generation of new information, as well as potentially requiring the reform of legislation and regulatory institutions and changes in social attitudes. Each tier of the typology influences, and is influenced by, the other tiers, and effective responses typically involve a combination of approaches across these different tiers.

27.1.2 Policy Context: European/ International Obligations

In order to understand the context within which UK decision-making on the environment takes place, it is important to recognise the impact of the country's wider global obligations and its membership of the European Union (EU). The UK is a party to many international conventions dealing with a huge number of environmental issues such as the United Nations Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity (CBD), the Ramsar Convention (wetlands conservation), the Espoo Convention on Environmental Impact Assessment in a Transboundary Context, and the Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention). Some, like UNFCCC, are more or less global in coverage, while others, like OSPAR, are regional, only applying to a certain area or set of countries. Some of these conventions, including UNFCCC, contain legally binding obligations; most do not, however, consisting of political pledges and aspirational targets instead. As a general rule,

standards contained in international conventions require some kind of implementation in national law to have effect. International conventions tend to lack enforcement mechanisms or sanctions for breach, although there may be monitoring and reporting obligations which can exert pressure to comply with commitments.

The key EU legislative instruments are Regulations (which are legally binding in their entirety and directly applicable in national law) and Directives (which are legally binding as to the result to be achieved, but leave the choice of form and method for implementation to the Member State). Regulations impose entirely uniform standards and rules and are relatively rare in the environmental sphere. The usual form for EU environmental law is a Directive, which must be transposed (by a set deadline) into national law via primary or secondary legislation at the national level. There will be a varying degree of discretion left to the national governments as to the precise detail of implementation. International conventions to which the EU is a signatory also become EU law and are directly applicable in all of the Member States (under Article 216 of the Treaty on the Functioning of the EU: TFEU).

The EU and Member States have shared competence in environmental matters (under Article 4 of the TFEU), which means (under Article 2) that both may adopt legally binding acts in that area, the national governments acting to the extent that the EU does not. There are also shared competencies in other sectors, such as agriculture, energy and transport, which have significant environmental impacts. Fisheries management is a shared competence, but measures relating to the conservation of marine biological diversity belong to the exclusive competence of the EU. A key principle of EU law governing to what extent the EU will legislate in these areas is subsidiarity—meaning that the EU should only act if the objectives of the proposed action cannot be sufficiently achieved by the Member States acting alone. Due to the transboundary nature of many environmental issues (for example, water quality, climate change, migratory threatened species and marine pollution) this will often be the case.

Article 191 of the TFEU sets out some important principles for EU environmental law: that it shall aim at a high level of environmental protection, and apply the precautionary and polluter pays principles. Article 193 of the TFEU expressly preserves the right of Member States to maintain or introduce in their national law environmental protection measures that are more stringent than those introduced by the EU. The European Commission (EC) and, ultimately, the European Court of Justice are responsible for making sure that EU environmental law is transposed and implemented properly, but, in practice, enforcement is frequently lacking.

27.1.3 Policy Context: UK and Devolved Administrations

In the UK, legislation can be passed by the UK Parliament in Westminster for the whole of the country. Following devolution in 1998, powers were granted to the devolved Parliament in Scotland and Assemblies in Wales and Northern Ireland. The Westminster Parliament continues

to legislate for England on issues that have been devolved to other Parliaments, and can still legislate for the UK, although by convention, this is only done by agreement. The legislation establishing devolution sets out which powers are transferred to the devolved governments, and which powers are reserved by Parliament in Westminster. Environmental matters are not, broadly speaking, reserved, so the devolved governments have power to legislate in this area, including for the transposition of EU Directives. The main regulators responsible for the application and enforcement of environmental law in the UK and each of the devolved jurisdictions are the Environment Agency, the Scottish Environment Protection Agency and the Northern Ireland Environment Agency. There are also a large number of other public bodies with specific responsibilities for implementation, enforcement, administrative and scientific research, and advisory roles, some of the key examples being Natural England, Scottish Natural Heritage, the Forestry Commission, National Parks authorities and the Rural Payments Agency.

Devolution has the potential to be an important influence on UK environmental law and some divergences of approach in environmental sectors have emerged (although, because a large proportion of environmental law is derived from the EU, the divergence may not be as great as could otherwise be expected). Waste management is a good example of an environmental sector where key differences exist under devolved mechanisms. Scotland has put in place more ambitious targets for waste management than are required under EU legislation or by Westminster, in the form of a 70% waste recycling target. Scotland's laws on countryside access also differ from those in England, with diverging rules on the evidence of habitual use leading to different public right of way designations in these two jurisdictions. Northern Ireland has differences in its waste and contaminated land regime, and Wales differs from England in certain rules implementing EU legislation like the Nitrates Directive (discussed in Section 27.3.3.2), and also in respect of its countryside access rules.

There are differing views on whether divergence of laws has a positive or negative effect as far as environmental protection is concerned—on the one hand it may lead to regulatory competition, encouraging an ambitious policy environment and establishment of best practice, on the other it may create inefficiencies, inequalities and perverse outcomes. Whether it works to promote or frustrate environmental protection will vary from case to case, as explored in some of the more detailed sectoral analyses in this document.

27.1.4 Sectoral Approaches and the Need for Integration

The majority of the assessment of response options that is presented in this chapter has been undertaken by sector. We have assessed response options available to the full range of actors within each sector by response type across the three tiers: foundational, enabling and instrumental. We have reviewed evidence for the impacts of these responses on habitats, their ecosystem services, and human health and well-being. Rather than undertaking specific assessments of

each country, examples and case studies have been drawn from England, Scotland, Northern Ireland and Wales to illustrate response options and highlight success stories. The specific sectors that are addressed in subsequent sections of this chapter are: a) biodiversity; b) water; c) agriculture; d) forestry; e) fisheries; f) marine and coasts; g) recreation and tourism; and h) urban planning, transport and energy.

This sectoral approach is a somewhat artificial division of the material into sections that are likely to be accessible to our readers based on familiar areas within which policy responses can be conventionally subdivided. However, there is considerable overlap in our discussion, partly because specific responses, even if they are initiated within particular sectors, often have impacts on other sectors. The chapter provides cross-references within each section to identify these influences. More importantly, however, the chapter emphasises the need to adopt approaches that go beyond sectoral divides and are able to adopt a more holistic and integrated approach to habitats and ecosystem management. Thus, readers would be advised to read the sectoral material as a guide to some of the key responses that are most relevant within that particular context, but also be cognisant of the cross-cutting nature of much of the material that we have reviewed, and to read the chapter in its entirety to get a holistic overview of the range of responses that have been assessed.

Ecosystems are non-discrete units where assemblages of living organisms interact with each other and with the chemical and physical environment. Researchers have defined ecosystems at multiple scales, from biota in soil to large global systems like the oceans. The recognition of these interactions is fundamental for understanding how to holistically manage the natural environment. Ignoring this knowledge in the design of responses can lead to unintended consequences. The ecosystem approach, as defined by the CBD, is “a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way”. It embodies knowledge of how complex, dynamic, interacting ecological and physical systems operate at different scales, and the ecosystem services provided to humanity. The approach also highlights that environmental limits must be adhered to if the land and sea are to continue to provide a wide range of ecosystem services in the future.

Internationally, the ecosystem approach has gained currency as a powerful framework for the assessment, planning and management of the natural environment and resources. It underpins the CBD, and at the World Summit on Sustainable Development (WSSD 2002) states were encouraged to apply the ecosystem approach by 2010. Since the publication of the Millennium Ecosystem Assessment (MA) in 2005 policy interest has risen further. As this chapter demonstrates, marine, coastal and water policy is currently being reconfigured in the UK in line with the broad principles of the ecosystems approach, and is adopting a more holistic and integrated perspective on response options. While these movements are important, there remain many challenges to embedding the ecosystem approach more widely in policy outside of the traditional domain of the ‘environment’ and especially into the decision-making processes of other

government departments that influence pressures on ecosystems.

The Department for Environment, Food and Rural Affairs (Defra) and others are increasingly interested in how the ecosystems approach can be embedded into multifunctional land use and management to secure rich and diverse landscapes delivering multiple ecosystem services (LUC 2008). In December 2007, Defra published *Securing a Healthy Natural Environment: an Action Plan for Embedding an Ecosystem Approach*. This action plan sets out a number of actions that Defra and its partners can follow to apply the ecosystem approach in managing the natural environment. The action plan’s core principles are:

- A more **holistic approach to policy making** and delivery, with the focus on maintaining healthy ecosystems and ecosystem services.
- Reflecting the **value of ecosystem services in decision-making**.
- Respecting **environmental limits** in the context of sustainable development.
- Taking decisions at the **appropriate spatial scale**, while recognising the cumulative impacts of decisions.
- Applying **adaptive management** of the natural environment to respond to changing pressures, including climate change.

The main aim of the plan was to shift policy making and delivery away from ‘silo’ thinking towards a more holistic approach, and to ensure the value of ecosystem services is reflected in decision-making in Defra and across government. An update of the action plan was published at the beginning of 2010 and reviewed progress since 2007. The updated action plan stressed the fundamental importance of stakeholder participation in decision-making for delivering an ecosystems approach, especially ensuring that the right stakeholders are engaged. Work on developing Defra’s Climate Change Plan (2011c) also emphasised the importance of taking a whole systems approach and the need for a policy framework that enables adaptive management, allowing actions to change in response to fluctuating pressures and new knowledge.

An ecosystems approach is now reflected in the plans and activities of Natural England, the Environment Agency and the Forestry Commission, and each organisation is exploring a variety of ways to embed this thinking into their work; for example, the Environment Agency are undertaking catchment management work with Defra, Natural England are running ecosystem service pilots, and the Forestry Commission has developed a Delivery Plan for England’s Trees, Woods and Forests. These organisations have increased cooperation with local authorities to find ways to support the delivery of environmental objectives.

Multifunctional land use has been placed at the heart of how to deliver improved ecosystems. Land use determines the social and economic functions of landscapes such as food and timber production, infrastructure and housing. The Scottish Government has, for the first time, set out a high level strategy for sustainable land use across the country. They aim to guide and support those involved in land use management decisions by providing a long-term vision and

objectives that will enable an integrated approach to land use in Scotland (Scottish Government 2010a).

Decisions about land use can be taken at various scales and by different sectors and actors. Many decisions taken on land use today are made within sectors such as agriculture, forestry and housing. While it is certainly important to account for the specifics of each sector in decisions, many of the big challenges going forward, such as climate change and optimising ecosystem service delivery, require a broader perspective on land use (Foresight 2010). In the UK, multipurpose land use is arguably one of the most important ways to maintain ecosystem services vital for the well-being and quality of life of UK citizens (LUC 2008). The Foresight Land Use Future report (Foresight 2010) called for a better understanding of how the various demands on land made by different sectors interact and the consequences of those interactions, and recommends “a broad and overarching perspective across sectors and different levels of governance”.

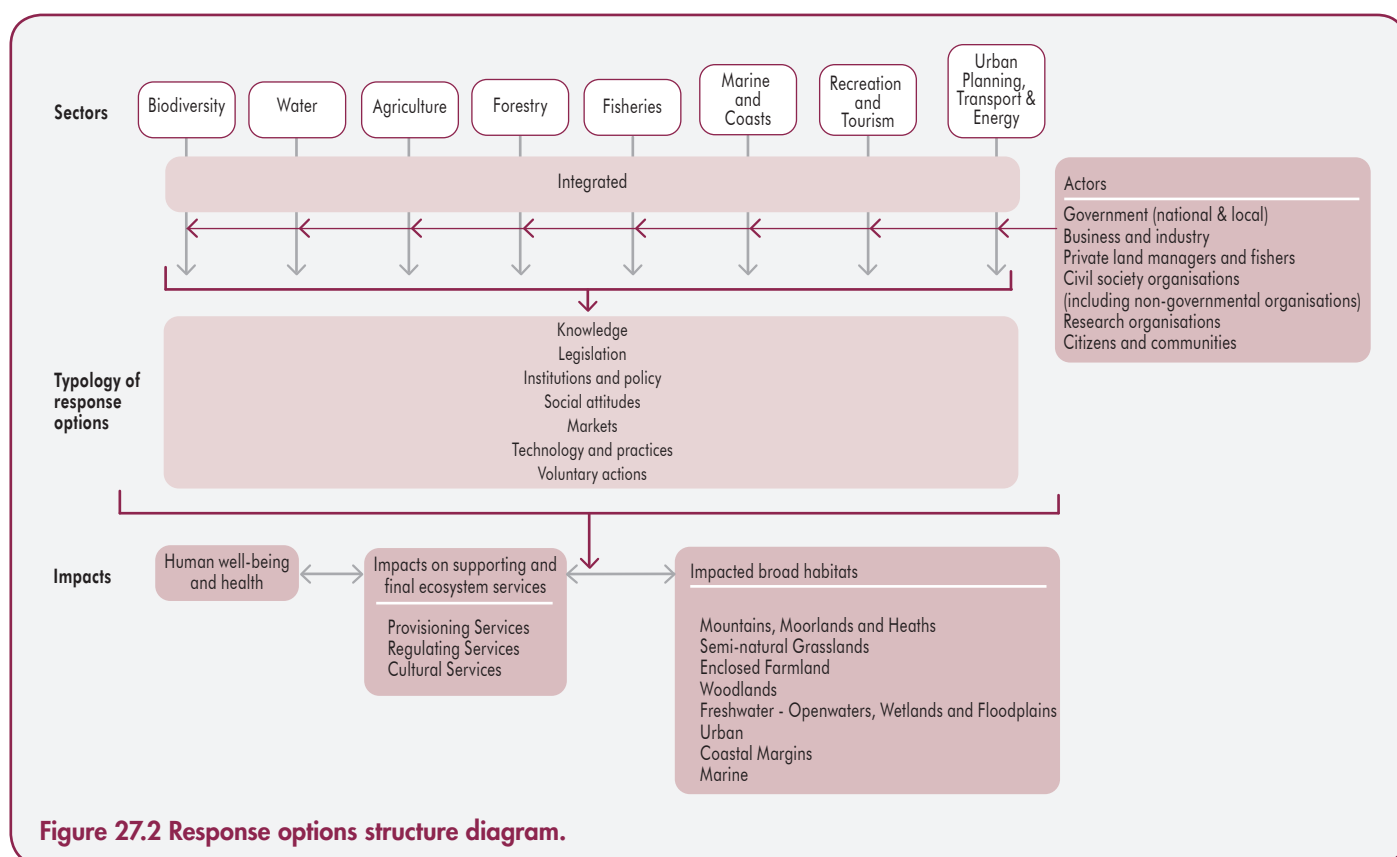
Embedding an integrated ecosystem approach into land use management will demand shifts in world views. It will require fundamental changes to established policy mechanisms as focusing on individual sectors and the segregation of land use have been entrenched for a long time (Lowe *et al.* 2009). However, the ecosystem approach offers unprecedented opportunities to rethink how the UK’s landscapes could look and function in the future. New, multifunctional landscapes could revitalise the distinctiveness of a place, and land use functions could be matched to a desired landscape character (LUC 2008). Section 27.10 provides more detail on the different areas within which an integrated approach to habitat and ecosystem management is being adopted in the UK. It also revisits the

sectoral evidence to demonstrate the substantial overlap in response options that cut across these boundaries.

Figure 27.2 provides a structural overview of the detailed content of this chapter, which is organised across eight sectoral sections. These sectoral sections are followed by a more synthetic discussion which reiterates the need for an integrated ecosystems approach, and examines potential synergies between interventions across different sectors.

Each sectoral section follows the typology of responses in **Figure 27.1** and discusses responses at each tier, as well as the roles of different stakeholders in adopting and implementing response options. The chapter finds that action has been undertaken by actors at every level, suggesting that there is scope for a wide range of actors to participate in the management of ecosystems. Different actors may be differently placed to undertake particular types of responses, but it is important to recognise that responses are not the exclusive domain of official/government actors, and that effective responses have been led by a range of private, non-governmental and community actors. Governments are primarily involved in foundational and enabling activities; the scientific community in foundational activities; the private sector primarily in foundational and instrumental activities, but also in enabling activities, especially in shaping social attitudes; and citizens and communities are mostly involved in enabling activities by changing social attitudes and values and instrumental activities by responding to incentives and undertaking voluntary activities.

The evidence reviewed in this chapter shows that managing ecosystems and their services sustainably (economically, environmentally and socially) requires an appropriate mix of approaches including regulations,



technology, financial incentives and behavioural changes. Evidence also shows that managing ecosystems and their services sustainably will be facilitated through the use of integrated approaches. Broadly, trends over the last 60 years suggest that responses are becoming more integrated and reflective of ecosystem thinking, which suggests that the overall direction of change is positive. Moreover, in an international context, EU and UK approaches to ecosystem management reflect more integrated and collaborative modes of intervention. However, considerable challenges remain and should not be underestimated.

27.2 Biodiversity

27.2.1 The Relationship Between Biodiversity, Ecosystem Services and Human Well-being

“The natural environment provides us with a range of benefits—ecosystems services...—and biodiversity underpins most, if not all, of them.” (Lawton *et al.* 2010, p.v)

Biodiversity is a unique case within the UK NEA in that it simultaneously defines and differentiates each habitat, underpins ecosystem services, and can even be seen as an ecosystem service in its own right (Chapter 4; **Box 27.1**). It will be tackled as a sector for the purposes of this chapter, with full acknowledgement of its truly cross-sectoral nature. The focus here will be to capture the range of response options that promote the conservation of biodiversity, allowing it to serve its many functions.

Chapter 4 suggests that there are two different challenges in considering response options in this context. Where there is relatively good understanding of the impacts of drivers on biodiversity (such as land-use change, pollution and

Box 27.1 Defining biodiversity.

For the purposes of the UK NEA, the Biodiversity Chapter (Chapter 4) defines ‘biodiversity’ as follows:

“The term biodiversity describes the diversity of life on Earth. Diversity can occur at a number of levels of biological organisation from genes, through individuals, populations, species and communities, to entire ecosystems.”

This is consistent with the definition adopted by the UN Convention on Biological Diversity. Use of the term ‘biological diversity’ became commonplace among members of the scientific community in the 1980s following publications such as *Conservation Biology* (Soulé & Wilcox 1980). The contraction ‘biodiversity’ was first published by Edward O. Wilson in 1988 (Novacek 2008).

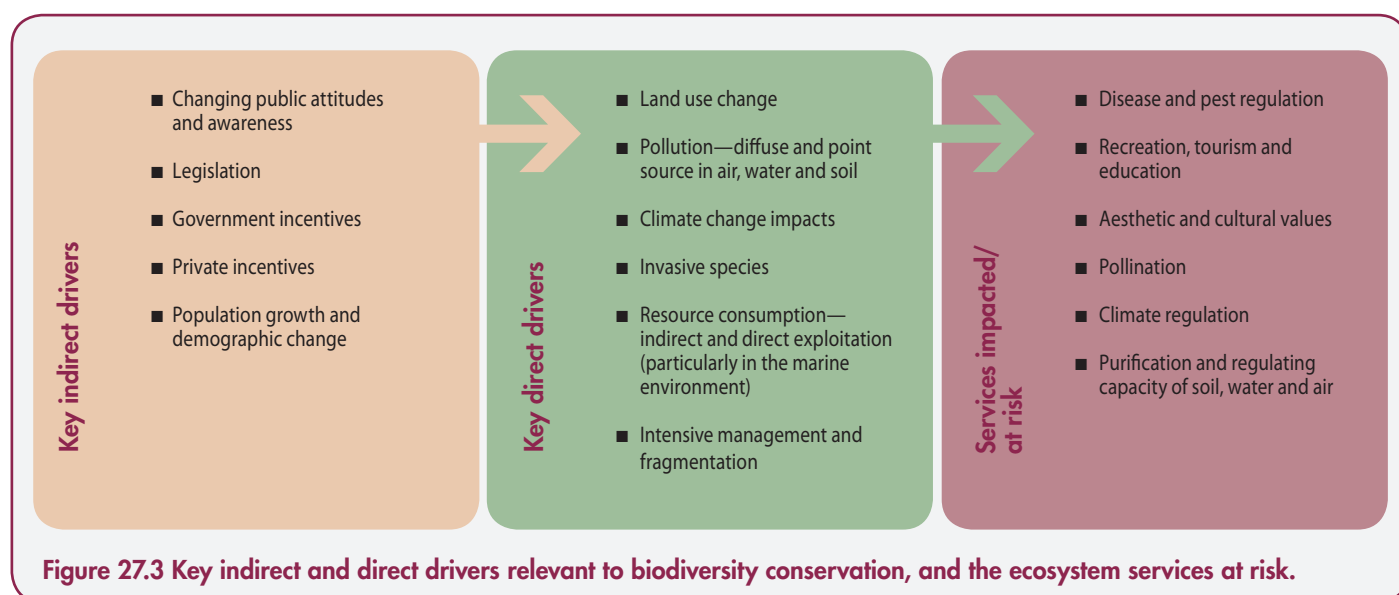
While there is reasonable scientific consensus around the meaning of the term, there is continued concern about the lack of public understanding and engagement with biodiversity as a concept, despite evidence that there is great affinity with nature in a more general sense (Defra 2002b; Christie *et al.* 2006).

exploitation), it is important to improve the effectiveness of policy and practice responses (e.g. land-use change). In the case of other drivers (such as climate change), we need better understanding of biodiversity impacts. Continued research into all drivers of biodiversity change will help to fill existing gaps and improve our overall understanding of this complex sector at different scales.

Most of the drivers impacting biodiversity are not uniform in their importance across biodiversity groups or habitats, although land use change and pollution are acknowledged to have a major general impact (Chapter 4). **Figure 27.3** summarises the key drivers and their impacts on ecosystem services. Many of these drivers interact with one another, and in some cases, such as land use change, are important both as an ultimate driver and as the proximate result of changes in other drivers (climate change, exploitation, etc.).

27.2.2 Challenges within the Biodiversity Sector

Previous chapters have described in depth the habitats and ecosystem services of the UK and biodiversity plays an



important role in all of them. Because of its importance, we face numerous challenges to increase our understanding of this cross-cutting issue while simultaneously striving to preserve the biodiversity which underpins ecosystem services, well-being and our future.

In 2001, the EU Heads of State and Government undertook to halt the decline of biodiversity by 2010 (Presidency Conclusions 2001). Under the CBD, the 6th Conference of Parties in 2002 adopted the strategic plan “to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on earth.” (CBD 2002). Despite these commitments, by 2008 it was recognised that it was unlikely that the 2010 target would be achieved, and dramatic loss of biodiversity still continues in the UK today (The Environmental Audit Committee 2009).

Most biodiversity value cannot be expressed in monetary terms (Chapter 22). Consequently, a major recurring challenge is the trade-off between provisioning services and impacts on biodiversity and other ecosystem services. There are countless examples, from all habitat types, which demonstrate that increased productive capacity, often the result of technological advances, can lead to decreased biodiversity. For example, wasteful discards from mixed fisheries as a result of unselective fishing gear and the quota system of the Common Fisheries Policy impact marine biodiversity (**Box 27.30**, Section 27.6.3.6). Mechanisms to support less intensive management may improve the situation in some cases, but may also lead to a change in the composition of habitats dependent on active management such as Semi-natural Grassland. The development of improved spatial planning mechanisms is needed to ensure that the adverse biodiversity impacts of land use change are targeted through management at appropriate scales (Section 4.6).

One important concern within the conservation community is that the ecosystem service approach may not maximise biodiversity. There is little evidence that directly correlates biodiverse areas with high ecosystem service delivery (Section 22.3.2). There is, however, evidence of significant decline in biodiversity in the UK as a result of the drivers described in **Figure 27.3**. It will be a challenge to maintain biodiversity within groups that appear to be more vulnerable to these drivers, such as amphibians, lichens, bryophytes and land plants (Chapter 4, Table 4.5). In particular, the impacts of climate change, offshore energy development and invasive species have the potential to increase in the future. These impacts will also cause and interact with land use change to drive changes in biodiversity. A decline in biodiversity affects the resilience and stability of ecosystems and the services they provide, feeding back to further compound many of the drivers.

27.2.3 Biodiversity-related Response Options

27.2.3.1 Knowledge (foundational)

The evidence base supporting the role and importance of biodiversity continues to grow in the UK through a number of programmes and initiatives. The Countryside Survey has provided scientifically reliable evidence about the UK

countryside since 1978, reporting in 1984, 1990, 1998 and, most recently, 2007 (Carey *et al.* 2008b). Results in the form of a Land Cover Map and field surveys are compared over this period to analyse change. One important application of the data is to determine status and trends in aspects of biodiversity, Broad Habitats and linear features such as hedgerows, walls and streams (Carey *et al.* 2008a). For instance, findings indicate that between 1998 and 2007: common plant species became more abundant; plant species richness in arable land increased by 30% (in GB); the lengths of managed hedges decreased by 6%; the area of broadleaved woodlands increased by 6.9%; competitive species have increased in heathlands and bog; and the condition of freshwater has continued to improve. A number of other monitoring programmes exist throughout the UK for particular groups of organisms (**Box 27.7**, Section 27.2.3.7).

In England, the State of the Natural Environment 2008 report provides a comprehensive account of the evidence on the state of, threats to, and actions taken to secure, the natural environment (Natural England 2008b). The Key Scottish Environment Statistics have been published annually since 2000 to provide an easily accessible reference for information and trends about the state of Scotland’s environment (National Statistics Scotland 2010). Most recently, Scotland’s Wildlife: an Assessment of Biodiversity in 2010 reported on Scotland’s progress towards biodiversity targets (Mackey & Mudge 2010). In Wales, reports are updated twice a year and published as an annual bulletin overviewing the progress made against the Environmental Strategy of the Welsh Assembly Government (Statistics for Wales 2010b) since the first Progress Report was published in 2007 (WAG 2007). The State of the Environment of Northern Ireland was first assessed and reported in 2008 (Environment & Heritage Service 2008) and, subsequently, the Northern Ireland Statistics Report was published in 2009 and updated in 2010 (Northern Ireland Statistics & Research Agency 2010).

The UK has adopted biodiversity targets and indicators to report on biodiversity status and trends (Section 4.1). The use of indicators in assessing broad trends in the ecological integrity of different habitats has been widely incorporated into policies and regulations (Carignan & Villard 2002). In the UK, an initial suite of biodiversity indicators were first reported in 2007 (Defra 2010k). The UK Biodiversity Indicators in Your Pocket 2010 report (Defra 2010k) now presents 18 indicators that are indicative of the general state of biodiversity in the UK, forming a basis for the assessment of progress towards biodiversity targets. The report indicates that 46% of all measures show an improvement since 2000, while only 27% show improvement over the longer-term (*ibid.*). A review of targets and indicators for the ecosystem approach by the Department for Environment, Food and Rural Affairs (Defra 2008d) concluded that “the currently available suite of indicators do provide a good overview of the state of the natural environment but there are gaps in terms of their ability to monitor the delivery of ecosystem services and, in particular, the pressures on specific ecosystems.” (p.2). The review also found that targets are not based on ‘functional’ limits and suggested that they be periodically reviewed so that they take into account the latest scientific understanding.

Scotland's Biodiversity Indicators report (Donnelley 2007) presents the state of 17 indicators of Scotland's biodiversity and 5 indicators describing the engagement of people with its conservation and enhancement. These indicators are used to assess progress towards the achievements outlined in Scotland's Biodiversity Strategy.

In terms of the Marine environment, the UK Marine Monitoring and Assessment Strategy (UKMMAS) was set up in 2005 by the UK Government and Devolved Administrations to provide a more integrated understanding of the seas (Defra 2010i). The Charting Progress 2 (CP2) report (UKMMAS 2010), updating the earlier report from 2005, provides the best evidence currently available for UK Marine environments, and was positively received by government (Defra 2010i). Despite these achievements, many knowledge gaps remain, and much work is needed to provide sufficient data for robust assessments (Section 27.7.3.1).

The UK Terrestrial Biodiversity Strategy adopts a systematic approach to improve the surveillance and monitoring of biodiversity, fill knowledge gaps and address future needs (JNCC 2011). Development of a Biodiversity Surveillance Strategy for Scotland is currently underway by Scottish Natural Heritage and aims to address knowledge gaps for habitats and species of statutory and policy importance in the country.

Efforts have been made to increase the accessibility of information about biodiversity and the environment, and it is now commonplace for environmental statistics and analyses to be freely available online. The Biological Records Centre (BRC) was established in 1964 as a national focus for recording terrestrial and freshwater species (other than birds) into a database (Hill *et al.* 2006). In 2000, the National Biodiversity Network (NBN) Trust was established as a partnership between a range of conservation NGOs and government agencies to build a network of shared information about UK wildlife. One way this is achieved is through the NBN Gateway website (<http://data.nbn.org.uk/>) which acts as an accessible online database of biodiversity information and receives contributions from government and country agencies, environmental agencies, wildlife conservation organisations, local records centres and numerous volunteers.

There remains a 'cultural divide' in the collection of monitoring data, with a bias towards culturally important biodiversity groups, sometimes at the expense of those that matter most for the delivery of provisioning and regulating ecosystem services (Section 4.7, Figure 4.7). There is a lack of data and information about trends for some groups of invertebrates, lower plants, fungi and microorganisms, limiting our understanding of the services in which these groups play a part. Knowledge gaps also exist for rare habitats such as Semi-natural Grasslands in Scotland (Section 19.4.2).

As biodiversity is increasingly linked to ecosystem services, there is a need to shift to a more functional understanding of biodiversity (Section 4.7). The MA (2005) highlighted, for the first time, the functional roles biodiversity plays in the context of ecosystem services and its benefits to humans and well-being. Existing functional data is limited to small-scale or highly simplified systems; hence there is a need to study the functional relationships between biodiversity and

ecosystem services at appropriate scales. This will require the development of new research tools and techniques to measure and describe the functional components of biodiversity (NERC 2007). Research programmes focusing on functional links at large scales have begun to emerge—for example, those under the Water Framework Directive (WFD) and the Insect Pollinators Initiative (BBSRC 2009; **Box 27.2**)—but a number of challenges remain. Continued research on broad drivers, such as climate change and invasive species, is needed to better understand their potential future impact. The role of biodiversity indicators to assess climate change, economics and ecosystem services is likely to increase and evolve (Parliamentary Office of Science and Technology 2008). Most significantly, a better understanding of *how* biodiversity underpins ecosystem

Box 27.2 Insect Pollinators Initiative. Source: BBSRC (2009).

As presented in Chapter 14:

"Pollination is a primary/intermediate ecosystem service which potentially has a large impact on regulating the provision of final ecosystem services such as crops and other plants (delivering, for example, food and fibre)... It is well established that both managed pollinators (honeybees) and wild pollinators (primarily non-managed bees and hoverflies) have been in severe decline for at least the last 30 years and it is very likely that this trend will continue. Twenty percent of the UK cropped area comprises pollinator dependent crops and a high proportion of wild flowering plants depend on insect pollination for reproduction."

Pollinators are essential for the maintenance of biodiversity in natural ecosystems. As such, the Insect Pollinators Initiative was established to "promote innovative research aimed at understanding and mitigating the biological and environmental factors that adversely affect insect pollinators." The Initiative is administering a fund of up to £10 million over five years which is jointly sponsored by the Biotechnology and Biological Sciences Research Council (BBSRC), the Department for Environment, Food and Rural Affairs (Defra), the Natural Environment Research Council (NERC), the Scottish Government and the Wellcome Trust under their Living With Environmental Change (LWEC) Programme. Currently, nine projects are receiving funding from the Initiative.

One of the projects, led by Dr Geraldine Wright at Newcastle University, is attempting to answer the question: can bees meet their nutritional needs in the current UK landscape? Changes in land management practices worldwide have impacted the ability of pollinators to obtain adequate nutrition. The research will examine the nutritional needs and foraging habits of honeybees (**Figure 27.4**) and bumblebees, and explore how nutrition influences disease and toxin susceptibility. The project aims to identify the most important floral food sources for pollinators in the UK as a basis for the development of artificial food sources.



Figure 27.4 A honeybee pollinating a flower through the collection and transport of nectar. Image © Mirek Srb, 2011. Used under license of Shutterstock.com.

services needs to be developed: “While we often have a broad understanding of which biodiversity groups are important in underpinning specific ecosystem services, such assessments are frequently hampered by a critical lack of quantitative data on biodiversity and ecosystem service relationships at the scales (spatial and temporal) typical of real world ecosystems” (Section 4.1).

A significant knowledge gap is the lack of economic values for the benefits or services of biodiversity; this limits the potential for market mechanisms to promote the conservation of biodiversity. The Economics of Ecosystems and Biodiversity (TEEB) study was conceived in 2007 to “initiate the process of analysing the global economic benefit of biological diversity, the costs of the loss of biodiversity and the failure to take protective measures versus the costs of effective conservation.” (TEEB 2010). Three (from the many) pertinent conclusions of the TEEB study state that:

- an ecosystem services perspective should inform economic valuations of biodiversity which include its multiple benefits and intangible values;
- a realignment of incentive structures, guided by the principles of ‘polluter pays’ and ‘full-cost-recovery’, is needed in order to take account of the full range of ecosystem services;
- and new positive incentives, such as payments for ecosystem services and tax breaks, can be a powerful means to encourage public and private actors to provide ecosystem services.

‘Natural capital’, which refers to “those aspects of the natural environment that deliver socio-economic value through ecosystem services”, needs to be integrated into economic statistics and policy making (GLOBE International 2010). Cost-benefit analyses which do not account for ecosystem services may lead to the adoption of solutions which deteriorate natural capital. To prevent this, a System of Environmental and Economic Accounting (SEEA), or ‘green accounting’, could be implemented, along with an economic appraisal of government policies and cooperation from all government departments (GLOBE International 2010). In the UK, the Office for National Statistics produces online ‘Environmental Accounts’ twice each year, which provide data on the environmental impact of UK economic activity and the use of the environment by the economy (Office for National Statistics 2010). This includes data on: atmospheric emissions; energy consumption; estimates of oil and gas reserves; production and stock of solid radioactive waste; UK imports and exports of material resources; government revenues from environmental taxes; and UK environmental protection expenditure by industry. However, there is a need to account for additional intangible benefits from ecosystem services.

27.2.3.2 Legislation (enabling)

The Habitats Directive (Directive 92/43/EC) and the Birds Directive (Directive 2009/47/EC) are the major pieces of EU legislation aimed specifically at the protection and conservation of wild animals, plants and their habitats. The Birds Directive is one of the oldest pieces of EU environmental legislation—created in 1979, it recognised that the protection of migratory birds from pressures such as over-hunting

and habitat loss was an issue of shared concern for all EU Member States. The Habitats Directive was adopted in 1992 with an overall aim to maintain or restore (at ‘favourable conservation status’) certain natural habitats and wild plants and animals. Favourable conservation status has a particular definition within the legislation, covering factors such as the natural range of species and habitat types, species population dynamics, and the existence of structural and functional attributes necessary to maintain habitats over the long-term (European Council 1992). It refers to the status of habitats or species across the territory of the EU, not just at a specific site. However, habitats and species at each site contribute significantly to the overall network, reflecting natural range and the diversity of populations; hence, each occurrence of a protected habitat or species contributes integrally to its overall, EU-wide status.

The Birds Directive obliged the UK to set up Special Protection Areas (SPAs) consisting of the habitats of particular species of birds. There are 195 species and subspecies singled out for protection via SPAs listed in an Annex to the Directive; they broadly consist of species which are in danger of extinction, vulnerable to habitat changes, or rare due to small populations or restricted local distributions. Migratory birds are also covered. The Habitats Directive also required the creation of protected areas, known as Special Areas of Conservation (SACs). These contain representatives of particular habitat types and species, as well as habitats of particular species which are considered to be in need of protection. The Directive contains lists of individual species and habitat types to be covered by SACs (for example, coastal dunes, temperate heath, rocky habitats, etc.) (European Council 1992). Together, the SPAs and SACs make up a European network of protected areas given the title ‘Natura 2000’.

In the UK, the obligations in the Birds and Habitats Directives are implemented in national legislation through the Habitats Regulations (1994 and 2010) and the Wildlife and Countryside Act 1981 (plus the Offshore Marine Conservation (Natural Habitats &c.) Regulations 2007, and certain equivalent regulations in devolved jurisdictions). The protected areas set up as part of the Natura 2000 network fit into a broader picture of protected areas at the national level including Sites of Special Scientific Interest (SSSIs; which also underpin Ramsar wetland sites of international importance), Areas of Outstanding Natural Beauty (AONBs) and National Parks. They may overlap—for example all terrestrial SACs in England are also SSSIs. The different legal regimes for each area (**Table 27.1**) impose different levels of protection, dictating what human activities can occur either in, or near to, an area.

The Birds and Habitats Directives, and their implementing laws in the UK, are widely seen by NGOs and the government as a useful and powerful tool for the conservation of biodiversity. This framework has had much success, but problems still exist. According to the Joint Nature Conservation Committee’s analysis of the most recent six-year report on the operation of the regime in the UK (produced in accordance with monitoring and reporting requirements under the Habitats Directive) (JNCC 2007), there has been some improvement in the number of UK

Table 27.1 The main designations of protected area recognised in the UK and the associated legislation. Source: data from JNCC (2010a).

Protected area	Where	Description and statutory basis
Special Areas of Conservation (SACs)	EU	Part of Natura 2000 network, strictly protected sites best representing the range and variety within the EU habitats and non-bird species under EC Habitats Directive .
Special Protected Areas (SPAs)	EU	Part of Natura 2000 network, strictly protected sites of the most important habitat for rare and migratory birds under EC Birds Directive .
Sites of Special Scientific Interest (SSSIs)	England, Scotland, Wales	Sites of statutory protection for the best examples of UK's flora, fauna or geological or physiological features, also used to underpin other national/international designations under the National Parks and Access to the Countryside Act 1949 , renotified under the Wildlife and Countryside Act 1981 with improved provisions under the Countryside and Rights of Way Act 2000 (England and Wales) and Nature Conservation (Scotland) Act 2004 .
Areas of Special Scientific Interest (ASSIs)	Northern Ireland	(Equivalent to above)
Ramsar Sites	Ratified by the UK	Wetlands of international importance designated under the Ramsar Convention .
Areas of Outstanding Natural Beauty (AONBs)	England, Wales, Northern Ireland	To conserve natural beauty under the National Parks and Access to the Countryside Act, 1949 (amended in Environment Act 1995), Countryside and Rights of Way Act 2000 .
National Scenic Areas	Scotland	(Equivalent to above)
Areas of Special Protection (AoSP)	England, Scotland, Wales	Sanctuary areas under the Protection of Birds Acts 1954 , amended to Wildlife and Countryside Act 1981 .
Wildlife Refuges	Northern Ireland	(Equivalent to above) under Wildlife (Northern Ireland) Orders 1985 .
Country Parks	England, Wales	Statutorily declared and managed under local authorities under the Countryside Act 1968 .
Country Parks	Scotland	(Equivalent to above), under Countryside (Scotland) Act 1967 .
Country Parks	Northern Ireland	Non-statutory designation
Historic Gardens and Designated Landscapes	Scotland	Gardens and landscapes identified for natural heritage and cultural importance under the Town and Country Planning (General Development) (Scotland) Order 1992 (GDPO) .
Local Nature Reserves (LNRs)	England, Scotland, Wales	Declared and managed for nature conservation under the National Parks and Access to the Countryside Act 1949 .
Local Authority Nature Reserves (LANRs)	Northern Ireland	(Equivalent to above)
Marine Conservation Zones (MCZs)	England, Wales (inshore), UK (offshore)	To protect important marine wildlife, habitats, geology and geomorphology under the Marine and Coastal Access Act (2009) .
Marine Nature Reserves (MNRs)	England, Scotland, Wales	To conserve marine flora fauna and provide study opportunities under the Wildlife and Countryside Act 1981 (in Northern Ireland under Nature Conservation and Amenity Lands (Northern Ireland) Order 1985).
Voluntary Marine Nature Reserves (vMNRs)	UK	Non-statutory by agreement between non-governmental organisations, stakeholders and user groups.
National Nature Reserves (NNRs)	England, Scotland, Wales	Managed to conserve their habitats or for scientific study under the National Parks and Access to the Countryside Act 1949 and the Wildlife and Countryside Act 1981 (in Northern Ireland under Amenity Lands Act (Northern Ireland) 1965).
National Parks	England, Wales	To conserve and enhance landscapes whilst promoting public enjoyment under the National Parks and Access to the Countryside Act 1949 .
National Parks	Scotland	(Equivalent to above) but in addition designed to promote the sustainable use of the natural resources of the area and the sustainable social and economic development of its communities under the National Parks (Scotland) Act 2000 .
Natural Heritage Areas	Scotland	Large discrete areas of countryside with a large range of nature conservation and landscape interests where integrated management is encouraged under the Natural Heritage (Scotland) Act 1991 . None have been designated.
Regional Parks	Scotland	Extensive areas where public access and informal recreation are allowed with existing land use under the Wildlife and Countryside (Scotland) Act 1981 .

species listed at favourable conservation status. However, a lot of action is still needed for those species and habitats which are continuing to deteriorate.

The kind of ecosystem services which may be either fostered or discouraged by this legal framework needs to be considered against a background of human engagement with protected sites. In addition, it is clear that the effect of the Birds and Habitats Directives on ecosystem services cannot be understood in isolation because the system

interacts with laws and policies regulating various human activities (agriculture, forestry, fishing and recreational activities) which may take place on the protected sites. Generally, habitat and species protection will require strong controls on the overexploitation of provisioning services, such as intensive agriculture and overfishing (CEC 2006). However, this will be to the benefit of certain regulating services, including: water regulation through preserving wetlands; climate regulation through preserving peatlands

or woodland habitats; and pollination services through the protection of invertebrate and bird abundance and diversity. Cultural services are another clear gain, with protected habitats and species providing highly valued recreational, aesthetic and spiritual outlets.

Legislation from a wide range of sectors impacts biodiversity. The CAP involves a number of legislative measures at devolved, UK, and EU-levels. Reform of CAP via Pillar 2 (Axis 2) has promoted environmental improvement including biodiversity conservation (Section 27.4.3.1; Section 27.4.3.5). In the realm of rural legislation, the Natural Environment and Rural Communities (NERC) Act 2006 contains a Biodiversity Duty (Section 40[1]) that requires every public authority in England and Wales to have regard for the purpose of conserving biodiversity. The Department for Environment, Food and Rural Affairs published a report of guidance for local authorities on implementing the biodiversity duty (Defra 2007c). A review of the impacts of this duty (Defra 2010a) found that further improvement could be achieved through better integration of biodiversity across the whole suite of public authorities' functions. In Wales, the promotion of this duty has involved annual audits of National Park Authorities' and local authorities' performance with respect to the duty. The Nature Conservation (Scotland) Act 2004 contains a similar duty to 'further' the conservation of biodiversity in Scotland.

The Marine Strategy Framework Directive 2008 (Directive 2008/56/EC) puts in place a system designed to combine environmental protection and economic use objectives. It specifically states that marine strategies shall apply an ecosystem-based approach to the management of human activities, ensuring that, by 2020, those activities are kept within levels compatible with achieving good environmental status, while also enabling the sustainable use of Marine goods and services (Section 27.7.3.2). Biodiversity considerations are integral—assessments of Marine waters should cover descriptions of habitat types and biological communities. A list of descriptors for determining good environmental status contained in an Annex to the Directive includes the maintenance of biological diversity, and refers specifically to the diversity of Marine food webs and the minimisation of biodiversity losses through eutrophication. The EC recently published a decision explaining in more detail how the biodiversity indicator should be applied at species, habitat and ecosystem levels (EC 2010a).

For biodiversity conservation, the spatial protection requirements of the MSFD and its interaction with the Habitats and Birds Directives are important. The MSFD requires Member States to provide a progress report on the establishment of Marine Protected Areas (MPAs) (including Marine SACs and SPAs) by 2013. It is essential that this operates to speed up the designation of MPAs including the Marine element of the Natura 2000 network. According to the EU's most recent BAPs (CEC 2006, Objective A1.1.1), Marine SACs and SPAs should have been designated by 2008, with management priorities and necessary conservation measures identified by 2012. The process is significantly behind schedule, although 15 new sites were submitted to the EC in August 2010 (Defra 2010b).

The Marine and Coastal Access Act 2009 has provided for the creation of a network of Marine Conservation Zones (MCZs) across the UK by 2012. These will protect nationally important Marine wildlife, habitats, geology and geomorphology. The sites of MCZs are currently being identified; they build on MPAs designated under the Habitats and Birds Directive, but also take account of social and economic considerations (Section 7.3.2).

Much of the legislation designed to control pollution has successfully restricted harmful impacts on biodiversity, and has even permitted recovery in some cases. The success of the Clean Air Act 1956, and more recent EU legislation on air quality and emissions, in drastically reducing air pollution in the UK has had positive impacts on biodiversity in many habitats. The EU WFD has already achieved positive impacts on Freshwater and Wetland biodiversity in the UK (Section 9.4.1). Despite the positive track record of improvements to air and water quality through statutory measures, there remains a need for specific legislation to protect the regulating capacity of soils and its associated biodiversity (Section 14.7.1). A number of different statutory measures and policies do contribute to soil protection, and a Soil Framework Directive has been proposed at EU level (EC 2010b). So far, Member States have not been able to agree on how to take it forward (Defra 2008a). Legislation in the context of provisioning services, especially food and fisheries, is discussed separately in their sectoral contexts, but there is increasing recognition of the need to minimise the impacts of intensive provisioning practices on biodiversity.

27.2.3.3 Policies, institutions and governance (enabling)

The UK framework for biodiversity conservation is shaped by international commitments under the CBD, and by European obligations. As presented in Chapter 4 (Section 4.1), significant loss of biodiversity worldwide "culminated in the Convention on Biological Diversity (CBD) in 1992, which established policies for the conservation of biodiversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising from biodiversity." In 1994, the UK Government published the UK BAP which combined new and existing conservation initiatives in response to the CBD and emphasised a partnership approach (Secretaries of State for the Environment 1994). This led to the development of a framework of BAPs implemented by a broad array of stakeholders who form the UK Biodiversity Partnership. Biodiversity targets are expressed at both UK and country levels (Table 27.2) and progress towards achieving these

Table 27.2 The strategic framework of national Biodiversity Action Plans (BAPs) in the UK. Source: adapted from Defra (2007e).

UK strategic framework			
Working with the grain of nature: a biodiversity strategy for England (Defra 2002)	Northern Ireland biodiversity strategy (2002)	Scotland's biodiversity: It's in your hands (Scottish Executive 2004)	Environment strategy for Wales (Welsh Assembly Government 2006)

targets is recorded by the Biodiversity Action Reporting System (BARS 2010). The list of UK BAP priority species and habitats was revised in 2007 and has grown in size reflecting improved data availability and the continuing decline of some species (Defra 2007e). It now contains 1,150 species and 65 habitats for which Species Action Plans (SAPs) and Habitat Action Plans (HAPs) are published.

More than 170 Local BAPs have also been developed through local partnership and community engagement to address the needs for priority habitats and species in a given local area (JNCC 2008).

‘Conserving Biodiversity—the UK Approach’ (Defra 2007e) presents the ecosystem approach as a key underlying principle for conserving biodiversity in the UK. This approach recognises that priority species and habitats cannot be considered in isolation and must be addressed through coordination at appropriate levels. One example is the ecosystem approach framework for action in Scotland as proposed by Scottish Natural Heritage (SNH 2010a) and endorsed by the Scottish Biodiversity Committee.

The role and responsibility of local authorities to assist with conserving and enhancing biodiversity is increasing, so fostering technical capacity and partnerships at this level will be a priority (Natural Capital Initiative 2010). Non-governmental conservation organisations also play an important role to stimulate support from the government and public alike for conservation initiatives (Lawton *et al.* 2010). Growth of membership numbers in these organisations—many of whom own or manage large areas of land important for biodiversity—has led to significant increases in expenditure and action for nature conservation purposes over recent decades (JNCC 2010a). Businesses, including developers, are investing more in biodiversity and this could be further encouraged through the accreditation of business initiatives that reduce detrimental impacts to biodiversity (Natural Capital Initiative 2010).

The designation of a protected areas network is one mechanism for addressing concerns of loss of habitat and species diversity. The institution of protected areas in the UK has continually grown to the complex network in place today; however, further improvements are needed to ensure that it is coherent and resilient to future challenges. The designations having the greatest impact on biodiversity are listed in **Table 27.1**. The extensive Making Space for Nature review of wildlife sites in England (Lawton *et al.* 2010) found that there has been recent progress in the condition of sites (particularly SSSIs), with 95.8% of SSSIs in favourable or recovering status in 2010, compared with 57% in the same condition in 2003. However, the review pointed out that many sites are too small, and extensive losses of certain habitats are likely to lead to further loss of biodiversity. It identified that most semi-natural habitats (outside SSSIs and Natura 2000 sites) are under-managed or insufficiently protected and that natural connections in the countryside have been lost. It recommends that “some form of national framework is required to ensure coherence and cost-effectiveness across the network,” and that “the sooner we act to establish a coherent and resilient ecological network, the lower the eventual cost and the greater the benefits for us all.” (p.ix).

At the moment, biodiversity, landscapes and historic environments are governed by separate systems in the UK. There is a need to coordinate these systems to support landscape planning mechanisms that both better connect protected areas and positively influence biodiversity outside these designated sites. An ecosystem services approach to land management could provide a valuable way of achieving these aims (Foresight 2010).

In 2002, the UK committed to halt biodiversity loss by 2010 as part of the EU Sustainable Development Strategy; however, significant biodiversity loss still continues today (JNCC 2008). At the tenth CBD Conference of the Parties held in Nagoya, Japan, a new Strategic Plan of the Convention was adopted for the period 2011 to 2020 (CBD 2010). It states that “there has been insufficient integration of biodiversity issues into broader policies, strategies, programmes and actions, and therefore the underlying drivers of biodiversity loss have not been significantly reduced.” These results are predicted to act as a key driver of biodiversity policy.

Despite failing to meet its target, the public sector in the UK has demonstrated its commitment to biodiversity by doubling expenditure in this area between 2000 and 2008 as shown in **Figure 27.5** (Defra 2009g). Biodiversity policy is guided in each country by national strategies and BAPs (**Table 27.2**). A number of policy areas relating to biodiversity are emerging as present and future priorities. Marine planning policy development has recently been recognised as important (Section 27.7.3.3), and fisheries policy restricting fleet numbers, days at sea, and catch quotas has decreased landings (Section 27.6.3.3). Increases in Semi-natural Grassland are being promoted through policy, emphasising the fact that policy has begun to account for non-market public goods. Much effort is going into the development of climate change policy backed by results from major assessments of the threats of climate change to biodiversity (SNIFFER 2007; EA 2010d). The control of

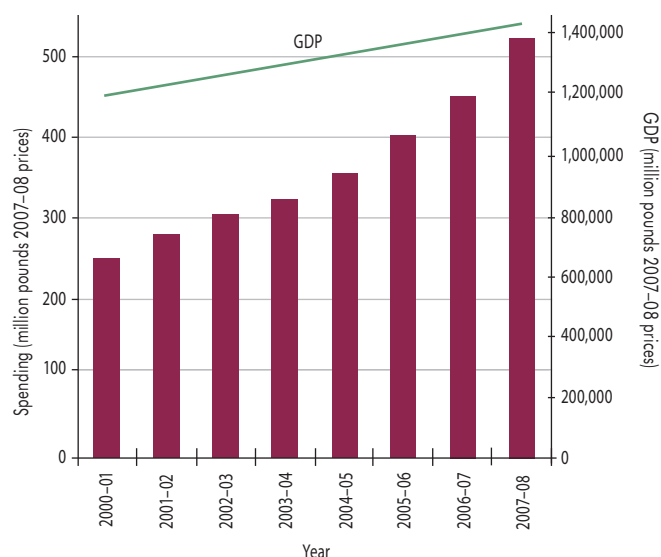


Figure 27.5 Public sector expenditure on biodiversity in the UK from 2000 to 2008. Source: reproduced from Defra (2009g) © Crown Copyright 2009.

Box 27.3 Evaluating efforts to conserve farmland bird biodiversity, and the co-delivery of conservation with other ecosystem services

Over the last two decades, the conservation of farmland biodiversity has been a policy priority in the UK, being implemented through agri-environment schemes. In 2000, a Public Service Agreement (PSA) to reverse farmland bird declines in England by 2020 was adopted by the UK Government (Davey *et al.* 2010a). The Entry Level Stewardship (ELS) scheme, which is the high uptake, whole farm, non-competitive agri-environment scheme, is the main tool to deliver the PSA target.

Evidence of overall improvements for a number of bird species has been reported. For example, the delivery of key winter foraging habitat through a special project resulted in doubling the national breeding population of ciril buntings (*Emberiza cirius*) from 1992 to 2003. A separate special project, which took place between 1998 and 2005, created fallow nesting plots for stone-curlews (*Burhinus oedipnemus*), increasing the number of breeding pairs from 63 to 103 during this period (Natural England 2009a).

Such positive results from special projects are not, however, necessarily indicative of the overall results achieved through ELS. A study by Davey *et al.* (2010a) assessed the efficacy of ELS as a mechanism to deliver farmland bird biodiversity benefits. Using data from 2005 and 2008 from lowland farmland survey plots of the Breeding Bird Survey (Section 2.3.7), supplemented with additional, professionally sampled, plots, the study found that the 'broad and shallow' approach of ELS "may not be adequate to induce satisfactory population-level effects in the short term," although evidence shows it does benefit some species (*ibid.*, p.472). Only 3 of 19 farmland bird indicator (FBI) species showed population increases between 2005 and 2008.

In order to determine how farmland management for species affects the delivery of other services, a study by Bradbury *et al.* (2010) ranked ELS management options in terms of their net impact on regulating ecosystem services (considering the six services: climate, water regulation, erosion, water quality, pest control, and pollination), and their ability to provide farmland bird resources. In using this approach, the authors identified that 'permanent grassland', 'field corner management', and 'very low inputs on either arable or grassland' were 'win-win' ELS options, benefiting both regulating services and bird species. Some options that ranked highly for birds, such as 'cereals for whole crop silage followed by over-wintered stubbles', scored negatively for service provision. "In seeking to find joint solutions for ES [ecosystem service] provision and biodiversity conservation, options can be considered which range in scale from the field-edge to the catchment" (*ibid.*, p.990).

invasive species is another policy priority as it is the second greatest threat to biodiversity worldwide (Wilcove *et al.* 1998). One example is the Invasive Species in Ireland Project (Invasive Species Ireland 2010), which started in 2006 as a joint venture between the Northern Ireland Environment Agency and the National Parks and Wildlife Service, and involves policy relating to specific species.

Improved soil management and protection has been encouraged through Safeguarding our Soils (which defines a strategy for England) (Defra 2009h) and The Scottish Soil Framework (Scottish Government 2009e), which seek to protect the biodiversity and ecosystem services derived from soils. Peat soils are of particular importance because they form three protected UK BAP habitats—fens, raised bogs, and blanket bogs—and store half of the 10 billion tonnes of carbon stored in all UK soils (Defra 2009h; Natural England 2011c). Minimising emissions from this source is, therefore, a policy priority, and measures aiming to protect and enhance peatlands for conservation and biodiversity reasons will additionally benefit climate change mitigation efforts (Scottish Government 2009e).

Policy that explores how a multifunctional ecosystem services approach might work is now being piloted (**Box 27.4**). A multifunctional approach will be necessary for the protection of certain biodiversity groups requiring coordinated actions. Conservation of lichen, for example, requires both a decrease in pollution and maintenance of high density and high quality mixed habitat. There is already a push towards more integrated and interdisciplinary approaches of biodiversity conservation; integration is occurring between government departments (such as planning, environment, energy, etc.), between national, regional and local levels of delivery, and between policy makers, practitioners and the public. The new framework for securing biodiversity in England (Natural England 2008a) emphasises the important role of partner organisations to

drive delivery and report on progress for species requiring urgent attention. In Scotland, there is a desire to further integrate biodiversity into planning and to encourage local approaches to conservation which may be more flexible and opportunity-based (Dick *et al.* 2009). The Scotland Rural Development Programme is a major policy of the Scottish Government which aims to better integrate biodiversity with other benefits in the rural sector, with particular links to water quality and climate change (*ibid.*).

27.2.3.4 Changing social attitudes (enabling) "We need to engage more people in taking action to maintain and enhance biodiversity as part of their everyday lives" (Defra 2007e, p.11).

The public are increasingly aware of the loss of biodiversity and actively involved in its conservation (Dick *et al.* 2009). Highly publicised campaigns to save charismatic species from extinction have pushed biodiversity into the public domain, and provided a greater role for local communities. According to some, "we are currently witnessing a paradigm shift in biodiversity conservation, away from the establishment and maintenance of protected nature reserves towards community-based conservation" (Goddard *et al.* 2010, p.95). There is also growing evidence and enthusiasm about the importance of biodiversity in Urban areas for the provision of health and well-being benefits and ecosystem services (**Box 27.5**). This includes the maintenance of the abundance of relatively common species which contribute towards the provision of ecosystem services. The need to further engage local communities and non-experts in matters of conservation is acknowledged by the government in national biodiversity strategies and policy, and by a range of organisations. Public understanding and opinion about the value of biodiversity have strong implications for the acceptance and adoption of measures (Natural Capital

Box 27.4 Multifunctional ecosystems approach at the Otmoor Protected Area, Oxfordshire. Source: McInnes *et al.* (2008).

Defra has funded a number of case studies aiming to explore the potential applications of an ecosystems approach in a range of situations. One of these projects involved the application of an ecosystems approach in the management of the Otmoor protected area in Oxfordshire from 2006 to 2007. The area covers 1,100 hectares (ha) of farmland involving differing management practices within the designations: SSSI, RSPB reserve and Upper Thames Tributaries Environmentally Sensitive Area (ESA).

The four objectives of the pilot were as follows:

To demonstrate approaches for identifying policy objectives for a protected site that takes into account the views of stakeholders.

The range of national-level policies which drive decisions and actions at Otmoor were explored. These included European legislation (Birds and Habitats Directives, WFD, etc.), Common Agricultural Policy, Acts of Parliament (Town and Country Planning Act 1990, Countryside and Rights of Way Act 2000, etc.), and government strategies. To assess understanding and application of an ecosystems approach, 44 stakeholders were consulted during the project (Table 27.3).

To demonstrate a method for measuring, predicting and communicating the actual and potential cumulative impacts of different stressors on these policy objectives, based upon common monetary and ecological currencies.

To demonstrate a method for identifying, predicting and valuing the ecosystem services provided by the site.

Four ecosystem services were investigated:

- **Regulating:** Water purification and waste treatment (removal of phosphorus and nitrogen)
- **Regulating:** Natural hazard regulation (reducing the likelihood of extreme flood events)
- **Provisioning:** Food (conversion of light, energy and nutrients into agricultural biomass)
- **Cultural:** Recreation (provision of recreational opportunity)

In order to improve decisions regarding wetland ecosystem management, the importance of these services to human society must be assessed. It will not be possible here to describe the conceptual framework in full (see McInnes *et al.* 2008), however the annual economic value of water purification (£15–£20/ha), food (£259–£355/ha) and recreational (£8–£31/ha) ecosystem services were quantified. The economic benefit of natural hazard regulation was not quantified due to the lack of reliable information (although a possible approach is provided). An uncertainty assessment, including sensitivity analysis, was conducted under two climate change scenarios to assess both data and model uncertainty.

To evaluate the applicability of elements of an ecosystems approach against the current level of understanding of a protected area and to demonstrate a prioritisation framework for balancing policy objectives against the value of ecosystem services and potential impacts.

The key driver at Otmoor is land management for food production. One conclusion of the project was: “to ensure that the wetland conservation interest are maintained in perpetuity the economics of agricultural production, including their role in protecting and enhancing biodiversity, need to be resolved and delivered by the market to the local land manager” (p.23). Through this pilot project, a conceptual and empirical method for quantifying and valuing ecosystem services was developed. Based on this experience, the strengths and weaknesses of the ecosystem approach are presented in Table 27.4.

This case study demonstrates that, by using an ecosystem service framework involving consultation with stakeholders, it is possible to discuss the trade-offs and synergies between different ecosystem services from an area, to determine the most appropriate management strategy.

Table 27.3 Points of agreement and disagreement among stakeholders concerning the Otmoor protected area.

Source: information from McInnes *et al.* (2008).

Points of agreement	Points of disagreement
The conservation of all species should be a priority	Finding an appropriate balance between profitable farming and achievement of biodiversity goals
Flooding should be allowed to occur naturally across Otmoor (at least in the long-term)	The extent to which flooding can and should be managed for the benefit of farming and conservation
A large increase in the number of visitors to Otmoor should not be encouraged	The extent to which M40 runoff is responsible for pollution of the area

Table 27.4 Strengths and weaknesses of the ecosystem approach based on experience from the Otmoor protected area pilot project. Source: information from McInnes *et al.* (2008).

	Implementation of an ecosystem approach at the Otmoor protected area
Strengths	■ Stakeholders recognise that Otmoor provides many benefits
	■ Some ecosystem services are recognised and reflected in decision-making
	■ Decision-making is devolved to several levels
	■ Some environmental limits are recognised and respected
Weaknesses	■ Several policy drivers do not recognise the interconnected nature of the natural environment
	■ Perverse incentives may exist which promote agricultural production at the expense of maintaining and enhancing biodiversity
	■ Ambiguity exists regarding the identification and evaluation of ecosystem services
	■ Opportunities for a more effective delivery of environmental outcomes are being missed
	■ Prescriptive rather than adaptive management is routinely applied

Box 27.5 Biodiversity in Urban Gardens project (BUGS2).

Following a successful first study in Sheffield, the second Biodiversity in Urban Gardens (BUGS) (BUGS2 2009) project was carried out between 2004 and 2007 in five cities: Leicester, Oxford, Cardiff, Belfast and Edinburgh. The study explored the extent and nature of domestic gardens, the features they include, and their floristic diversity. Garden features such as trees, mature shrubs, ponds, lawn areas, compost heaps and nest boxes are important for the maintenance of biodiversity, the provision of ecosystem services, and for human health and well-being. "[Urban green spaces] provide opportunities for people to interact with nature and are, therefore, vital in fostering interest in nature conservation issues." (Goddard *et al.* 2010, p.90).

Some of the results of the BUGS2 project published by Gaston *et al.* (2007) indicated that a significant number of households were participating in wildlife gardening, and that the most common form of participation was the feeding of wild birds. It was found that access to gardens and garden size were positively associated with activities aimed at encouraging wildlife. Interestingly, neither household density nor socioeconomic status of households were found to strongly effect participation in activities to encourage wildlife. The study suggests that, in order to increase awareness and participation in wildlife gardening, advice and opportunities should be carefully tailored to the kinds of spaces that are available in different areas.

Spatial scale is an important factor in the conservation of biodiversity. Many organisms operate at scales larger than individual gardens, so coordinated management at larger scales (from groups of gardens up to Urban green space planning) may be required (Goddard *et al.* 2010). **Figure 27.6** shows a conceptual framework of the socioecological characteristics which influence garden management.

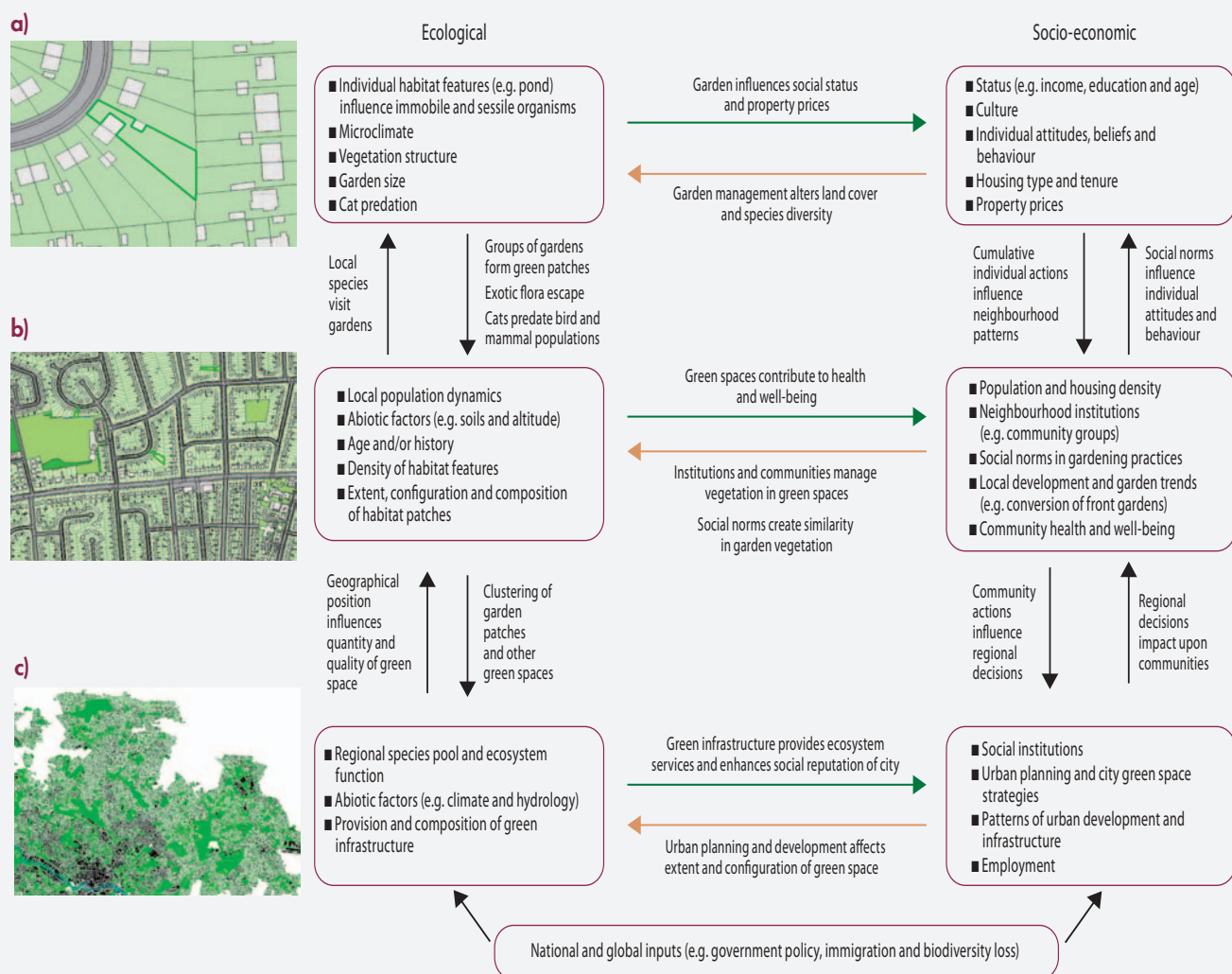


Figure 27.6 Gardens as socio-ecological constructs. A conceptual framework showing the key ecological and socio-economic components impacting on private gardens at multiple spatial scales. A nested hierarchy in garden management was identified that spans three scales: a) the individual garden or household; b) the neighbourhood or garden 'patch'; and c) the city or landscape scale. In reality, many of the ecological and socio-economic factors can act at more than one scale along this continuum (e.g. vegetation structure or social status) and interactions exist between scales to illustrate feedbacks within the garden ecosystem (black arrows). Ecological factors influence socio-economic factors through the provision of ecosystem services and economic and health benefits (green arrows). Socio-economic factors influence ecological conditions via human decision-making and subsequent management (orange arrows). Research and management is necessary at multiple scales to maximise the utility of private gardens for native biodiversity conservation. Source: Goddard *et al.* (2010). Copyright (2010), reproduced with permission from Elsevier.

Initiative 2010). Mechanisms of decision-making and trade-off negotiation should be transparent.

The government plays an important role in enabling and encouraging behavioural change. In *Securing the Future*, the sustainable development strategy from 2005 (HM Government 2005), a behaviour change model for policy making is presented (**Figure 27.7**).

This approach can apply to the promotion of biodiversity conservation—it helps to conserve natural habitats, wildlife, quality of greenspace, and generally brings people closer to nature. ‘Enabling’ involves educating people about the benefits of biodiversity, allowing people to make responsible choices based on the evidence. ‘Encouraging’ involves the use of many of the instruments presented in this section to provide positive incentives to reward good behaviour, and to enforce regulations and penalties when necessary. ‘Engagement’ through public involvement over long periods is imperative in changing behaviours through examples people can relate to. Finally, the government needs to lead by example (‘exemplify’) through its own operations and in creating consistent policies.

Public support to halt the loss of biodiversity is also fostered through local action by local authorities, Statutory Agencies, NGOs, and collaborations between these actors (Defra 2007e). It is important that key messages are targeted through communication strategies to different audiences in order to maximise their impact. The report *Conserving Biodiversity—the UK Approach* (Defra 2007e) emphasises the need to be ‘positive’, ‘practical’ and ‘personal’ when communicating biodiversity issues. The report promotes the following behaviours (*ibid.*, p.15):

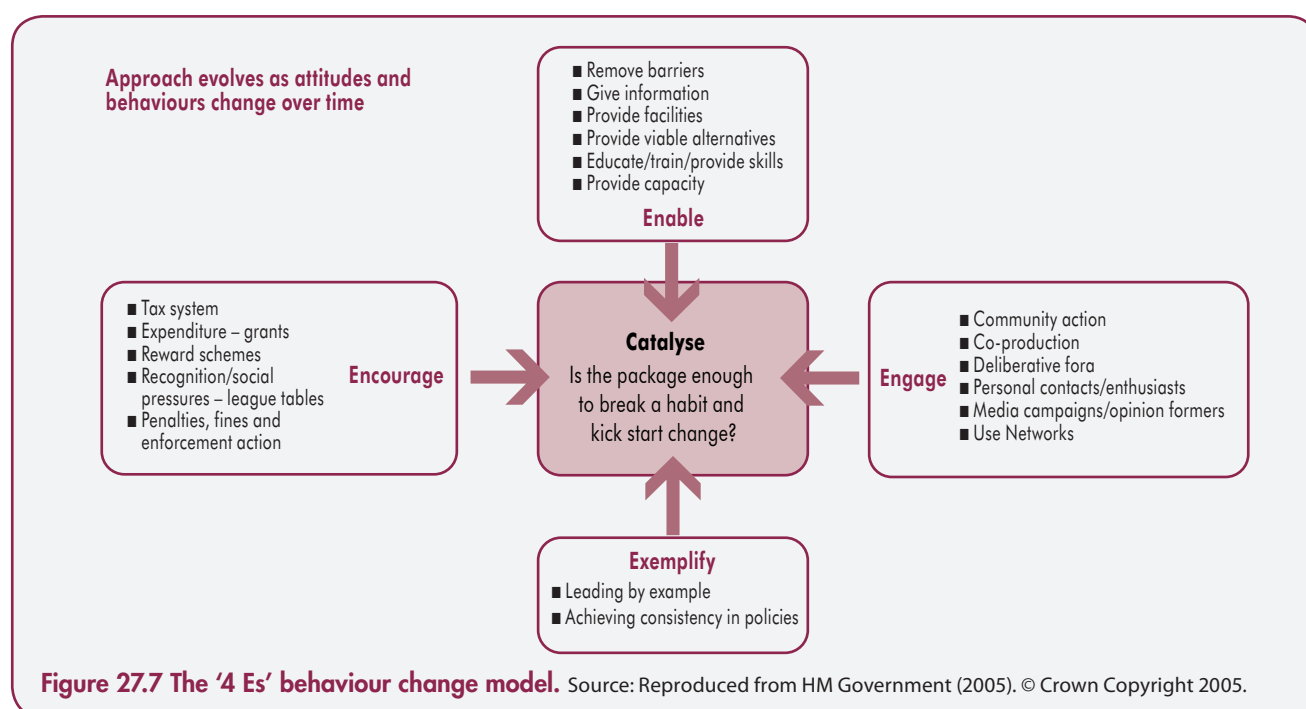
- **Create**, or encourage others to create, **wildlife-friendly spaces**—at home, in your local community and through work.
- **Enjoy** (and value) your local wildlife-friendly space and share this enjoyment with others.
- **Support** the work of wildlife conservation organisations.

- **Think before you buy**, for example, wildlife-based products or souvenirs from overseas trips; buy wildlife/ environmentally friendly/sustainably-sourced products.
- **Record** what you see and send results to your Local Records Centre.
- **Exercise** your civic duties to ensure those that represent your views reflect your environmental concerns.

There is a need to better craft the message that biodiversity is enormously important for the sustainability of the environment, the provision of ecosystem services and for our own well-being. The term ‘biodiversity’ itself lacks recognition or understanding among the public (Novacek 2008; Defra 2009a). Public interest in species, habitats and sites is highly responsive to stories and pictures made available through television programmes and the news. One example is the Nature Tales posters and activity guides made available through the BBC’s Breathing Places initiative (BBC 2011a). Providing an inspiring message, however, is only the first step; lasting engagement with environmental issues, such as biodiversity loss, is often the result of a connection between people and nature through active involvement and participation (Section 27.2.3.7).

Education is a “key vehicle for increasing public knowledge and understanding of the importance of conserving biodiversity... this is true for all age groups” (Defra 2007c). Local authorities are encouraged to enhance biodiversity of school grounds and statutory requirements stipulate that the science curriculum must include ‘sustainable development’, ‘life processes and living things,’ and ‘global citizenship’ (*ibid.*). The Department for Children, Schools and Families (now the Department for Education) published a booklet entitled *Top Tips for Schools to Engage with Biodiversity* (DCSF 2010) which emphasises the benefits of engaging with biodiversity in schools.

The power of behavioural change to induce human action cannot be underestimated. We know more about culturally



important biodiversity groups because they have received a bias in terms of research effort and funding (Section 4.7). The conservation of rare breeds, varieties and genetic resources is dependent on government and societal preference. Chapter 25 demonstrates the importance of social attitudes in shaping the future. Each storyline is dependent on the adoption of prevalent 'attitudes', 'beliefs', or 'societal concerns'. An appreciation of the importance of social attitudes in enabling the conservation of biodiversity is paramount.

27.2.3.5 Markets and incentives (instrumental)

Incentives have long been used in the UK as an instrument to influence production. Historically, this has negatively impacted habitats, such as moorland and grassland, through conversion to maximise production from agriculture and forestry (Section 19.4.2). More recently, incentive schemes have aimed to conserve biodiversity in agricultural landscapes. A review of the achievements of agri-environment schemes over the past 20 years in England (Natural England 2009a) highlighted specific successes. Some of the options under this scheme have significantly increased breeding populations of nationally scarce farmland birds and have benefited other farmland biodiversity. Higher Level Stewardship (HLS) schemes have been the main mechanism used to increase the condition of SSSIs, and have generally led to the maintenance and proactive restoration of existing habitats. Of the BAP priority habitat, 84% is under agri-environment agreements, as is 41% of actively managed hedgerows and 24% of actively managed stone walls. Agri-environment schemes protect 250,000 in-field trees and have supported the planting of 2,000 new parkland and hedgerow trees. Despite these achievements, it was found that the free choice and balance of options selected under many agreements were not ideal for achieving desired outcomes. Unexpected landscape-scale consequences, such as detrimental impacts to specialist species due to comparatively uniform management, have arisen, and there is a need for greater flexibility and a better evidence base at the landscape-scale.

Davey *et al.* (2010b) found that there was limited evidence of short-term effects of Environmental Stewardship schemes on lowland farmland birds, except for corn bunting and common starling under Entry Level Stewardship (ELS). They also found insufficient evidence of specific management options increasing the abundance of the species which they were targeted at. The authors expect, however, that time lags in bird populations responding to changes in the farmland environment mean that it is too early to draw conclusions on the success of the schemes. One potential reason they cite for the possible underachievement of ELS schemes is that the current pattern of options taken up by farmers focuses predominantly on boundary management options (accounting for 50% of all options selected). The rebalancing of option uptake to address gaps in option coverage (including in-field options), and the improvement of the quality of the options, may determine the future success of the ES scheme. The schemes will also need to mitigate against the loss of set-aside (Section 27.4.3.5). Given the voluntary nature of Environmental Stewardship, however, precaution has to be taken when changing the scheme to ensure options remain sufficiently attractive to maintain good levels of uptake

(Defra 2008b). At present, ELS schemes do not "account for spatial heterogeneity in species' responses to management" and it is suggested that scheme targeting could be improved in the future (Davey *et al.* 2010b, p.126).

Results from the Monitoring and Evaluation of Agri-environment Schemes study in Scotland, undertaken from 2004 to 2008, suggest that during this period implementation of the three agri-environment schemes in Scotland (Organic Aid Scheme, Countryside Premium Scheme, and the Rural Stewardship Scheme) had little impact on the biodiversity measures investigated (Scott Wilson Scotland Ltd. 2009).

Support via the CAP has evolved through a number of reforms which have increased environmental management and protection (Section 27.4.3.2). It is suggested that further reform of the CAP is needed to safeguard biodiversity and ensure that a wide range of public benefits are provided at appropriate scales (Davey *et al.* 2010b). A recent study by the UK Research Councils' Rural Economy and Land Use Programme suggested that building an ecosystem services approach into agri-environment schemes could promote multifunctional land use through a stronger role in the following areas (RELU 2010a):

1. Rewarding the provision of carbon stores.
2. Promoting integrated pest management.
3. Reducing risks to public health from livestock waste in water.
4. Responding to new disease threats linked to climate change.
5. Reviewing support for organic conversion in intensively farmed regions.

Civil society organisations and charities are increasingly seen as a financial support mechanism for the conservation of biodiversity outside the public domain.

27.2.3.6 Technologies and practices (instrumental)

Many forms of technology have inadvertently led to the destruction of biodiversity. Excess application of chemicals (including fertilisers and pesticides) developed to increase productivity in agricultural and aquacultural systems have negatively impacted biodiversity as pollution, but have subsequently been reduced through environmental regulations (Section 15.4). These chemicals have also made it possible to expand productive agriculture into other habitats, where land was previously unsuitable. The mechanisation of agriculture, peat removal and fishing industries have heavily impacted terrestrial and marine biodiversity. Seabed trawling technology, in particular, has had a widespread impact on benthic habitats (Section 12.3.1.3). Advancements in motor pumps since the 1940s have made moorland drainage and land reclamation possible.

As we learn from these lessons, technology has been created to reverse or minimise many of these adverse impacts. In lowland conservation areas, machinery is used for re-wetting, and in upland mires, 'grip blocking' maintains water levels, benefiting both biodiversity and carbon sequestration (Section 3.3.5.1). Fishing technology has come a long way in specialising the catch to minimise harm to non-target species and juveniles through the use of enhanced netting and sonar technology (Section 27.6.3.6).

The practice of set-aside, taking land out of agricultural production, was traditionally practised and, more recently, enforced through policy to control overproduction (Section 27.4.3.5). It was found to have the potential to deliver a range of environmental benefits including: introducing wildlife habitat into farmland; buffering and reducing diffuse pollution; improving soil quality and preventing erosion; and contributing to the adaptation and mitigation of climate change (IEEP 2008b). Set-aside was abolished in the CAP Health Check reform, so other measures will be needed to retain the benefits of this practice (Scottish Government 2009a). One such measure is the Campaign for the Farmed Environment which aims “to retain and exceed the environmental benefits that used to be provided by set-aside” (Section 27.4.3.7; CFE 2010).

An interesting development has been the potential to use ‘biodiversity offsetting’ in the UK as a mechanism for enhancing biodiversity in the wider countryside. It can be defined as:

“Measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from development plans or projects after appropriate prevention and mitigation measures have been taken” (BBOP 2008).

A successful pilot of this mechanism from Australia is explored in **Box 27.6**. Monitoring and enforcement are necessary components of an offsetting mechanism which could be implemented through market or regulatory methods. A scoping study by the Department for Environment, Food and Rural Affairs (Treweek *et al.* 2009) concluded that the situation in England could lend itself to greater use of this mechanism to move towards no net loss or net gain of biodiversity, but that further work is needed to determine what additional policy may be required. A workshop addressing the practical challenges for biodiversity offsetting in the UK (Natural Capital Initiative 2010) concluded that, “current methodologies, tools and evidence are sufficient to begin encouraging increased use of biodiversity offsetting.” The process of developing a framework should involve local planning authorities, land owners, businesses and the public. Pilot projects are currently underway in the UK (Environment Bank 2010) to determine the application of this mechanism in practice, and to ascertain the costs and benefits involved. Safeguards are essential, as are currently in place under the Habitats Directive, in order to avoid a shift towards a permissive regime in which access to easy offsetting options will encourage development in sensitive areas. However, if offsets are well managed, transparent and as close as possible both physically and ecologically to the converted sites, they do potentially have a role and could encourage greater private sector involvement in conservation and habitat creation.

27.2.3.7 Voluntary actions (instrumental)

Voluntary and civil society action plays an important role for biodiversity conservation in the UK. A review of literature relating to volunteering in the natural outdoors by the Institute for Volunteering Research (Ockenden 2007) stated that:

“The conservation and environmental sectors appear to have become increasingly receptive to the concept

Box 27.6 BushBroker exchange pilot biodiversity offsetting initiative, Australia. Source: Plott *et al.* (2008).

There is an obvious trade-off between economic development and environmental conservation in Victoria, Australia, where 66% of the native vegetation has been cleared due to growth and economic development; this has left a total of 7.4 million hectares (ha) of native vegetation on public land and 1.1 million ha on private land. Because native vegetation is not seen to have monetary value, it has traditionally been considered an externality. Policies to limit its destruction, such as taxes and penalties attempting to approximate the economic value of environmental goods, have failed to be economically viable. The BushBroker vegetation offset scheme has been piloted as a mechanism to directly link decisions of economic development with environmental conservation using a market-based mechanism.

“Complex trading rules govern the transactions in the vegetation offset market in order to ensure equivalency in the biodiversity conservation value of the vegetation cleared and that used as an offset” (*ibid.*, p.8). The project’s environmental metric incorporates data on the quality, quantity, type, significance level and location of the native vegetation to be cleared in order to allow ecologists to make informed decisions about what type of offset should be required. Using landscape classifications (28 bioregions, 300 ecological vegetation classes), conservation status significance levels, and techniques to evaluate the quality and quantity of native vegetation, appropriate offset areas are determined. ‘Like-for-like’ trading rules require that vegetation gains from an offset are ‘commensurate’ to the vegetation loss with respect to conservation significance, habitat and vegetation type, and quality. The loss resulting from the clearing of old trees is given special attention due to their ecological importance.

Offsets are traded in the form of contracts which require active vegetation management over ten years and then permanent site protection. The scheme is dependent on the fulfilment of these obligations, and endogenous risks (e.g. insufficient incentive) and exogenous risks (e.g. bushfire) have been minimised as far as possible through contract design.

The performance of the electronic BushBroker exchange software was tested experimentally and found to be a “simple and effective solution to the complex environment of native vegetation trading” (p.23). Plott *et al.* (2008) concluded that “successful implementation of the electronic BushBroker exchange will enable meaningful trade-offs to take place between economic development and environmental conservation...this will be an important step in allowing environmental conservation to compete on equal grounds with economic interests” (p.33).

of involving people in the management of nature and providing opportunities for volunteers... People are increasingly seen as playing a central role in the solution to environmental and conservation problems... this has directly contributed to the development of ‘community-based conservation’, and an end to ‘expert-based’ solutions and management” (p.10).

‘Citizen science’ involves non-expert volunteers in the collection and/or processing of data and, therefore, aims to increase participation in formal scientific research (**Box 27.7**). The role of citizen science has grown tremendously over the past few years due to the availability of technical tools for disseminating information (e.g. the internet, mobile computing, etc.), increased realisation by the scientific community of this free source of labour and skills, and requirements by funding agencies for grant-holders to undertake science outreach (Silvertown 2009).

A comparison between 47 countries found that the USA and the UK have the highest percentage (8%) of people volunteering in the ‘environment’ (Hodgkinson 2003). The UK Biodiversity Indicators in Your Pocket 2010 report (Defra 2010k) found that between 2000 and 2009 there was a 51% increase in the time spent volunteering at eight major UK

Box 27.7 Volunteer-based biodiversity monitoring programmes. Two examples of volunteer-based monitoring programmes in the UK:

1. The **Breeding Bird Survey (BBS)** is run by the British Trust for Ornithology (BTO) and is jointly funded by BTO, the Joint Nature Conservation Committee (JNCC), and the Royal Society for the Protection of Birds (RSPB) (Risely *et al.* 2010). Since 1994, the survey has recorded population trends for over 100 breeding bird species across the UK which are used by government and NGOs to set conservation priorities. The survey method involves volunteer visits during the April to June survey period to an assigned 'square'. During the visit, the volunteers record all birds encountered while walking two 1 km transects across their square. Habitat and mammal sightings are also recorded during transects. Additional data has been collected by professional fieldworkers from under-represented areas, including upland areas in England since 2006, and wooded areas in Scotland since 2007. Inclusion of these habitats results in more robust trend analysis. In 2003, the survey introduced an online recording system (www.bto.org/bbs), and in 2009, 76% of the results (from a total of 3,243 squares) were submitted online, thereby saving paper.

2. The **National Bat Monitoring Programme (NBMP)** has involved more than 2,200 volunteers in bat monitoring activities since 1996 (BCT 2011). The collection of data allows the:

- assessment of the conservation needs of the UK's 18 bat species;
- identification of any rapid population declines;
- selection of conservation priorities and informing of conservation policy;
- and the distribution of limited resources to where they are most needed.

"Without the valuable information collected by volunteers we would be unable to track how the UK's bat species are faring." (BCT 2011).

conservation charities¹, totalling around 1 million working days in 2009. Environmental programmes run by these and other conservation organisations have demonstrated the ability to raise public awareness and understanding of environmental concerns, and to engage communities (Binley *et al.* 2008).

There is considerable collaboration between biodiversity actors. A number of partnerships have formed between local authorities, statutory agencies and NGOs, particularly through the Local BAP mechanism, to deliver local action for biodiversity (Defra 2007e). For example, the Scottish Biodiversity Forum is a working partnership between public, private and voluntary organisations that has created an online communications toolkit which can help public and private enterprises communicate the benefits of biodiversity (SNH 2010b). As part of the Northern Ireland Biodiversity Strategy, Biodiversity Delivery Groups bring together Departmental, Agency and non-government partners to implement the targets and actions of the 37 Northern Ireland HAPs (NIEA 2010).

The Community Infrastructure Levy is a voluntary mechanism that came into force in 2010 in England and Wales allowing local authorities to raise funds from developers (DCLG 2010a). Money raised can be used to fund a range of infrastructure, including parks and green spaces, according to the needs of the local area. Levy rates are set in consultations with local communities and developers and expand the minimal contributions required under the planning obligations system.

Table 27.5 Biodiversity Summary

	Established responses	Early implementation, pilots	Proposed, under development
Knowledge	<ul style="list-style-type: none"> ■ Country Surveys ■ State of Environment Reports ■ National Biodiversity Network Gateway 	<ul style="list-style-type: none"> ■ Biodiversity Indicators Reports ■ The Economics of Ecosystems and Biodiversity 	<ul style="list-style-type: none"> ■ Research on functional relationships (e.g. Insect Pollinators Initiative)
Legislation	<ul style="list-style-type: none"> ■ Habitats Directive ■ Birds Directive ■ Common Agricultural Policy ■ Natural Environment and Rural Communities Act ■ Marine Strategy Framework Directive 		
Policies, institutions and governance	<ul style="list-style-type: none"> ■ UK Biodiversity Action Plans and national strategies ■ Local Biodiversity Action Plans 	<ul style="list-style-type: none"> ■ Scotland Rural Development Programme ■ Scottish Soils Framework ■ Invasive Species in Ireland Project 	<ul style="list-style-type: none"> ■ Multifunctional ecosystems approaches
Changing social attitudes		<ul style="list-style-type: none"> ■ Biodiversity in Urban Gardens project ■ BBC Breathing Places Initiative ■ Department for Children, Schools and Families – guidance on biodiversity for schools 	<ul style="list-style-type: none"> ■ UK Sustainable Development strategy ■ Conserving Biodiversity – the UK approach
Markets and incentives	<ul style="list-style-type: none"> ■ Agri-environment schemes 		
Technologies and practices			<ul style="list-style-type: none"> ■ Reformed set-aside practices ■ Biodiversity offsetting
Voluntary actions	<ul style="list-style-type: none"> ■ Conservation volunteers ■ Volunteer-based biodiversity monitoring programmes 	<ul style="list-style-type: none"> ■ Campaign for the Farmed Environment ■ Scottish Biodiversity Forum ■ Northern Ireland biodiversity delivery groups 	

¹ Including: Bat Conservation Trust, BTCV, British Trust for Ornithology, Butterfly Conservation, Plantlife, Royal Society for the Protection of Birds, The Wildlife Trusts, Woodland Trust, and the public body Natural England.

The Campaign for the Farmed Environment encourages voluntary management by farmers to benefit the environment while ensuring profitable food production (Section 27.4.3.7).

An example of action to raise awareness about biodiversity in the Marine environment is Natural England's Under England's Seas campaign (Natural England 2011b). The campaign provides regional information about the wildlife found in underwater landscapes.

27.2.4 Biodiversity Summary

Table 27.5 summarises the key insights from this review of responses in the context of biodiversity, highlighting those that have been well-established, but also identifying a set of responses that are either in early implementation or are proposed. It is important to learn from these early pilots across all sectors to scale-up the adoption of an integrated ecosystem approach to the management of the UK's diverse habitats, which is one key policy direction that this review recommends.

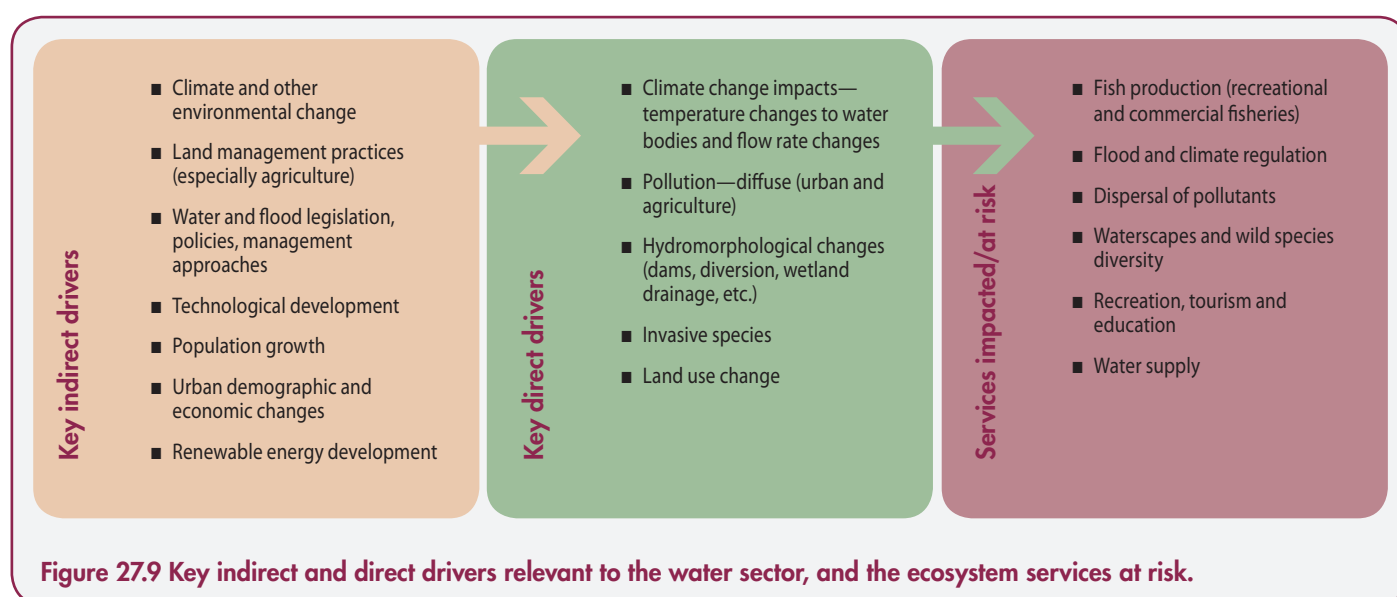
27.3 Water

27.3.1 Freshwater Ecosystem Services and Human Well-being

The myriad services provided by Freshwater are critical for human well-being (Chapter 9). While water is used directly to supply homes, industry and agriculture, and generate power, it also sustains a variety of ecosystems, such as rivers, wetlands and lakes, which provide multiple benefits to people (MA 2005; **Figure 27.8**). In the UK, Freshwater ecosystems are a source of many cultural services—millions enjoy the diversity of wildlife and natural beauty of the UK's waterscapes. Freshwater ecosystems regulate water quality, flooding and local climates, and play a fundamental role in sustaining essential supporting services that ensure both water- and land-based goods and services continue to be delivered to our society and economy. **Figure 27.9**



Figure 27.8 Rocky stream waterscape in the Lake District, England. Photo by Rick Harrison, available under a Creative Commons Attribution-ShareAlike license.



summarises the major water-related direct and indirect drivers and their impact on ecosystem services. Given the cross-cutting nature of water, this sector should not be considered in isolation from the other sectors; response options for agriculture (Section 27.4.3) have particular relevance to Freshwater ecosystems.

27.3.2 Challenges for Water Management

Significant progress has been made improving the quality of the UK's rivers over the past two decades. Point source pollution from industry and urban areas has dramatically decreased, largely as a result of a European-driven regulatory framework that has led to investments in wastewater treatment. Although some point sources of pollution are still significant, diffuse source pollution from agriculture and urban areas remains an elusive issue, demanding a more comprehensive response. Nitrate concentrations have increased in approximately 4,000 km of rivers in the last two decades, and biological quality has declined in approximately 2,500 km of hill-rivers in Wales and the Welsh borders (Chapter 9).

Historically, Wetlands have been drained, dams built, dikes raised and channels straightened, deepened and widened in a bid to control water. Freshwater ecosystems have become highly fragmented, and flow rates have been modified, resulting in the loss of valuable Freshwater habitats and an increased flood risk. Severe flooding in 2007 emphasised the economic and social costs of flooding (Pitt 2008), the risk of which is expected to increase as a result of climate change (Defra 2009b).

According to evidence in Chapter 9, aquatic ecosystems appear particularly vulnerable to catastrophic regime shifts that, once incurred, can lead to large service losses which are difficult to restore. Emerging data also show that rivers, lakes and other Wetlands are especially sensitive to climate change, with temperatures in some UK rivers already rising and impacting river biodiversity (Chapter 9, Section 4). Hot, dry summers are apparently reducing juvenile populations of brown trout, salmon and eels (*ibid.*). Climate change is also likely to increase pressure on water supplies, particularly groundwater resources in some areas like south-east England. In addition to climate change, water stress is likely to become more widespread due to population growth and increasing environmental protection measures which reduce abstraction (Weatherhead & Howden 2009).

Non-native species that become invasive are a growing problem in UK Freshwater ecosystems (Strayer 2010; **Figure 27.10**), although there is insufficient evidence of their consequences. Novel pollutants, such as endocrine-disrupting substances, nanoparticles, and the effects of synthetic biology are emerging issues (Chapter 9). Changes in land use and climate, and increases in flood risk, are likely to continue to be important drivers of change in the water environment.

27.3.3 Water-related Response Options

27.3.3.1 Knowledge (foundational)

The way we perceive and manage water is very different today than it was 60 years ago. Historically, water was mainly valued for its supply for domestic, industrial and agricultural purposes, a place to dispose of wastes, and for game and course fisheries. There was little understanding of the multiple additional services it supports or our impact on them through the misuse of water. This has changed over the last two decades, with an increasing number of responses aimed at protecting the water environment. Advancements in environmental and social research have been a major driver behind the transformation of water management.

In the past, research has focused more on building knowledge of the basic biological, chemical and physical processes relating to catchment dynamics, especially in relatively undisturbed ecosystems. This has revealed the connections between habitats and how the hydrological cycle exchanges water between the atmosphere and land, the uplands and lowlands, terrestrial and aquatic habitats, fresh and saline habitats, and between surface and groundwater systems (Chapter 9). By better understanding these processes, the management of water has moved from administrative districts, such as counties and regions, to the natural units of river basins and catchments, embodied in Integrated Water Resource Management (IWRM).



Figure 27.10 Topmouth gudgeon eradication programme, Surrey. It may be less than 3 inches in size, but this tough invader from Asia preys on the eggs of native fish, breeds fast and spreads disease via a parasite that attacks other fish. Photo © Environment Agency.

We now know, with a high degree of certainty, that rivers, lakes, ponds and wetlands provide critical services to society, and that these services have been threatened by human activities, resulting in among the fastest rates of habitat modification in the UK (Chapter 9). Rivers are the most monitored environments in the UK, reflecting the importance placed on Freshwater through legislation, the effect of water quality on human activities, and the value of river organisms as indicators of wider environmental change. Long-term data are available for over 25,000 km of rivers in England, Wales and Scotland. Such data have allowed water quality trends to be tracked, prompting the enactment of legislation such as the Integrated Pollution Prevention and Control (IPPC) Directive in 1996 (Directive 96/61/EC) which led to the better protection of aquatic ecosystems and their services (*ibid.*).

The role of Freshwater ecosystems in reducing flood risk is increasingly being recognised. Based on this knowledge, government policy is moving away from engineered flood protection and towards working with nature by capitalising on the flood storage capacity of ecosystems—an approach endorsed in the Department for Environment, Food and Rural Affairs' Making Space for Water (Defra 2005), the government strategy for flood and coastal erosion in England. The Pitt Review (2008) was an independent inquiry carried out following devastating flooding in Gloucestershire (and other parts of England) in the summer of 2007. It resulted in a series of recommendations for improving the way flood risk is managed in England, which the government and relevant agencies are responding to, including improving the ability to predict the timing and extent of flooding (Defra 2009c).

In order to have a more integrated approach to water management, local and regional planners in the UK are adopting more holistic assessment tools. Water cycle studies are one way of providing a more comprehensive assessment of the impacts of proposed developments on the water environment. These studies assess existing information, identify knowledge gaps and consider options for sustainable development (EA 2009c).

However, considerable knowledge gaps remain (Chapter 9, Section 7); the benefits of Freshwater ecosystems are insufficiently quantified or valued in a meaningful way for policy makers. Monitoring networks currently misalign with the ecosystem service approach, making it difficult to quantify the links between ecosystem services and ecosystem functioning, structure and species composition. An increased understanding of how Freshwater can be managed sustainably within an ecosystem services approach is needed to ensure short-term uses do not undermine longer-term capacity. We also need to understand how Freshwater systems interact with different land types to deliver ecosystem services (Maltby 2009). The linkages between ecosystem functioning and ecosystem services are poorly understood, as is the importance of connectivity between wetlands, rivers, lakes and land for delivering ecosystem services. Climate change is likely to place greater pressure on aquatic ecosystems, the full effect of which is unclear, yet monitoring programmes are mainly targeted at stressors that were most dominant in the past (Hering *et al.* 2010). Further research is required to support efforts to optimise catchment management under climate change.

27.3.3.2 Legislation (enabling)

Command-and-control regulatory responses applied to Freshwater services (such as technological, end-of-pipe controls and discharge permits) are typically targeted at point sources of pollution (MA 2005). The European IPPC Directive is partly responsible for the significant reduction in industrial pollution across Europe, including in the UK. Industrial installations are issued permits that require them to employ Best Available Techniques in their production processes. Regulations for the collection and treatment of waste from homes (sewage) and industry stipulated in the Urban Wastewater Treatment Directive (Directive 91/271/EEC) has further reduced point source pollution loads in UK rivers (**Figure 27.11**).

Long-term monitoring data demonstrate significant improvements in chemical water quality, and the biological and chemical classification of 7,000 km of rivers in England and 12,000 km in Wales has dramatically improved over the past two decades (Chapter 9). The investments in wastewater treatment and other end-of-pipe solutions have, through regulation, monitoring and enforcement, been a major driver of these improvements, enhancing the delivery of multiple ecosystem services (Defra 2008c).

Although greatly reducing some point sources of pollution, these regulations have been less effective at achieving wider ecological objectives and there remain issues with some point sources. Phosphorus is elevated in many localities, probably due to continued discharges from wastewater treatment works, with more modest amounts from agriculture (e.g. Jarvie & King 2010). Diffuse sources of pollution from agricultural and urban areas, and water system fragmentation remain problematic (Chapter 9).

The WFD (2000/60/EC) was introduced with the aim of consolidating water legislation while also providing a framework to facilitate additional measures, allowing wider ecological objectives to be met. It obliges all 27 EU Member States to protect, enhance and restore water bodies, with the aim of achieving 'good' ecological, chemical and quantitative status in those water bodies by 2015. Extensions to the



Figure 27.11 Wastewater treatment works have significantly reduced point sources of pollution. Sewage treatment plant. Photo by Chesapeake Bay Program, available under a Creative Commons Attribution license.

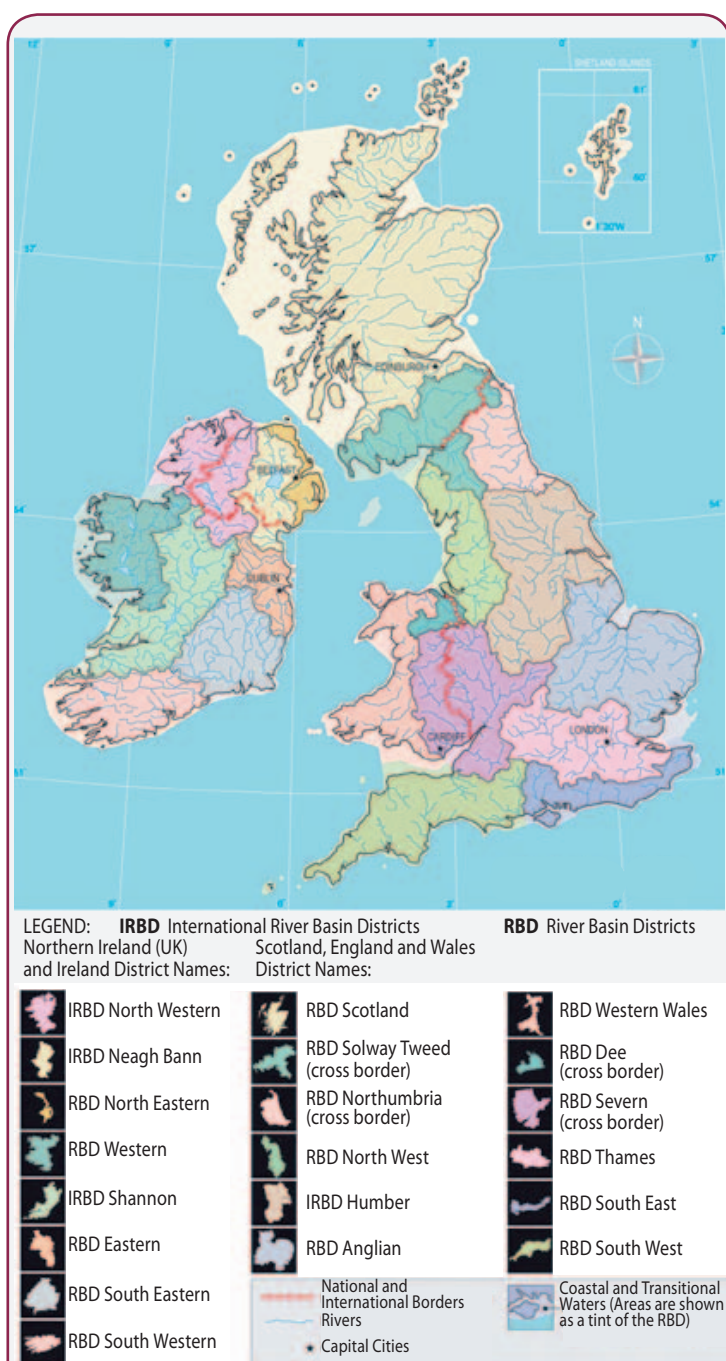


Figure 27.12 River Basin Districts in the UK and Republic of Ireland. Source: reproduced from UKTAG (2005).

2015 target may be permitted under specific circumstances, such as where the objectives are technically infeasible or disproportionately expensive, provided that no further deterioration in status occurs. The WFD aims to integrate water quality, quantity and ecological objectives, as well as all water users, functions and values. In doing so, it accounts for water use in the environment, health, consumption, recreation and other economic sectors.

The WFD deals with the management of all inland water bodies, including surface waters, groundwater, coastal waters and estuaries. Its introduction represented a step-change from previous water legislation in two major ways. Firstly, it designed a system for water management along ecological boundaries, and with ecological objectives. Water management under the WFD is structured by River Basin

District, using this as the natural hydrological unit rather than political or administrative boundaries (**Figure 27.12**). This means that for river basins which cross national frontiers there must be cross-border cooperation (Northern Ireland shares three international River Basin Districts with the Republic of Ireland). The overall purpose of the WFD (set out in Article 1) is to prevent further deterioration of aquatic ecosystems, and to protect and enhance their status. It requires that objectives are set for water bodies taking into account ecological, as well as chemical and physical, criteria.

Secondly, the WFD combines at-source pollution control and quality standards regulatory approaches. This integrated strategy is intended to close the gaps left open in the past by using one or other strategy in isolation. Pollution emission limits applied at source can fail to deal with cumulative effects, while focusing on water quality standards can underestimate the effects of a particular substance in complex environments, especially where scientific understanding of the ecology of that environment is incomplete. As such, the strategy under the WFD is to make sure that source controls, including best available technologies, are applied as rigorously as possible. It also requires additional measures where source control alone is not enough to reach set quality objectives.

The WFD requires the production of River Basin Management Plans (RBMPs) by the competent authorities for each River Basin District. These must contain details of the analyses carried out for each water body including a summary of its current status, the pressures on it due to human activity, the specific objectives set for it and the measures planned to achieve those objectives.

In 2009, RBMPs which had been prepared for each of the UK jurisdictions were finalised according to the WFD timetable. The preparation of the RBMPs was a complex task, involving in depth consultation with stakeholders. Their publication illustrated the scale of the task ahead: in England and Wales only 27% of water bodies were assessed as currently being at or above good status. Current statistics (EA 2008b) show that over 84% of rivers, 85% of lakes, 97% of estuaries and 58% of coastal waters by length in England and Wales are failing to meet good status. The RBMPs set out predictions for the increase in the number of water bodies to reach good status by 2015 according to the programmes of measures which they set out. The Department for Environment, Food and Rural Affairs (2008c) estimates that £5 billion will need to be invested to improve the number of water bodies meeting good status by 5% by 2015. Scotland's water resources are in a better state, with 65% of water bodies assessed as good. The RBMPs will be updated on a six-yearly cycle, enabling changes to the pressures on a water body to be identified and new measures developed to overcome them. New knowledge from better monitoring and data can be incorporated into future planning cycles.

The WFD employs an ecosystem approach, aiming at holistic and ecologically sound management. Economic concepts are also a fundamental feature of the legislation. An economic analysis of water use is specifically required, and Member States must take account of the principle of recovery

of costs of water use, making sure that water pricing policies contribute to the Directive's environmental objectives, and reflect the polluter pays principle. The disproportionate expense analysis under Article 4 must consider monetised and non-monetised benefits of healthy water ecosystems. There is potential for these economic approaches to be used very effectively to promote water management methods with multiple ecosystem service benefits—for example, wetland restoration over more traditional end-of-pipe solutions to water management.

The EC (2010) has suggested that the cyclical outlook of the WFD should be leveraged in the process of adapting water body management to climate change impacts. The WFD itself does not make reference to climate change, but the importance of the issue is reflected in EU guidance on WFD implementation. This notes that climate change is projected to lead to major changes in yearly and seasonal precipitation and water flow, flooding and coastal erosion risks, water quality, and the distribution of species and ecosystems. Strategies for monitoring scientific forecasts on climate change impacts and designing robust adaptation strategies are recommended to be built into RBMPs (EC 2010).

The RBMPs of England and Wales have been criticised as demonstrating a lack of ambition for improving water body status (RSPB 2010b). The issue is not restricted to the UK—across the EU, RBMPs have been received critically. For England and Wales, allegations of inadequacies in the RBMPs relate to a number of issues: extensive reliance on deadline extensions; failure to specify the measures that will be taken; non-compliance of monitoring programmes with WFD requirements; and an unlawful approach to disproportionate costs (EEB 2010).

The WFD overlaps geographically with the MSFD (Section 27.7.3.2) in so far as both deal with coastal waters. The environmental status objectives of the MSFD (which operates a similar framework to the WFD) apply to coastal waters which are not covered by actions taken under the WFD. This arrangement is designed to avoid overlap, and will require cooperation by relevant authorities.

The laws dealing with flood risk management have been overhauled recently in the UK, first by the EU Floods Directive (2007/60/EC on the assessment and management of flood risks), and second by the Flood and Water Management Act 2010. The latter was enacted following the recommendations of the Pitt Review (2008).

Until these developments, the laws dealing with flood prevention and response in the UK had been dispersed in several different pieces of legislation. Relevant provisions were to be found in the Water Act 2003, Environment Act 1995, Water Resources Act 1991, and Land Drainage Act 1991. For example, certain local authority powers concerning drainage were set out in the Land Drainage Act, while the Environment Agency's powers in relation to flood defence actions were introduced through the Environment Act. The legislative picture was not very clear, and had developed in a piecemeal fashion alongside institutional developments. One of the Pitt Review's key recommendations was to bring flood control within one unifying legal framework. As yet, this has not quite been achieved, but there has been a significant degree of consolidation.

The EU Floods Directive was also introduced as a response to various serious flooding incidents in Europe during the last decade. It aims to put in place a proactive system of flood risk assessment and management. It is implemented in England and Wales by the Flood Risk Regulations 2009, in Scotland by the Flood Risk Management (Scotland) Act 2009, and in Northern Ireland by the Water Environment (Floods Directive) Regulation (Northern Ireland) 2009. It requires preliminary assessments identifying river basins and coastal areas most at risk of flooding to be carried out by 2011. Flood risk maps for those areas must be drawn up by 2013, and flood risk management plans must be in place by 2015. For England, the responsibility for these flood risk management plans is divided between the Environment Agency (for sea, major river and reservoir risks) and local authorities for other flooding sources in their areas. In Scotland, the task is allocated between the Scottish Environment Protection Agency and local authorities. For Northern Ireland, the main authority responsible is the Department of Agriculture and Rural Development. The Directive requires that flood risk management plans take into account the role to be played by natural floodplains. The Scottish implementing legislation is notable for imposing an express duty on the Scottish Environment Protection Agency to assess whether alteration (including enhancement) or restoration of natural features and characteristics of any river basin or coastal area in a flood risk management district could contribute to the management of flood risk for the district.

These flood risk management plans must have regard for the WFD, i.e. consider the effect of proposed flood management measures on achieving the ecological status objectives set out under the WFD. The flood risk maps and management plans are organised to correspond with WFD River Basin Districts. Northern Ireland has a duty to cooperate with Ireland in respect of shared River Basin Districts.

The Pitt Review (2008) noted that many of the defects it had identified in the UK's flood legislation could be addressed through the Floods Directive (at that time, awaiting implementation), but not all. In England and Wales, the Flood and Water Management Act 2010 was, in part, a response to this. It is not in full force yet; its first provisions commenced in October 2010, requiring the Environment Agency and local authorities to begin implementing flood risk management strategies.

Designated freshwater areas play an important role in protecting biodiversity and preserving landscapes, especially Wetlands (Section 27.2.3.2). Approximately two thirds of Wetlands designated as SSSIs are in target condition, and it is thought that non-statutory Wetlands are likely to be in poorer condition (Chapter 9). Although a successful conservation regulatory instrument, designated areas, including SSSIs and SACs, are argued to be too rigid to protect and maintain other ecosystem services in a changing environment (Section 27.2.3.3).

Nitrate Vulnerable Zones (NVZs), first described in 1998 under the Nitrates Directive, are designated areas draining into waters polluted by nitrates from agriculture. Farmers with land in NVZs must follow mandatory rules to tackle nitrate loss from agriculture, specifically rules for the application of fertiliser and manure. Currently, about

62% of England and 4% of Wales are designated as NVZs (EA 2011b). A re-survey of a sample of farms located within NVZs found that manure nitrate loading had decreased between the baseline taken in 1996–97 and 2003, and rates of compliance are almost absolute (ADAS 2004). The study also found that farmers were taking into account more factors, such as type of crop, application rates and fertiliser analysis, before spreading inorganic fertilisers on the field. Recent unpublished evidence suggests that nitrate levels may have fallen in rivers over the last decade (Bowman *et al.* unpublished), but more research is required to test this result and to understand the contribution of NVZs. Improvements in groundwater quality are likely to take time, but some reduction of nitrate levels in rivers would be expected (EA 2007a). New regulations were introduced in 2008, the impact of which on nitrate levels is not known yet.

Water Protection Zones (WPZs) are a regulatory instrument aimed at addressing diffuse pollution and hydromorphological changes. They give additional powers to the Environment Agency in England and Wales to use measures to prohibit or manage activities that could pollute or degrade water. The Environment Agency is currently undertaking desk studies of candidate sites.

27.3.3.3 Policy, institutions and governance (enabling)

There is a high degree of agreement internationally that traditional, fragmented, sectoral approaches to the management of water have failed to prevent the unsustainable use of water resources and their associated ecosystems (MA 2005; UNEP 2007). It is increasingly evident that the delivery of Freshwater services is dependent on the management of all habitats in a river basin—the soil, forests, woodlands and freshwater. The most effective management is, therefore, only likely to occur by considering how land and water is managed across entire catchments, not just riparian areas. The provision of Freshwater services is also determined by a complex system of interdependent environmental, social and economic components, further complicated by uncertainties associated with changes in climate, markets and society. Set within this context, piecemeal and rigid policies are unlikely to be able to meet the challenges ahead.

The principles of Integrated Water Resource Management (IWRM) provide for a more holistic approach to water management. The Global Water Partnership (GWP 2010) defines IWRM as “the coordinated development and management of water, land and related resources in order to maximise economic and social welfare without compromising the sustainability of vital ecosystems and the environment.” The principles of the IWRM informed, in part, the WFD and the changes to water management in the UK that its implementation entails. The WFD provides an opportunity to move from fragmented to more integrated approaches. It sets objectives for water bodies to be of ‘good status’, with the intention that if rivers, lakes and groundwater are healthy then the catchment from which the water drains is also healthy. In this way, the management of the land has become integral to managing water. A healthy river catchment (including both land and water) is better

able to deliver a wide range of ecosystem services from food production to recreation (Quevauviller 2010).

The ecosystem services approach may prove a useful framework for accounting for the interconnections of water systems, and for framing wider economic and social considerations (RELU 2010a). By valuing the full range of freshwater ecosystem services in decision-making processes, synergies and trade-offs can be identified and programmes of measures in RBMPs tailored to optimise the mix of services. This may offer a practical approach to meeting the triple challenge of climate change, food security and water allocation (Chapter 9). The ecosystem approach may also be effective at engaging stakeholders around commonly understood beliefs, helping to identify innovative and equitable solutions through participative decision making (EA 2009a).

Integrated ecosystem approaches intrinsically consider the linkages and interactions between hydrological entities that cross multiple boundaries—geographic, political or administrative. This requires planning and management to align with the natural management unit, i.e. the catchment or river basin. The WFD has established River Basin Districts (a single system of water management) and assigned competent basin authorities responsible for the development of RBMPs. Since the first round of RBMPs were only completed in 2009, there is no evidence yet of their outcomes in terms of ecosystem service delivery.

The Environment Agency in England and Wales, the Northern Ireland Department for the Environment and the Scottish Environment Protection Agency are the competent authorities in the UK. In the first round of RBMPs, the Environment Agency established ‘liaison panels’ (stakeholder groups) in each River Basin District to represent local interests, but coordinated planning at a national level to ensure consistency (EA 2009c).

Some countries in the EU have devolved greater responsibility for the WFD’s implementation to local government institutions and their local partners. In the UK, there may be opportunities to learn from their experiences of implementing the Directive (RELU 2010a) and from international experiences of catchment management. The argument for giving more responsibility to local and regional government is that they have a direct interest in water problems affecting their area, and have responsibility for development and planning in their region. The Rural Economy and Land Use (RELU) Programme’s (2010a) Catchment Management Project studied water management programmes in the New York City water supply catchment, alongside other international examples and UK experiences; it found that local solutions are needed to better reflect local land use and diffuse pollution. The Project proposed that adaptive management, including applied research and stakeholder deliberation, and supported by multilevel partnerships and enabling regulations, could create the conditions for such local solutions. Such adaptive management may provide the necessary flexibility in water management to deal with uncertainties associated with changes in climate and society. The greater involvement of local authorities and local partners in environmental policy delivery (as is the case in most other European countries),

and the integration of spatial planning with river basin planning, could provide for better local participation and ownership in water management (Quevauviller 2010). These principles broadly align with those of localism. Further discussion on collaborative approaches for integrated land-water management can be found in Section 27.10.

A challenge for the UK is that the management of water has traditionally been top-down, with limited connections between the policy making level and implementation activities at local levels. Quevauviller (2010) argues that the current, centralised institutional framework does not enable the flexibility necessary for more informed, participative and adaptive approaches. The use of existing data, knowledge and governance structures in the first round of the RBMPs may have perpetuated a top-down, uniform approach, with only limited local influence. This may have hindered the ability to consider trade-offs, conflicts and synergies that exist when several policies and regulations affect multiple ecosystem services (*ibid.*).

Stakeholder engagement in river basin planning can enhance the effectiveness of decisions since it can improve understanding of impacts and vulnerability, account for the distribution of benefits and costs, and co-create a wider range of response options (MA 2005). Conventionally, decision-making followed a path of: problem definition, response options development by experts, public consultation, political decision-making and final implementation ('Decide-Announce-Defend'; RELU 2010a). Increasingly, people's values, as well as facts, are recognised as contributing relevant knowledge, and it is considered that one can neither presume that people have values nor that experts have facts. In the West Wales River Basin District, the Environment Agency used deliberative analysis—a systematic process that incorporates analysis and deliberation as two complementary approaches to form understanding on the basis of knowledge, and reaching agreement through logical argument and reasoning (EA 2009b). These decision-making processes can be described as 'Engage-Deliberate-Decide' (RELU 2010b).

There are a growing number of projects that address the management of land and water interactions within a catchment; these projects are typically initiated and managed locally and independently from national policy frameworks. Interestingly, several water companies (e.g. South West Water, United Utilities, Dwr Cymru, Northumbrian Water) are trialling catchment interventions. As a result of investments in land management upstream of their treatment facilities, they expect to reduce the treatment costs of water supply (**Box 27.8**). Given that the contamination of drinking water supplies by farming costs an estimated £129 million a year (Jacobs 2008), substantial savings could be made. Other water companies intend to join the early adopters of 'upstream thinking'. A total of seventeen companies plan to undertake 100 'catchment management schemes' taking action or investigation at the catchment-level to address deteriorating water quality, rather than pursuing traditional, capital-intensive treatment solutions (OFWAT 2009). The Mersey Basin Campaign, another local catchment intervention, was launched with government support to clean up the Mersey River and its tributaries by 2010. It successfully engaged many organisations, authorities, businesses, communities

Box 27.8 Catchment interventions by water companies and non-governmental organisations. Source: South West Water (2010); West Country Rivers Trust (2010); www.unitedutilities.com/scamp; RSPB (2011); EA (2009a).

'Upstream Thinking'

South West Water has developed a scheme called 'Upstream Thinking', which aims to improve the water and ecological quality of the rivers of South West England in order to protect the company's assets (**Figure 27.13**). The water company hopes to make cost savings by working with landowners to change land management practices in upland areas to decrease the costs of water treatment for supply. One-to-one advice is offered to farmers, and farm plans were developed in cooperation with the West Country Rivers Trust and incentivised through a capital grant scheme. Above the Upper Tamar Lake, improvements in water quality have been realised through this scheme. Post-scheme monitoring revealed the quality of water downstream of farms involved in the project is now better than the inflows. Wider benefits for the river system are expected in addition to the protection of the water source for water supply.

SCaMP project

United Utilities developed the SCaMP Project in partnership with the Royal Society for the Protection of Birds on land they own in the Bowland and Peak District area, North West England. Overgrazing by sheep, air pollution, historic drainage of blanket bog, the erosion of peat, and the loss of native trees were all impacting on wildlife and water quality. The upland area gathers water through heath and blanket bogs, where oxidised, exposed peat causes the water to become discoloured so requires treatment before being supplied to homes. The project aimed to address the land management problems at source, rather than at the end-of-pipe through water treatment. By working with farmers they developed management plans that identified how the land could be restored and managed to benefit water quality and wildlife. Twenty tenant farmers made use of agri-environment schemes, such as the English Higher Level Stewardship and Woodland Grant schemes, to receive compensation for changing their practices and for capital investments.

SCaMP has resulted in 2,000 less sheep on the uplands, which has allowed vegetation to recover; the blockage of over 100 km of drainage grips to improve raw water quality; and the revegetation of 5 km² of once bare peat. Moreover, 500,000 deciduous trees have been planted near the banks of streams and on steep cloughs, and 95% of the SSSIs located on United Utilities' land are now in favourable or unfavourable recovering condition. The important role of the peats in storing carbon for climate change mitigation was considered in the second phase of SCaMP. Restoration of the peatlands is anticipated to maintain the carbon store and enhance its ability to sequester carbon.



Figure 27.13 Upstream Thinking site on Exmoor, England.
Photo courtesy of South West Water.

and volunteers through 20 Action Partnerships, which resulted in significant improvements in river and estuary water quality, and the provision of ecosystem services and associated social benefits (Mersey Basin Campaign 2010; Quevauviller 2010).

The involvement of the third sector may have increased the trust of stakeholders in these schemes. Interventions in the River Tamar catchment carried out by the West Country Rivers Trust, including the Tamar 2000 project, improved the ecology of the River Tamar through advice to landowners and managers. The Environment Agency (EA 2009a) observed that because the West Country Rivers Trust led the Tamar 2000 project it was more bottom-up than the government's Catchment Sensitive Farming scheme, which consequently had less acceptance of prescribed actions by landowners, despite close similarities between the schemes.

Because most of these projects were intended to improve a particular ecosystem service, such as water quality, there may be scope to improve their design to optimise a wider range of ecosystem services. They also operate in isolation, and may benefit from support from regional or national policy. Furthermore, there are likely to be opportunities to learn from such schemes about what form of collaboration can work (Quevauviller 2010).

Until recently, flood management has concentrated on engineered solutions such as building flood banks, and deepening and straightening channels (Pitt 2008). Not only are they expensive to construct, but often shift the problem downstream, rather than providing a sustainable solution. However, a growing number of ecosystem-based alternatives exist (Natural England 2009g). The Department for Environment, Food and Rural Affairs' Making Space for Water Strategy (Defra 2005) lays out a more strategic approach to flood risk management with a wider portfolio of responses. This implies the wider employment of land use solutions, including the restoration of Wetlands and washlands, coastal realignment, river corridor widening and river restoration. 'Slowing water down' through ecological engineering has been suggested as a win-win-win solution: reducing flood risk while also improving water quality and increasing security of supply (Chapter 9). Woodlands, Mountains, Moors and Heaths, Semi-natural Grasslands and Wetlands have significant water storage capacity and slow surface water before it reaches streams and rivers. Water can also be slowed by restoring natural rivers and Floodplains (Sections 27.3.3.5, 27.3.3.6).

Policies to address water stress are likely to focus on demand management and water-saving, rather than resource development (e.g. reservoirs), as it is both cheaper and less carbon intensive (Weatherhead & Howden 2009). Because the distribution of water stress is uneven, with South East England particularly at risk, large-scale water transfers by rivers or canals from other river basins is feasible. However, this is less likely to be sustainable than demand management. Another option is to discourage land uses that increase evapotranspiration and runoff rates in water-stressed regions, and encourage land uses which increase infiltration (Weatherhead & Howden 2009) through, for example, catchment sensitive farming and agri-environment schemes (Section 27.4.3.5).

27.3.3.4 Changing social attitudes (enabling)

Water is impacted by the behaviour of a wide range of actors and land managers—from farmers and businesses to the public—so responses discussed in Agriculture (Section 27.4.3.4), Forestry (Section 27.5.3.4), and Urban planning, transport and energy (Section 27.9.3.4) have relevance to changing social attitudes about the water environment as well.

The adoption of more integrated, adaptive and participatory approaches (Section 27.3.3.3) to water management will likely require cultural changes in society if they are to be effective. Social attitudes are crucial for understanding barriers to the adoption of technologies and new management strategies. Social learning in river basin management involves different authorities, experts, interest groups and the public working collaboratively, and requires stakeholders to learn about their interdependence and differences, and to deal with them to resolve conflicts. Social learning should lead to increased capacity to address catchment issues. Information in this context is often a means to support communication rather than providing expert advice (Pahl-Wostl *et al.* 2008).

The Pitt Review (2008) made a number of recommendations for improving public awareness about flood risk and for how the public should respond to flood warnings. If residents of flood-prone regions took appropriate self-protective behaviour they could reduce the monetary damage of floods by up to 80%, thus reducing the need for public flood risk management (Grothmann & Reusswig 2006). Frequently, the public fail to respond appropriately to flood warning information, probably due to issues of lack of understanding, mistrust of authority and a lack of ownership on flood risk reduction actions (Parker *et al.* 2009). Many people living in flood-prone areas are in denial about the risk and expect protection from authorities, making them unprepared to respond to flood warnings. Parker *et al.* (2009) recommend several principles for improving flood warning response in the UK. Flood communication and education is likely to be more effective if it reduces uncertainty in people's minds and is targeted at specific audiences. There is also some evidence of a willingness among floodplain residents to engage in flood risk management including participating in informal communication networks within local communities and making arrangements to help the elderly and infirm in an emergency (*ibid.*).

People's perception of drought and climate change may be an important barrier to behaviour change for sustainable water management in areas facing water stress, such as South East England. A survey found that the public are more willing to accept restrictions than agree to pay higher water bills to ensure supply (Dessai & Catherine 2010). While respondents to the survey were concerned about the impacts of climate change, they did not necessarily take action to use water more efficiently. Barriers to engagement with climate change and water efficient behaviour included a lack of accessible information, a lack of resources and a perceived lack of institutional engagement. A number of water-saving initiatives have been established by the government including activities by the Water Saving Group and the Scottish Water Saving Network, and engagement

programmes by Waterwise aimed at changing public behaviour towards water use.

27.3.3.5 Markets and incentives (instrumental)

Market-based instruments, incentives and pricing policies can alter demand for water and the way in which water and its associated ecosystem services are exploited. In the past, many Freshwater ecosystem services have been undervalued economically. Market-based instruments include appropriate pricing of water resources, metering of water use to reflect the cost of water supply, tradeable quotas, fees, permits and subsidies (UNEP 2007). Disincentives can be deployed in water-stressed regions to discourage land use that increases evapotranspiration or that increases surface runoff, thereby reducing the recharge of soil moisture or groundwater. Conversely, incentives can be used to encourage land uses that conserve water (Weatherhead & Howden 2009).

Household use is the main component (52%) abstracted from the public water supply and has increased by more than 30% since 1970 (Foresight 2010). Water metering is a long-established measure for reducing domestic water demand by connecting water use to water bills. Less than one third of homes in England have a water meter (Defra 2008c) and even fewer are in place in Scotland; in the remaining unmetered homes, there is little financial incentive to use water wisely. According to the Department for Environment, Food and Rural Affairs (Defra 2008c), fitting a meter reduces water consumption by about 10%. Although the take-up of meters is usually due to consumer choice, the regulatory framework was changed in 2007 to allow water companies in regions of water stress to implement compulsory water metering. The Environment Agency found the cost of near-universal water metering to be good value compared to water provision options (Table 27.6).

While research has been underway to understand the value of ecosystem services, mechanisms for integrating these values into decision-making processes are needed. The concept of Payments for Ecosystem Services (PES) has received growing interest as a way of establishing a market for ecosystem services. Landowners are currently unrewarded financially for services their land provides that have wider benefits to society. Providing PES could reward landowners for delivering multiple ecosystem services from their land (Natural England 2009g). Within catchments this could involve, for example, downstream users paying

upstream landowners to maintain water quality or quantity. Agri-environment schemes could provide a mechanism to reward farmers for taking action to reduce flood risk by, for example, reducing runoff rates or storing floodwater (RELU 2010a). Some recent studies have demonstrated a willingness from the public to pay for improved water quality (Box 27.9).

A system of licences issued by the environment agencies of each country governs the abstraction of water from all sources of supply, including rivers, lakes, canals and groundwater, in order to minimise impacts on the environment. The availability of licences is determined at a local level using Catchment Abstraction Management Strategies (CAMS) in England and Wales, and Water Resource Management Strategies in Scotland. Licensees must pay water abstraction charges in all UK countries. In England and Wales, there is also a system of water rights trading, introduced following the publication of Taking Water Responsibly in 1999. Water rights trading involves the transfer of licensed water rights from one party to another to use water that is already licensed rather than abstracting

Box 27.9 The Norfolk Broads. Source: Turner *et al.* (2004); Pretty *et al.* (2002).

During the 1980s, the Environmentally Sensitive Area scheme was pioneered in the Norfolk Broads, and by 1989, the Broads Authority had been established to take responsibility for conservation, planning, recreation and waterways in the area (Figure 27.14). The Broads Authority has experimented with a number of fen management measures (from ponies to mechanical fen-harvester machines), and has run a publicly funded flood alleviation initiative (which includes soft engineering) for 20 years. More recently, the Authority has begun to adopt the ecosystem services approach and has put initial values on some of the services it manages.

A 'willingness to pay' survey by Turner *et al.* (2004) showed that individual households in the region were willing to pay around £75 per year to improve wastewater treatment in order to prevent algal blooms. This equates to annual benefits of £169 million if all households in East Anglia were to make this payment—a figure which far exceeds the amount of money required to make similar improvements across the whole of England and Wales: an estimated £50 million per year (Pretty *et al.* 2002). This demonstrates that, in some cases, if the value of ecosystem services are fully understood, the willingness to pay for them can exceed the amount required to sustain them (Pretty *et al.* 2002; Turner *et al.* 2004).

Table 27.6 The cost of near-universal water metering relative to other options. Source: EA (2009d).

*Costs taken from EA (2008c); †Average incremental social costs of other options are taken from EA (2007b).

Option	Range of costs (pence per cubic metre)
Near-universal (90%) metering *	140–160
Groundwater development †	100–500
Surface water development †	100–500
New reservoir †	300–1,000
Desalination plant †	400–800



Figure 27.14 Welsh ponies at How Hill National Nature Reserve in the Norfolk Broads, East of England. © Broads Authority. Photo by Ian Aitkin.

more water, and to encourage abstractions to be transferred to locations where more water is available (EA, 2011).

The Cave Review (2009) looked at competition and innovation in the water markets in England and Wales, and identified a number of weaknesses in the current abstraction licensing system. It reported that the licences are issued on a first-come first-served basis, and charges are limited to cost-recovery and are fairly crude. Historically, issued licences are also not limited by time. As a result of these characteristics, the system fails to ensure water is delivered to those who value it most, or to the environment. The Review recommended that “where license levels are sustainable, licenses should be fully tradable subject only to modification for direct environmental impacts and the impact on other users from a change of use or location.” It also recommends that in cases where the licensed volume of water is unsustainable “legislation should empower the Environment Agency to facilitate the return of licenses through reverse auctions and negotiated agreements”, and that a scarcity charge should be introduced to restore sustainable licence volumes. The price of water would be uniform across overabstracted catchments and rise over time (above that required for cost-recovery) to encourage licence holders to trade or retire their rights and realise the true value of the water (*ibid.*). The Department for Environment, Food and Rural Affairs and the Welsh Assembly Government are currently considering these recommendations.

27.3.3.6 Technologies and practices (instrumental)

In the past, technological responses have been perhaps the most important tools for addressing water quality issues. Industry standards, such as Best Available Technology, Best Environmental Practice and Best Environmental Management, have also driven and shaped the development and improvement of technologies (UNEP 2007). The most common application of technological responses in the UK has been in the treatment of wastewater and for water reuse, including pollution source control (e.g. clean technology, recycling municipal and industrial wastes) and centralised wastewater treatment facilities. While there remains considerable wastage of water from leakages in the distribution system, the amount of water abstracted for the public water supply is slowly decreasing due to an overall reduction in leakages (Orr *et al.* 2007). Non-point source pollution, however, is difficult to control with high-tech applications, instead requiring ecological approaches and educational and awareness building responses.

Ecosystem restoration is now a popular option, with the overall aim to restore degraded ecosystems in order to enhance the services that they provide (UNEP2007). However, restoration projects—including controlling invasive species, restoring hydrological regimes and ecological engineering—are normally more expensive than the protection of existing ecosystems (UNEP 2007).

Floodplains store water that would otherwise increase flood magnitude downstream (Acreman *et al.* 2003). They also provide benefits in terms of carbon sequestration, wild species diversity and purifying water of pollution. Restoring Floodplains is, therefore, held up as a win-win-win response. Meyerhoff & Dehnhardt (2004) found that the water quality

benefits provided by Floodplain restoration projects can have gains outweighing costs by a factor of 2.5 to 4. Yet raising water levels in Floodplains may not reduce flood risk. Although this response has mostly beneficial outcomes for ecosystem services overall (such as carbon sequestration), it cannot reduce flood storage in the long-term since saturated wetland soils with a water table near the surface have no, or limited, water storage capacity (Section 9.2.2.1).

Other types of restoration may, therefore, be better at reducing flood risk. Sustainable catchment drainage involves managing land to increase water infiltration rates and slow water down, providing benefits in terms of flood mitigation, maintaining low flows and purifying polluted water to reduce contamination of aquatic ecosystems and water supplies (Chapter 9). Encouraging water infiltration through appropriate land use practices in urban infrastructure development, land management and farming can also be effective at recharging aquifers and maintaining summer flows (HM Government, 2010b).

River restoration often involves the reinstatement of linkages between primary channels and nearby floodplains to increase flood attenuation. Morris *et al.* (2004) found that rivers restored with well-vegetated river channels can slow floodwaters down and enable them to infiltrate undeveloped floodplains, thus reducing the magnitude of flooding in built up areas. The re-creation of water and sediment transfers may not only reduce the flood severity downstream, but also improve the ecological water quality of rivers and create biodiverse Wetlands and washlands (Wharton & Gilvear 2006), offering opportunities for recreation, education and conservation. **Box 27.10** describes the environmental benefits that were achieved through the restoration of the River Glaven in North Norfolk.

Naturally occurring Wetlands can improve water quality by intercepting pollutants. This can offer a particularly useful way of addressing diffuse pollution from agriculture and urban sources (MA 2005), but their effectiveness depends on the Wetlands being situated in locations that intercept the pathway of the pollutant (Blackwell *et al.* 2009 in Chapter 9). Constructed Wetlands have long been used as a more cost-effective way of treating contaminated water than engineered solutions, with more than 1,000 projects in the UK (Cooper 2007; Section 9.2.2.4). Where such projects have been planned, implemented and managed well, they have

Box 27.10 Brown trout restoration work on the River Glaven, North Norfolk. Source: EA (2010c).

The Environment Agency established the River Glaven Sea Trout Restoration project with the primary aim to restore populations of brown trout in the river. Reconnecting the river laterally and longitudinally, and restoring the health and functions of the river, achieved this aim, but also brought a number of other benefits. While the project benefited anglers through the greater abundance of fish, more widespread benefits came from improving habitats for other species and increasing recreation and tourism. The extension of the project to provide routes for fish to bypass major obstructions on the river is also expected to provide benefits for flood risk management. The Environment Agency found that in cases like this, where the positive outcomes of a restoration project clearly outweigh the costs, an economic valuation of the benefits is not always necessary.

been successful long-term responses to pollution, and have also provided a range of other services such as increased wild species diversity and the supply of reeds for thatching. In cases without appropriate management, constructed Wetlands have become a source of pollution. Riparian buffer zones, a strip of protected habitat between the top of the riverbank and the river channel, can also protect wildlife and intercept sediments and pollutants before reaching the river (**Box 27.11**).

27.3.3.7 Voluntary actions (instrumental)

In the UK, the Rivers Trusts (which collectively fall under the umbrella organisation of the Association of Rivers Trusts) and fisheries boards carry out river improvements by attracting charitable funds. Each individual Rivers Trust was formed due to a particular trigger such as a growing awareness of the environment, a decline of certain indicator species, or a pollution event (ART, 2009). The Trusts draw upon teams of volunteers, typically from angling clubs and riparian landowners. They offer the advantage of gaining the trust of local communities and actors (Raven 2011). As decision-making is moved from central and regional government to local authorities and communities, the River Trusts may be able to play a greater role in the management of catchments (*ibid.*). As discussed previously under *Policies, Institutions and Governance*, local action in catchments can be effective (Section 27.3.3.3). A good understanding of catchment-scale processes is also required, however (Newson 2010), with some coordination needed to ensure that action taken

locally does not have unintended consequences downstream. Raven (2011) expresses concern that cuts in government funding for land management grants, monitoring, research and conservation projects could hinder River Trusts and other voluntary groups in making river improvements.

Many stakeholders are voluntarily involved in the management of water through, for example, Stakeholder Groups that work with the Environment Agency to develop CAMS, and Catchment Flood Management Strategies. River Trusts and fora, such as the National Flood Forum, enable the Environment Agency to connect with communities and find solutions to complex local problems (Orr *et al.* 2007).

In addition to Rivers Trusts, there are also a wide range of other trusts and NGOs involved in the conservation of rivers, lakes, Wetlands and Freshwater species. Voluntary conservation organisations, including The Wildlife Trusts, the National Trust and the RSPB, own considerable Wetland areas, affording them protection and managing them appropriately for biodiversity gain. Such organisations also mobilise significant numbers of volunteers. For instance, the Water for Wildlife partnership between The Wildlife Trusts, water companies and the Environment Agency involved nearly 5,000 volunteer working days to help the partners achieve the maintenance and restoration of 95,000 ha of Wetland and 750 km of rivers, and conduct otter (*Lutra lutra*) and water vole (*Arvicola terrestris*) surveys (The Wildlife Trusts 2010).

In some nations, community volunteerism plays a larger role in land-water management. In Australia, the government has emphasised voluntary action as a key instrument in river basin management, and invested heavily in participatory approaches. Almost all river rehabilitation schemes are implemented with volunteer involvement, with regional authorities and the Natural Heritage Trust providing support to volunteer groups (Fryirs *et al.* 2008). The aim is for participatory decision-making through regional governance, decentralisation, accountability, equity and empowerment. The intention is for management strategies to be designed for regional conditions and circumstances to increase the likelihood of success, but there are often problems with the process being influenced by vested interests and the exclusion of important stakeholders (*ibid.*). The Landcare movement in Australia has been the main mechanism through which volunteers have been engaged. It is a type of community-based natural resource management that involves individuals with varying backgrounds in local groups to cooperate with government and non-government stakeholders to manage the natural environment (Prager & Vanclay 2010). Read more about the Landcare groups in **Box 27.57**. Rivercare programmes were a spin-off of the Landcare movement, addressing specifically water quality and river system issues. Participants in Rivercare establish plans for the rehabilitation of rivers (Fryirs *et al.* 2008).

If the role of voluntary action in the management of UK catchments increases, it would be wise to learn from the experiences of countries with a stronger tradition of decentralised natural resource management. In addition to Australia, Landcare is also found in Germany, for instance, and Canada has a strong focus on decentralised and participatory management approaches.

Box 27.11 Providing ecosystem services in the Upper Bristol Avon through the creation of a buffer zone.

Source: EA (2010b).

A 330 m buffer zone along one bank in the Upper Bristol Avon catchment (North Wiltshire) was created following concerns raised by Somerford's Fishing Association: the field boundary near the river edge had been poached by grazing dairy cattle, and had eroded the riverine habitat; and diffuse pollution from sediments was impacting the river habitat and fish populations. Following discussions with the landowner and the Environment Agency, a buffer zone was created in 2008 at a cost of £4,700.

By the end of 2009, the area had been revegetated to such an extent that the riverbank was stabilised and the river channel narrowed. Not only did this reduce the runoff of pollutants into the river, but also improved the scour of the riverbed and increased flow and habitat diversity. The buffer zone created a suitable habitat for the breeding and protection of game and coarse fish species, and provided them with a source of food. The semi-static water and vegetation cover also provided a nursery area where juvenile fish can shelter from predators and where warmer shallow waters aid fry growth rates. Residents and visiting anglers report high numbers of birds and other wildlife, and an improved waterscape.

The project is estimated to have created gross lifetime benefits valued at £144,860—a benefit-to-cost ratio of 31:1. The project demonstrates that, by restoring the functioning of ecosystems, wider benefits to society can be achieved other than just the primary focus of the intervention (in this case, the fisheries). Buffer zones may be a useful measure to provide social and economic benefits, and for supporting the achievement of 'good ecological status' required under the Water Framework Directive.

27.3.4 Water Summary

Table 27.7 summarises the key insights from this review of responses in the water sector, highlighting those that have been well-established, but also identifying a set of responses that are either in early implementation or are proposed. It is important to learn from these early pilots across all sectors to scale-up the adoption of an integrated ecosystem approach to the management of the UK's diverse habitats, which is one key policy direction that this review recommends.

27.4 Agriculture

27.4.1 Agriculture, Ecosystem Services and Human Well-being

The agricultural sector is still managed and valued primarily for food production, and to a lesser extent forage, fibre,

bioenergy and pharmaceuticals. Arable crop yields have grown significantly (for example, wheat yields have risen by 300% during the period 1940 to 2008), but the sector's contribution to the national economy has declined since the 1970s, and livestock numbers have fallen in the last decade, particularly in upland grazing areas (Section 7.3.1). In addition to agri-products, agricultural land delivers many other ecosystem services—from drinking water supply to climate regulation—that are fundamental to the well-being of UK citizens. Upland grazing areas, for example, not only provide food, but are known for their outstanding beauty and provide a range of public benefits such as carbon sequestration, drinking water and recreation opportunities.

Up until the 1990s, maximising food provision often caused unintentional losses of other ecosystem services on farmland. Disservices of the sector included declines in farmland wildlife, nutrient loading of watercourses, and a significant contribution to the UK's greenhouse gas

Table 27.7 Water Summary.

	Established responses	Early implementation, pilots	Proposed, under development
Knowledge	<ul style="list-style-type: none"> ■ Research on catchment dynamics ■ River monitoring ■ Flood prediction 	<ul style="list-style-type: none"> ■ Understanding how freshwater ecosystems reduce flood risk ■ Holistic assessment tools (e.g. water cycle assessment) 	Research: <ul style="list-style-type: none"> ■ Valuation of freshwater ecosystem services (ES) ■ Land-water interactions delivering ES ■ Monitoring of climate change impacts ■ Linkages between ecosystem functioning and services, and connectivity between water bodies
Legislation	<ul style="list-style-type: none"> ■ Command and control regulations (e.g. IPPC Directive) ■ Designated areas (e.g. SACs, SSSIs, Nitrate Vulnerable Zones) 	<ul style="list-style-type: none"> ■ Water Framework Directive ■ Floods Directive ■ National flood and water legislation ■ Water Protection Zones 	
Policies, institutions and governance	<ul style="list-style-type: none"> ■ Top-down, sectoral water management ■ Decide-announce-defend decision-making ■ Engineered flood defences ■ Resource development (e.g. reservoirs) and demand management 	<ul style="list-style-type: none"> ■ Integrated Water Resources Management ■ Catchment management (land and water), e.g. by water companies ■ Stakeholder engagement ■ Third sector led schemes (e.g. River Trusts) ■ Flood risk management, including ecosystem-based approaches 	<ul style="list-style-type: none"> ■ Ecosystem services approach ■ Management responsibilities devolved to local and regional authorities and actors ■ Collaborative approaches ■ Engage-deliberate-decide decision-making ■ Support of local schemes by regional and national policy and funding, and catchment-scale coordination
Changing social attitudes	<ul style="list-style-type: none"> ■ Water saving initiatives ■ Land manager education & awareness raising programmes 	<ul style="list-style-type: none"> ■ Flood risk awareness raising 	<ul style="list-style-type: none"> ■ Social learning in river basin management
Markets and incentives	<ul style="list-style-type: none"> ■ Water fees ■ Water metering ■ Abstraction license trading 	<ul style="list-style-type: none"> ■ Payments for ecosystem services (e.g. through agri-environment schemes to reduce flood risk) 	<ul style="list-style-type: none"> ■ Disincentives to discourage land-use which increases evapotranspiration and decreases infiltration in water stressed regions ■ Universal water metering
Technologies and practices	<ul style="list-style-type: none"> ■ Wastewater treatment and water re-use technologies ■ Reducing leakage from water supply system ■ Ecosystem restoration (e.g. rivers, wetlands) 	<ul style="list-style-type: none"> ■ Ecosystem restoration designed to deliver multiple ecosystem services ■ Buffer zones to provide multiple ecosystem services 	
Voluntary actions	<ul style="list-style-type: none"> ■ Rivers Trusts and voluntary activity ■ Volunteer conservation organisations buying and restoring important freshwater habitat sites 		<ul style="list-style-type: none"> ■ Volunteers integrally involved in catchment decision making and restoration activities (e.g. Rivercare, Australia)

emissions. As evidenced in this section, however, some responses have led to a reduction, or even a reversal, in the deterioration of ecosystem services associated with agricultural landscapes (Chapter 7).

Agriculture also benefits from ecosystem service flows from nature. It relies on supporting services such as soil structure and fertility, nutrient cycling, water cycling and genetic biodiversity used in the improved breeding of crops and livestock. Pollinators visiting from adjacent unmanaged land can increase yields, while wild species can control pests (Chapter 14). Ecosystems can also purify and regulate the supply of inflowing water, improving plant growth (Power 2010).

Public access to agricultural landscapes offers opportunities for education and recreation, including exercise and relaxation that can support healthy lifestyles (Section 27.8). Farmers can manage the land to better conserve and enhance biodiversity and landscapes, which can attract tourism and, therefore, provide a source of income for rural economies. Promising evidence considered in this chapter suggests that agriculture can also reverse the negative ecosystem trends associated with its activities and enhance a suite of other benefits as well, such as food, energy, climate change mitigation, flood regulation, wild species diversity and water purification. Occupying almost 74% of the terrestrial UK (Foresight 2010), agriculture defines how the majority of land is managed and, thus, the range of ecosystem services provided to the public (**Box 27.12**). Therefore, the decisions taken by the sector in the coming

years are not only important for food security, but for many other socially and economically important objectives, too.

Figure 27.15 summarises the key drivers impacting on the agricultural sector and related ecosystem services. The sector has a significant influence on, and is influenced by, the other sectors discussed in this chapter. Readers are especially advised to read the water (Section 27.3), biodiversity (Section 27.2) and recreation and tourism (Section 27.8) sectors, in addition to the integrated responses section (Section 27.10), to gain a wider perspective. Biocrops are discussed in more detail under energy (Section 27.9) and forestry (Section 27.5).

27.4.2 Challenges for Agriculture

Global demand for food and other agricultural products, including biofuels, is expected to increase substantially over the next 50 years due to population growth, changing diets and government policy (Chapter 3). World market prices for agricultural commodities influence land use and practices, and largely determine the income of farms. Agriculture in the UK is, therefore, highly sensitive to world market volatility (Foresight 2010). Globally and nationally there are also growing concerns about food and energy security. At the same time, climate change and natural resource limitations will require more food to be produced sustainably.

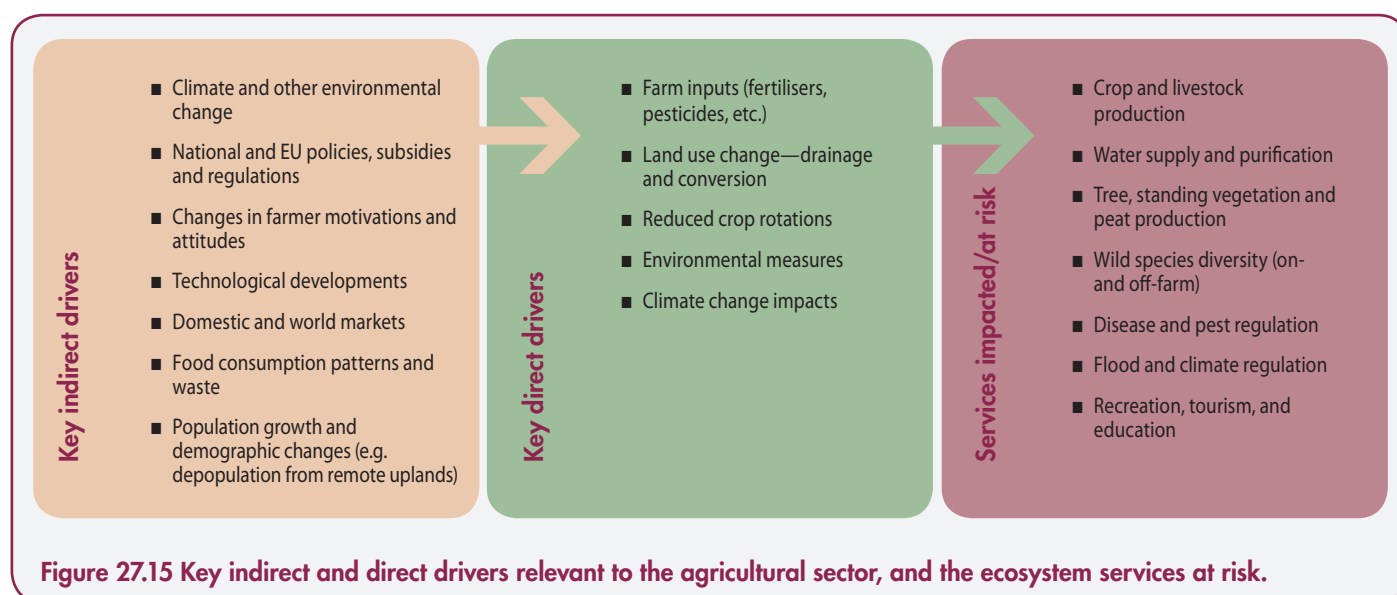
The public value of non-production ecosystem services provided by agriculture is increasingly reflected in legislation, markets and subsidies, both nationally and internationally. The Foresight Land Use Futures report (Foresight 2010) estimates that the value of these services is about £1.74 billion per year, whereas the impact agriculture has on ecosystem services is as much as £2.57 billion—a net cost to the UK of about £830 million per year. Although these figures need to be treated with caution, it asks whether this balance could be turned around, with agriculture becoming a net contributor of environmental value.

Demand for agricultural land is not uniform across the four countries of the UK; demand from other land uses has decreased the area of farmland in England (Angus *et al.* 2009), while remote grazing areas in Scotland are experiencing depopulation with implications for the maintenance of agri-

Box 27.12 Ecosystem services and public goods.

Source: ENRD (2010).

Public goods refer to a range of goods, services and other matters of societal interest that are typically not delivered through the market. Public goods include environmental goods, such as biodiversity or cultural landscapes, which are termed ecosystem services in the UK NEA. Please refer to literature from the European Network for Rural Development for further discussion of public goods in the agricultural context.



landscapes (SAC 2008; **Figure 27.16**). Pressure on essential inputs of water, energy and nutrients is intensifying, and the costs of such inputs is rising; to increase productivity, farmers will need to reduce waste, use precision application of chemicals and use water more efficiently (Foresight 2010). Climate change further complicates the sector's outlook and may increase risk to ecosystem service delivery. Moreover, the loss of productive land in other parts of the world due to climate change is likely to increase pressure on food production in the UK. The agricultural sector will also be asked more and more to play its part in climate change mitigation efforts. The UK NEA Economic valuation found that the loss in carbon storage on Enclosed Farmlands since 2004 will come at a cost of £600 per capita every year under a United Kingdom Climate Impacts Programme (UKCIP) high carbon emissions scenario for 2050 (Chapter 22).

The challenges for agriculture are therefore great: farmers must produce more food and energy with fewer inputs (energy, nutrients and water), and they must be productive in the provision of other ecosystem services, while becoming more resilient to climate change and world market volatility. A further major challenge is managing trade-offs between food production and environmental goals to optimise the provision of multiple ecosystem services for both public and private good.

27.4.3 Agricultural-related Response Options

27.4.3.1 Knowledge (foundational)

The monitoring of biodiversity, water and soil quality, and a body of academic studies in multiple disciplines, have revealed the dramatic declines in environmental quality resulting from the intensification, mechanisation and specialisation of agriculture since the Second World War (WWII). Responding to this knowledge (and public sentiment), agricultural policy has provided increasing protection to the environment, reflected in reforms to the CAP and the establishment of agri-environment schemes.

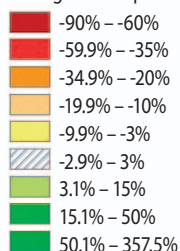
In the past, research developments have contributed to the political debate on various farming technologies. For example, the toxicity of organochloride and organophosphate insecticides to humans and wildlife was publicly revealed in the book *Silent Spring* by Carson (1962), and following further investigation, several harmful pesticides are now controlled in the UK under the Food and Environmental Protection Act (FEPA 1985—as amended) and the Control of Pesticides Regulations (COPR 1986).

In the near future, the agricultural sector is set to change in response to advances in climate science that have predicted significant environmental changes in the UK and globally. The work of the UKCIP has revealed a number of ways that climate change will impact agriculture, including greater pressure on water supplies, and changes to the growing season and types of diseases and pests (Section 7.2.2.1). Tools and guidance based on this science are being developed to help farmers adapt to future climate change (UKCIP 2011). Research organisations and agro-technology industries will also play a role in finding climate change adaptation solutions. The development of resilient crop varieties, for example, seeks to develop plant types that are productive under environmental stresses imposed by climate change. Furthermore, knowledge of the greenhouse gas contribution from agriculture (7% of the UK's total emissions; DECC 2009) and the potential for reducing emissions has resulted in concerted efforts from government and the industry to integrate climate change mitigation into farming practices (Section 27.4.3.3).

Despite significant advances, new research, spanning several disciplines, needs to further develop agricultural knowledge, science and technology to meet this century's challenges for farming. Spatial optimisation of land management has been suggested as one way to provide multiple ecosystem services from agricultural lands. Better understanding is needed of how such integrated land use could be achieved, and of the impact of different types of land use management on services such as food production (Chapter 7). A strong evidence base will also be important for supporting the food strategies of the four administrations (Scottish Government 2009b). A cross-government strategy for Food Research and Innovation has been launched to coordinate research in this area.

Decision-makers need to know how to meet the demand for ecosystem services in a changing environment. Understanding how to create resilient agro-ecosystems will be important for coping with climate shocks and market

Change in sheep numbers



Only Parishes containing five or more units with sheep have been included to meet disclosure requirements. Source: RERAD June Agriculture and Horticulture Census of Scotland

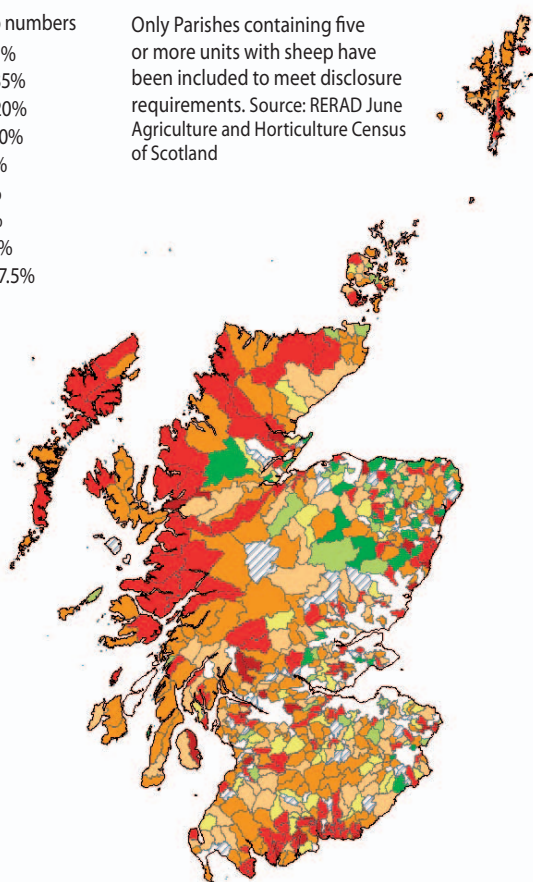


Figure 27.16 Changes in sheep populations in Scotland.
Source: reproduced from SAC (2008).

volatility. This may include research on farm- and catchment-scale systems, including the social and economic context of farmers and how they will deliver ecosystem services.

Knowing how to respond to likely cost increases of nitrogen inputs and potential shortages of phosphorus will be important. Food 2030 (Defra 2010e) highlighted the need to develop crop varieties that require fewer chemical inputs, but still meet consumer demands and agri-environment goals. Such research should consider the value of, and impact on, agricultural biodiversity and relatives of the crop in the wild.

Given the multifaceted influence of agricultural management on ecosystem services and human well-being, further investment in science, technology and skills is necessary to maximise the benefits from agricultural landscapes. The development of knowledge networks and collaborative mechanisms between public, private and non-governmental stakeholders will aid this process. Collaboration between researchers and the agricultural industry can identify the challenges that need to be understood (Defra 2010e), and better incorporation of farmers' local knowledge could improve the design and delivery of agri-environment initiatives.

A new Sustainable Agriculture and Food Innovation Platform, led by the Technology Strategy Board, was established with funding from the Department for Environment, Food and Rural Affairs and the Biotechnology and Biological Sciences Research Council (BBSRC) of £90 million over five years. The platform aims to support innovative technological research and development in areas such as crop productivity, sustainable livestock production, waste reduction and management, and greenhouse gas reduction (Defra 2010e).

27.4.3.2 Legislation (enabling)

Agriculture is affected by a large number of different pieces of legislation at EU, national and devolved level. The summary below focuses on the CAP as an example of legislation governing farming practice. Some other pieces of legislation relevant to farming in the UK, such as the WFD, Nitrates Directive, and Habitats and Birds Directives, are discussed in the Water and Biodiversity sections of this chapter.

The CAP embodies a raft of legislation governing the application of the EU's system of agricultural subsidies which currently account for over 40% of the total EU budget. The CAP has evolved over the years from its roots as a post-war food security policy towards a gradually increasing emphasis on rural development and environmental protection. Most recently, significant reforms took place in 2003, followed by a number of further amendments via the CAP Health Check in 2008. Further large-scale reforms will be developed in time for implementation in the next EU budgetary period, 2014 to 2020. The EC has begun developing proposals for the new legislation, and will issue more details during 2011 (EC 2010c).

The CAP is implemented separately by England, Scotland, Wales and Northern Ireland, so different sets of regulations exist and different agencies are responsible for allocating the payments and enforcing the rules in each jurisdiction.

In its current form, the CAP is organised into two 'Pillars'. Pillar 1 contains rules allocating around two thirds of the

total subsidy amount in the form of direct payments to farmers. This system is known as the Single Farm Payment Scheme. The origins of Pillar 1 payments are production-linked subsidies of the early CAP, which largely took the form of guaranteed prices: the more farmers produced, the more subsidy they received. Following the 2003 reforms, payments are no longer directly 'coupled' to production in this manner for the majority of agricultural products, although some direct production-linked elements remain, as do a limited number of price intervention mechanisms. The goal is for production linkages to be phased out completely by 2012 (although Scotland will retain some production-linked payments through the Scottish Beef Calf Scheme). However, it is crucial to note that the allocation of the Single Farm Payment currently still reflects the historical, production-linked position, which means it is biased towards large, high intensity farms.

The Single Farm Payment is linked to a system called 'cross compliance'. This means that there is a set of standards concerned with food safety, environmental management and animal welfare which farmers must comply with as a condition of receiving their subsidy. Some of these cross compliance standards are obligations of existing EU legislation. These are known as the Statutory Management Requirements. Further standards have been introduced explicitly through the cross compliance scheme; these are known as Good Agricultural and Environmental Condition (GAEC) standards and are set broadly by the EU legislation and defined in more detail at national or regional level. For example, the Department for Environment, Food and Rural Affairs has implemented a GAEC requirement for soil protection by requiring farmers to complete an annual Soil Protection Review. Cross compliance is intended to promote sustainable agriculture, while lending legitimacy to the direct payment system by making it conditional on farmers complying with basic rules, including for environmental protection (CEC 2007).

Pillar 2 refers to the second main financial instrument of the CAP, accounting for approximately one third of the budget. This is the European Agricultural Fund for Rural Development. The overarching rules are set out in the Rural Development Regulation (1698/2005 as amended) and supplemented by Commission Regulations 1974/2006 and 1975/2006, dealing with further details of how the scheme should be implemented and enforced. Under this regime, payments may be targeted at specific types of action, which are categorised under three headings: Axis 1, improving competitiveness in the agriculture and forestry sectors; Axis 2, improving the environment ('agri-environment'); and Axis 3, improving quality of life and diversification for rural communities. These payments are designed to compensate farmers for additional costs and income foregone through undertaking the environmental improvement measures. In the UK, for the 2007 to 2013 EU budgetary period, approximately 80% of Pillar 2 money is allocated under Axis 2 (Defra 2009d).

In England, Axis 2 subsidies take the form of Environmental Stewardship schemes, administered by Natural England and the Rural Payments Agency. There currently include the Entry Level Stewardship (ELS) and

Higher Level Stewardship (HLS) schemes, plus particular schemes for organic and uplands farming. Both ELS and HLS involve environmental obligations going beyond the baseline standards set by cross compliance. Entry Level Stewardship payments are allocated per hectare of land, and farmers must apply particular land management actions to the area covered. A range of management options is available, and points are awarded for each action undertaken, building up to a points target. The options include the protection of in-field trees, the management of hedgerows, maintaining buffer zones, and providing in-field grass areas to prevent soil erosion and runoff. Higher Level Stewardship schemes involve tailored management agreements undertaken over ten-year periods and intended to address specific local targets.

In Scotland, previous agri-environment schemes have been incorporated into the Scotland Rural Development Programme, which also contains schemes for forestry, rural enterprise and business development. All support provided through Pillar 2 of the CAP (i.e. Axis 1, 2 and 3) in Scotland is managed through the programme, and priorities for achieving national outcomes are set by stakeholders at a regional level. More details of the operation of agri-environment schemes in each of the UK jurisdictions are given under Markets and Incentives (Section 27.4.3.5).

In terms of their effects on ecosystem services, the production-linked subsidies of the CAP (still reflected in the current direct payments system) were aimed at dramatically increasing provisioning services by encouraging high intensity, monocultural production, with high inputs of energy, water and chemicals. But these subsidies had unintended consequences for regulating, supporting and cultural services. The intensification of agriculture, promoted by the CAP (Baldock *et al.* 2002; EEA 2009), has correlated strongly with a substantial decline in farmland biodiversity (BirdLife International n.d.; Donald *et al.* 2006). Although some biodiversity declines have levelled off more recently, the CAP has not yet changed enough to protect against further losses (Biala *et al.* 2010). Supporting services reliant on biodiversity, such as invertebrate pollination, biological pest control and soil nutrient cycling, continue to be at risk as a result. Favouring large-scale and intensive farming practices in subsidy allocation (EEA 2009) has also led to the loss of valued landscapes (Ellison 2001) and countryside features, and fails to account for the role farming can play in maintaining the countryside for the provision of cultural ecosystem services (CPRE & NFU 2006).

A major challenge for the latest reform round will be how to design a CAP capable of supporting a much wider range of public goods provision including soil functionality, water quality, carbon sequestration, flood resilience, biodiversity and landscape goals (Cooper *et al.* 2009). Cross compliance and agri-environment schemes have aimed to tackle this objective, but various features of the way the current legal framework is structured continue to stand in the way. Three examples of these weaknesses are as follows:

1. Lack of efficacy of cross compliance penalties.

Cross compliance is intended to form a baseline standard for good environmental practice, animal welfare and public, plant and animal health in agriculture. However,

significant problems with enforcing the system mean that it fails to fully meet its environmental objectives (CEC 2007; European Court of Auditors 2008; Boccaccio *et al.* 2009b). Environmental cross compliance obligations are, in many cases, vaguely worded and difficult to check, varying in stringency across different regions. The legal requirement for the frequency of farm inspections is very low. In addition, the main sanction for a breach of cross compliance rules is a percentage reduction in the amount of subsidy payment, up to a maximum of 5%. The European Court of Auditors has criticised the fact that the size of the subsidy, rather than the severity of the breach, may be the main factor determining the penalty, with the outcome that a big polluter receiving low subsidies may pay a low fine, while a small polluter receiving larger payments pays more. Overall, the likelihood and size of the sanction may be offset by the gain to be made from committing the breach, such as benefiting from high prices gained from the extra productivity (*ibid.*). In addition, the system has been criticised for effectively turning a set of mandatory legal obligations into a voluntary arrangement (Boccaccio *et al.* 2009b). The Statutory Management Requirements of cross compliance are all pre-existing legal rules which must be complied with in any event, not simply to avoid a reduction in subsidy.

2. Non-inclusion of certain important environmental standards in cross compliance. Simplification of cross compliance during the 2008 Health Check led to mixed outcomes, including the removal of certain items considered by some stakeholders (such as the RSPB and the Institute of European Environmental Policy) to be of crucial importance for sound environmental management (IEEP 2008a; Boccaccio *et al.* 2009b). Of particular concern was the removal of certain biodiversity protections, like Article 8 of the Birds Directive and Article 15 of the Habitats Directive, which prohibit indiscriminate methods of killing birds and other animals (such as using poisoned bait and traps). The EC believed that these standards were not relevant in an agricultural context (EC 2009b). Conservationists believe that a broader vision of rural land management is necessary, bearing in mind the overlapping uses of land for agricultural and other purposes such as recreational hunting and fishing (Boccaccio *et al.* 2009, p.19, 21).

3. Implementation of Axis 2 measures. Generally, the fact that Axis 2 payments are, according to the legislation, compensation for income foregone rather than incentives, is seen as a constraint on the ability of scheme organisers to set up dynamic and ambitious environmental stewardship programmes (Defra 2008b). In addition, the organisation of ELS schemes makes it difficult to encourage ambitious environmental outcomes. From the range of management options available, the least onerous or most affordable measures may be chosen. While this system may have encouraged greater uptake of the scheme by farmers, environmental NGOs have voiced concern that there are insufficient mechanisms to make sure that more complex measures, with as much or more ecological significance, are not neglected (Boccaccio *et al.* 2009a). A recent study tracking 70 Scottish farms over seven years has indicated the added benefits to be gained from properly targeted agri-environment measures over more generic management

options (Perkins *et al.* 2011). Rural Priority Setting by the Scottish Government is an example of a system designed to help ensure that Axis 2 CAP payments are aligned with regional conservation priorities: payments are awarded to those applicants whose management proposals fit best with delivering the priority outcomes for their region.

A further weakness is that the consideration of conflicts is not built into the legal framework. This means there is potential for conflicts to arise between payments for environmentally sensitive farming, and farm modernisation measures that have adverse effects on habitats and biodiversity such as infrastructure installations. Clearer mechanisms for identifying positive links between environmental protection actions and economic development outcomes could be considered in future CAP reform.

In November 2010, the EC released a communication setting out its high level proposals for the next round of CAP reform (EC 2010c). The Commission envisages three main objectives for the future CAP: viable food production; sustainable management of natural resources and climate action; and balanced territorial development. The proposals maintain the two Pillar structure, noting that Pillar 1 payments must become 'greener' and more equitably distributed. Linking payments to actions involving permanent pasture, green cover, crop rotation and ecological set-aside are specifically mentioned. With regard to environmental measures under Pillar 2, the communication states that these "should be more closely tailored to the specific needs of regions and even local areas such as Natura 2000 and [High Nature Value] areas"; however, the detail of the framework will be crucial and remains an open question. It is not yet resolved whether the new legislation will be an adjustment or a far-reaching reform with a strong focus on environment and climate change objectives.

Conservation groups have welcomed the proposals for the greening of Pillar 1 and the recognition that both an enhanced cross compliance baseline and incentive payments for ecosystem protection will have a role to play. Nevertheless, there is strong criticism of the proposal for its failure to recognise the importance of agri-environment schemes (IEEP 2010). The UK Government has called on the EU to be more ambitious in its plans, and has emphasised the importance of maximising the scope of Pillar 2 to reward farmers for the provision of public goods (Defra 2011).

Robust environmental protection rules under a reformed CAP will be vital to the success of the Birds and Habitats Directives. A large proportion of Natura 2000 sites are on farmland, and extensive agricultural practices (e.g. low impact grazing and sustainable forestry) are essential to Natura site management. Clearly, environmentally damaging agricultural practices would breach the Habitats and Birds Directives provisions. The wider impact of agriculture generally on Natura 2000 sites, for instance through diffuse pollution effects, must also be considered. The EC has emphasised that "Natura 2000 and the conservation of threatened species will not be viable in the long term without a wider terrestrial, freshwater and marine environment favourable to biodiversity" (CEC 2006).

The Nitrates Directive and the WFD (Section 27.2.3.2) are also important areas of legislation which seek to influence

the way agricultural practice impacts on other sectors, in this case affecting the health of inland and coastal water systems. Diffuse pollution from agricultural land, particularly from nitrates, remains one of the major pressures on aquatic systems (EEA 2010); hence, robust monitoring of pollution control requirements under the CAP and the Nitrates Directive are essential to the success of the WFD.

27.4.3.3 Policies, institutions and governance (enabling)

In the mid-1970s, food self-sufficiency was the prevailing agricultural policy, which resulted in food provisioning services being maximised, with unintended negative consequences for other ecosystem services. Today, none of the UK governments and assemblies have targets for national self-sufficiency. Instead, the UK's Food 2030 Strategy (Defra 2010e), for example, seeks to achieve food security through "strong UK agriculture and international trade links with EU and global partners".

As self-sufficiency priorities have given way to international markets, subsidies have been rolled back from supporting food production, and have moved towards protecting the environment. This is evident in CAP reforms and European Directives, such as the WFD, as well as in the extensive enrolment of farmers in agri-environment schemes (Section 27.4.3.2; 27.4.3.5). Agri-environment schemes have been an effective means of widening the remit of rural land management to protect the environment, and their further development is likely to be an important mechanism for policy makers to bring about real change.

Under the schemes, land managers are currently rewarded with annual payments for adopting management practices which protect soils and water, and maintain or enhance biodiversity. These practices can protect some of the services provided by farmland that currently do not have a market value by compensating farmers for the opportunity costs. A policy direction that is receiving growing support (e.g. in the Foresight Report, Foresight 2010) proposes a more integrative view of land planning where the value of non-production public goods are considered and land managers are rewarded for managing them. To achieve this integrated approach, the Rural Economy and Land Use Programme (RELU 2010a) recommend the adoption of an ecosystem service approach to agri-environment policy (**Box 27.13**)

Deliberately managing a more diverse range of ecosystem services from agricultural land will inevitably require trade-offs to be made, but there are also likely to be opportunities for management options to conserve or enhance more than one service. The key trade-off in agriculture is between increased food and energy production, and regulatory and cultural services. For instance, habitat and species diversity normally declines with increases in agricultural production, although environmental management practices are available that can minimise the impact on biodiversity without negatively affecting production. Further examples include food competing for land with bioenergy (Section 27.9.2), and changes to livestock management to reduce greenhouse gas emissions impacting livestock managed habitats (Defra 2010e). Food security, climate change mitigation and the implementation of the WFD are current policy priorities, and

Box 27.13 Advantages of an ecosystem service approach to agricultural policy. Source: RELU (2010a).

The Rural Economy and Land Use Programme (RELU) used the ecosystem service approach as a framework for several of its projects on land use. For instance, the Sustainable Uplands Project identified several advantages of adopting the approach in developing and implementing land management policies:

- By rewarding farmers for providing environmental public goods, rather than only for food and fibre, competing objectives may be reconciled.
- The diverse mechanisms used to pay farmers for providing different services could be reorganised within a single ecosystem services framework that provides incentives for the provision of a wider range of environmental public goods.
- Public funds could be deployed more effectively by using capability assessments to target funds on those locations which can most efficiently deliver the specific public goods.
- Diverse sources of information (e.g. on water quality, ecology, soils and landscape) could be brought together within a single framework; thus, when determining how support should be targeted spatially, they could be evaluated alongside each other, rather than relying on designations which tend to focus on one service at a time, such as Nitrate Vulnerable Zones (water quality) and EU Natura 2000 sites (biodiversity).

may determine which ecosystem services are prioritised, with the risk of conservation becoming “marginalised as an ‘added value’ element of multi-objective landscapes” (Bradbury *et al.* 2010).

New research, however, is revealing opportunities for win-win policies and demonstrating that trade-offs between agricultural production and regulatory and cultural services are not always necessary. The appropriate management of ecosystems that provide services to agriculture can increase production as a result of enhanced pollination, pest control, soil fertility and retention, and regulation of nutrient cycling (Power 2010). Badgley *et al.* (2007) analysed yields from agro-ecosystems from around the world and found that agricultural systems that use measures that protect ecosystem services (e.g. minimum tillage, grassland management, biological control and less agrochemical inputs) perform as well as intensive, high input systems. In the UK, farmers have managed to increase yields since the 1990s, while reducing greenhouse gas emissions and inputs of artificial fertilisers. For example, potato yields have increased by 18%, sugar beet by 45% and wheat yields by 8%, while the application of fertiliser has decreased by up to 52% between 1990 and 2007, and total greenhouse gas emissions have fallen by 20% (although this is largely due to a reduction in livestock numbers) (Defra 2010e). However, more research is needed to identify beneficial synergies (Chapter 7).

Low intensity agricultural landscapes, where food production is limited by environmental conditions, may prove easier areas in which to establish win-win management that provides multiple environmental public goods (Bradbury *et al.* 2010). Livestock-grazing managed by many generations of farmers has played a fundamental role in shaping the aesthetics and culture of the UK’s countryside. The provision of ecosystem services from moors, heathlands and grasses are typically dependent on the continuation of low intensity livestock grazing systems (Section 5.1.3). But livestock numbers are decreasing in many upland areas (SAC 2008), which may have negative impacts for some of these services. The High Nature Value (HNV) farming concept recognises the nature conservation value of such landscapes, which the EC

hopes to protect through the Rural Development Programmes (Box 27.14). While there may be some benefits of destocking to revegetate bare or eroding peats to enhance carbon storage, a substantial decline in sheep population in the uplands could have unexpected consequences (Section 5.2.1). It may be necessary to consider how sufficient stocking densities can be maintained to ensure current upland landscapes and their ecosystem services are retained. Chapter 5 discusses options for the sustainable management of these uplands in more detail, and recommends that management of Mountains, Moorlands and Heaths should be sufficiently flexible to allow adaptation to uncertain changes in condition.

When considering how to optimise the delivery of ecosystem services from farmland, scale is important, both spatially and temporally. Win-win measures, as described above, often take time before benefits to production are realised, and the short-term provision of one service can affect its provision and other services in the future (Power 2010). Policy makers should also consider the scale of implementation that is required for a measure to achieve its objective (Bradbury *et al.* 2010). For example, the control of arable weeds requires management at the field-scale, farmland birds need a mixture of habitat at the landscape-scale, and water quality is likely to be best considered at the catchment-scale. Moreover, climate change adaptations that increase the resilience of farmland habitats may need regional-scale strategies, and planning for carbon sinks, a national-level strategy (RELU 2010a). This suggests that there is no one scale that agri-environment policy should be implemented at, and that schemes need to target appropriate scales or risk being ineffective. RELU (2010a) recommend designing agri-environment schemes that can be applied at multiple scales to maximise their impact. In the case of mobile species, such as butterflies and birds, schemes would go beyond actions at the farm-scale, requiring multiple farmers to collaborate to achieve landscape-scale benefits. Section 27.10.5 discusses incentive options for encouraging collaboration between farmers.

Current agricultural governance arrangements are unlikely to be appropriate for managing these multi-scale issues, especially at landscape- and catchment-scales, or delivering ecosystem services cost-effectively (Chapter 7). The Foresight Land Futures report (Foresight 2010) described policy pertaining to agriculture as fragmented and sometimes conflicting, and recommends the development of new governance structures to reward farmers for providing ecosystem services. Greater stakeholder engagement is likely to be critical in a governance structure that adopts the ecosystem services approach to land management. Involving stakeholders can help to understand who benefits and loses from policies, and can strengthen and validate the setting of priorities, values and the fair management of agri-ecosystems. RELU (2010a) suggest that policies designed to enhance a wider range of ecosystem services from a given area of land will only be successful if they manage these distributional aspects. Involving stakeholders, especially farmers, in the design of agri-environment schemes at a local scale, such as a catchment or landscape, from the outset and through continued engagement may encourage greater local ownership (RELU 2010a). Readers are strongly

Box 27.14 The High Nature Value (HNV) of Scottish farming systems.

Source: McCracken (2009).

The HNV farming concept recognises that many European habitats and landscapes considered to be of high value for nature conservation are dependent on the continuation of specific low intensity farming systems such as those found on the islands, and in the hills and uplands of Scotland (Figure 27.17). These farming systems are becoming economically unviable due to market, policy and social pressures; for example, Europe-wide changes to the CAP reduced support for low intensity farming activity in Scotland. The abandonment of these farms would change the nature conservation value of these landscapes.

The HNV concept has been adopted by the EC, requiring Member States to ensure that Axis 2 (environmental improvements) of their Rural Development Programmes is targeted at “biodiversity and preservation of high nature value farming and forestry systems, water and climate change”. The implementation of HNV through Scotland’s Rural Development Programme will provide financial support for low intensity farming that maintains HNV. Scottish Natural Heritage is currently establishing a baseline of how much and where HNV farming occurs in Scotland. McCracken (2009) suggests there is also a need to consider what support mechanisms are most appropriate and what policy framework is needed to ensure that support can be implemented effectively.

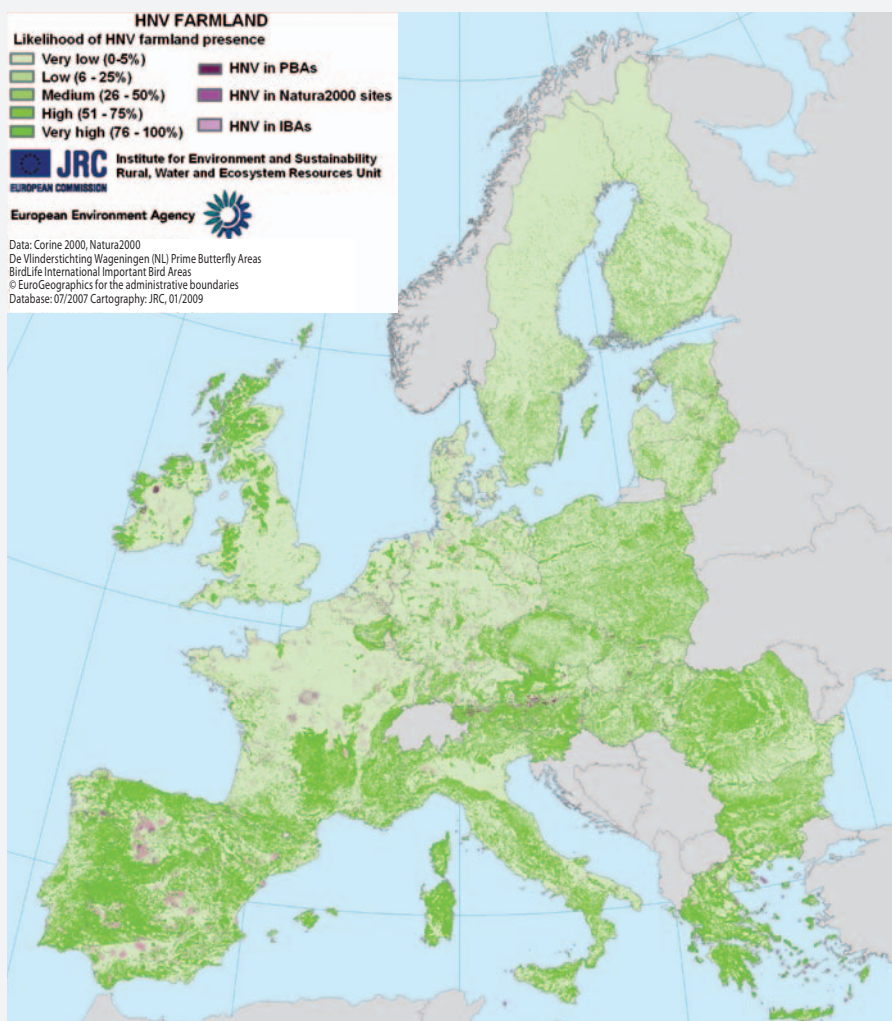


Figure 27.17 Map of potential High Nature Value (HNV) areas in Europe.
Source: KnowledgeScotland.org.

advised to examine lessons on engagement identified during the RELU projects (RELU 2010a).

It may even be necessary to look beyond agricultural management to think more holistically about all land uses—the spatial optimisation of land management may be more effective at delivering a greater range of ecosystem services. Scotland’s A Forward Strategy for Scottish Agriculture

aims to “promote an integrated, landscape-scale approach to environmental improvement”. The Scottish Government is also developing their first national Land Use Strategy to guide an integrated approach to land use management (Section 27.10.3, **Box 27.51**).

Future challenges due to environmental change are likely to demand landscape-level responses. **Box 27.15** discusses

Box 27.15 Agricultural policy and climate change.

Climate change has emerged as a major issue for the agricultural sector both in terms of adaptation and mitigation, with a number of important government policies driving responses. Agriculture can reduce its emissions of greenhouse gases by changing practices, storing carbon within agri-ecosystems, and also through the production of bioenergy (where energy input is less than energy produced).

Each of the Devolved Administrations has produced an action plan for tackling greenhouse gas emissions from agriculture. The UK Low Carbon Transition Plan resulted in the industry-led development of the Agriculture Industry Greenhouse Gas Action Plan 2010, whereby English farmers have agreed to reduce their collective emissions by 3 million tonnes carbon dioxide equivalent by 2020, from a level of 44 million tonnes carbon dioxide equivalent in 2008. The Land Use Climate Change Group (2010) reported to the Welsh Assembly in March 2010. Its key suggestions for reducing emissions from agriculture are: the introduction of anaerobic digestion to reduce methane emissions; improving farm productivity; using manure, fertilisers and energy more efficiently; the expansion of woodlands; and the development of renewable energy sources.

Existing agri-environment policies have already made a contribution to climate change mitigation and have the potential to be targeted more effectively. According to the Department for Environment, Food and Rural Affairs (Defra 2007b), the Environmental Stewardship scheme (Section 27.4.3.5) saves an estimated 3.46 million tonnes of carbon dioxide per year, and emissions from agriculture would be 11% higher without it. The value of these savings has been estimated at between £600 million and £1.8 billion.

the role of agriculture in mitigating and adapting to climate change, which has become a major agricultural policy area in recent years.

27.4.3.4 Changing social attitudes (enabling)

Public attitudes to food and farming. Overconsumption and obesity are major health concerns and costs in the UK, and are related to the consumption of unhealthy (and often processed) food and inactive lifestyles. The economic cost of people being overweight or obese is estimated to be £49.9 billion by 2050 (Foresight 2007). Prevailing diets in the UK also comprise intensively produced food that carries environmental costs that are not reflected in the price to consumers. Changing the behaviour of consumers towards more healthy, sustainable diets is, therefore, a priority policy area.

In contrast to these general dietary trends, demand for organic and ethically produced food has increased significantly, and an interest in local, seasonal food has emerged (**Figure 27.18**). The number of consumers buying locally produced food has almost doubled from 15% in 2006 to 27% in 2009, while those buying organic food increased from 12% to 24% between 2006 and 2008, but fell back to 19% in 2009 (Defra 2009e). The recent dip in demand for higher value organic food is likely to be a response by consumers to the economic recession, but it is unclear whether demand has reached a plateau or will grow further in the future. However, the reasons for people buying organic foods may be more the result of perceptions of improved quality and health benefits than concerns about the environment (Wier *et al.* 2008).

Local food markets (**Figure 27.19**) have grown in popularity over the past decade, enabling consumers to interact with producers and better understand where their food is grown and by whom. Moreover, an increasing number of households are growing their own food in their gardens and at allotments: an activity that can have a number of benefits for mental and physical health, and community cohesion. Novel community food projects are also appearing

across the country, with the potential to increase food produced in urban areas. Supermarkets have played a role in enabling products with an added environmental value to reach a wider consumer base than that of local markets by stocking them in their extensive network of retail outlets and promoting them widely (Chapter 7). The purchasing power of supermarkets has been a driver of change throughout the food chain.

In addition to government support for the conversion of agricultural land to organics (e.g. Organic Farming (Aid) Regulations 1994), the rise in demand for 'ethical' foods has acted as an incentive for farmers to convert land to organic systems and adopt more environmentally friendly practices. This has changed the environmental impact of these farms, reflecting the power of consumers to alter markets, farmer behaviour and, ultimately, the impact of agriculture on ecosystems. Organic farming, for instance, can be beneficial for farmland biodiversity (Hole *et al.* 2005), long-term soil fertility (Watson *et al.* 2002), and tends to have more semi-natural habitats capable of providing multiple benefits (Section 27.4.3.6). Concerns over intensive agriculture have had a significant influence on policy as well as markets, and consumer resistance to new agricultural technologies can be powerful. Public objections to genetically modified (GM) crops, for example, have prevented them being commercially planted in the UK to date (Section 27.4.3.6).

The certification of food that meets standards of production allows consumers to feel confident of the ethical claims made by the producer and retailer; this makes them more willing to pay the high prices the food commands. This is particularly true where the consumer and producer do not meet face-to-face (as is the case at farmers' markets), such as in supermarkets where the majority of organic food is purchased in the UK (Daugbjerg & Sønderskov 2009). Certification schemes also set criteria that can guide farmers to use best practice. In addition to organic certification that restricts the use of agrochemicals, farms that meet the Conservation Grade protect wildlife habitat, while Linking Environment and Farming (LEAF) promotes integrated and

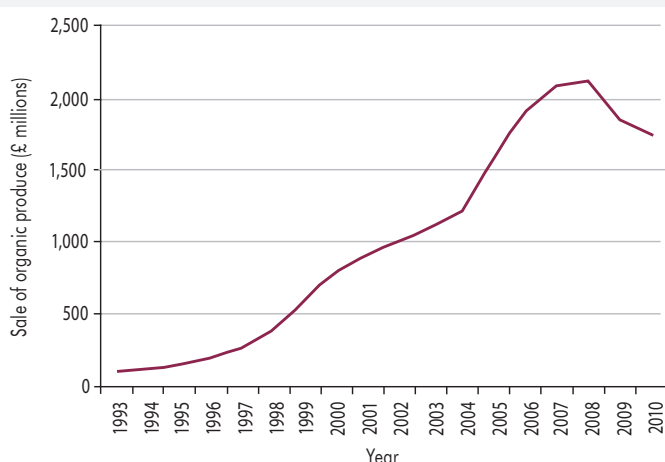


Figure 27.18 UK sales of organic products from 1995 to 2009*.

Source: reproduced from Soil Association (2010); www.soilassociation.org.

*Soil Association Organic Market Reports/Organic Food and Farming Reports 1999–2009.



Figure 27.19 Fresh vegetables at Borough Market, London.

Photo by Stacy Cashman at RamblingTraveler.com, available under a Creative Commons Attribution-ShareAlike license.

precision crop management (Section 27.4.3.6). The Assured Foods Standards' Red Tractor scheme, which has over 78,000 members, brought together several food assurance schemes to set standards for food safety and hygiene, animal welfare and environmental protection. The scheme only restricts members to minimum standards for environmental protection due to concerns that stricter standards would harm the competitiveness of producers (Snowdon 2002). With the exception of the organic food label, studies have found that the range of eco-labelling logos and schemes often confuse consumers (Foresight 2011).

The Department for Environment, Food and Rural Affairs' Food Strategy (Defra 2010e) sets a vision for 2030: people are connected to their food and are more involved in cooking and growing healthy food; they understand the impacts of their diet on health, the environment and other people; and they minimise their waste. Changes to diets will have implications for the management of agricultural land. For instance, reduced demand for carbon-intensive produce, such as beef, lamb and dairy products, would lower the emissions from the agricultural sector (Sutherland *et al.* 2010). Some consumers are already concerned about the climate change impacts of their food (Defra 2010e).

Every year, 8.3 million tonnes of food and drink is wasted by UK households (65% of which is avoidable), representing 22% of all purchases by weight (WRAP 2009). This costs people in the UK £12 billion annually (**Figure 27.20**). Shifting behaviour further up the waste hierarchy towards the initial prevention of waste is the preferred response option (Defra 2010o); the use of campaigns and advice aimed at households is a particularly popular response (**Box 27.16**). In theory, reducing food waste should reduce food demand, and thus reduce pressure on agricultural land and create space for other land uses such as conservation and carbon sequestration. Given that food waste produces the greenhouse gas equivalent of 20 million tonnes of carbon dioxide every year (WRAP 2009), reducing it could also make a significant contribution to climate change mitigation. While households contribute over one half of the UK's food waste, food and drink is also wasted on farms, and during manufacture, distribution and retail (**Table 27.8**). Waste and Resources Action Programme (2010) estimate that the

diversion of food waste from landfill to animal feed could save a manufacturing company £85 per tonne, and £555 per tonne if they avoided the waste altogether (in terms of saved raw materials, energy and labour).

Farmer attitudes and values. The decisions farmers make can have a wide-ranging impact on ecosystem integrity both on- and off-farm. Understanding the motivations for their decisions and behaviour is, therefore, important for finding ways to move towards more sustainable agricultural systems (Feola & Binder 2010). A number of instruments can be employed to initiate behaviour change among farmers including regulatory and economic incentives and disincentives, provision of advice, and voluntary collective actions (Blackstock *et al.* 2010). Here, we discuss knowledge sharing networks and engagement of farmers in decision-making as a means to change behaviour.

A review of theoretical and applied evidence of farmer behaviour (Defra 2008e) found that the decisions made by individual farmers are shaped by their own specific contexts: not every farmer seeks to maximise

Box 27.16 Love Food Hate Waste—a campaign to reduce food waste. Source: www.lovefoodhatewaste.com; Defra (2010o).

Waste and Resources Action Programme (WRAP)'s Love Food Hate Waste campaign aims to raise awareness about the environmental and social costs of avoidable food waste and provide practical advice to households on how to reduce food waste. Research has shown that consumers are generally interested and willing to reduce their waste. The campaign highlights the benefits of reducing waste through positive messages that promote easy, practical changes to behaviour such as better planning of shopping and cooking. Information to help reduce food waste, such as recipes for leftovers and guidance on storage, is provided on a website and through local roadshows which visit supermarkets, businesses and community groups. WRAP also hope that the campaign will contribute towards reducing carbon dioxide emissions from the production and disposal of wasted food.

Table 27.8 Food waste in the supply chain. Source: data extracted from WRAP (2010); data from Food & Drink Federation, Environment Agency, WRAP/DHL, WRAP & Eurostat.

Supply chain stage	Food
Manufacturing*	2,591,000
Distribution†	4,000
Retail	362,000
Household‡	8,300,000
Total	11,257,000

* The manufacturing data is from 2006.

† Scaled up from information supplied from one major supermarket company.

‡ Food and drinks waste including that sent for sewer disposal (an additional 1.8 million tonnes) and not recorded in the other stages.



Figure 27.20 Food waste costs the UK £12 billion per year. Photo by Nick Saltmarsh, available under a Creative Commons Attribution license.

profits, decisions are made based on a range of long-term attitudes, and behaviours are rational to the individual. Hence, a segmented approach to designing policy options to change farmer behaviour may be more effective than 'one size fits all' approaches. Agri-environment schemes have often failed to persuade farmers that they can, or need to, change their behaviour (Macgregor & Warren 2006). This is particularly the case when the impact of an activity or the benefit of an option is felt downstream rather than on the farm. A literature review by Blackstock *et al.* (2010) stressed the importance of providing strong and consistent messages which convince the farmer that the problem is serious and affects them, but that they are also capable of performing the requested actions.

Individual farmers and other land managers are nested within networks and communities (for example, around farming type) that influence attitudes and decisions. Within such networks, there are key individuals who can be targeted and engaged to bring about wider change (Defra 2008e). Advice coming from a trusted source, particularly from the farming community, is known to have more resonance with farmers (Blackstock *et al.* 2010). This suggests that voluntary initiatives established by the industry, such as the Campaign for the Farmed Environment, may be well-placed to communicate advice (Section 27.4.3.7). Furthermore, influencing individual behaviour at the farm-scale may not always be the most appropriate scale to manage ecosystem services delivered by agricultural landscapes (Section 27.4.3.3). Collective action at landscape- or catchment-scales may enable agri-environment schemes to be more effective (RELU 2010a). Understanding how to strengthen and influence farm group dynamics is, therefore, essential.

Box 27.57 (Section 27.10.7) gives an example of collective action at a catchment-scale and outlines potential options for fostering collaboration amongst farmers through agri-environment schemes (Section 27.10).

Inclusive approaches and the engagement of farmers in decision-making can prove successful because farmers understand the reasoning for change and so, are better motivated and more inclined to comply with regulations. Appropriate engagement with farming networks and organisations may also help to establish well-designed programmes and a sense of cooperative effort (ENRD 2010). Farmers have demonstrated a willingness to maintain and develop their skills and knowledge through advice, informal and formal education, and knowledge exchange programmes. The industry owned Agri-skills Forum, for example, was formed to re-skill and raise professional standards (www.agriskillsforum.co.uk). These approaches are likely to be important for improving the uptake of new technologies and practices. The expansion and widespread recruitment of farmers to agri-environment schemes has exposed them to environmental management and offers opportunities for future knowledge development and transfer to, from and among farmers (Natural England 2009a). The involvement of farmers in monitoring is being trialled by the English Beef and Lamb Executive as one approach to help farmers better understand the impact of their activities and improve cooperation between them and regulatory authorities under the Better Returns Programme.

27.4.3.5 Markets and incentives (instrumental)

Government incentive schemes, in combination with regulatory guidance, have been used to alter agricultural practices with some success in terms of ecosystem service provision. Financial incentives are only required to encourage land management practices that go beyond the legislative baseline (ENRD 2010). Direct subsidy payments to farmers for cross compliance, with minimum standards for food safety, environmental management and animal welfare, have been delivered through the Single Payment Scheme (Section 27.4.3.2). Cross compliance is compulsory, whereas agri-environment schemes are voluntary, incentive-based schemes that reward farmers for higher standards of environmental management than that required under the Single Payment Scheme.

Set-aside is a compulsory instrument that was introduced in 1992 to take land out of production in order to reduce the overproduction of cereals. By 2007, set-aside land accounted for 10% of the UK's arable land area (Foresight 2010), creating fallow arable land across the UK which enhanced a number of ecosystem services (IEEP 2008b). Set-aside land has substantially higher biodiversity than intensive arable land, with strong evidence of benefits to declining farmland birds, as well as plants, invertebrates and mammals. Set-aside land has also been found to reduce soil erosion and increase fertility, while buffering watercourses from diffuse pollution. The fragmentation of habitats that resulted from the intensification of agriculture had been partly counteracted by set-aside increasing the size and connectivity of habitats. This service could be particularly important in helping species to migrate in response to climate change. The success of set-aside in delivering ecosystem services depends on the location of the set-aside and the way it is managed (*ibid.*). Whether the set-aside is rotational or non-rotational determines the types of ecosystem services it provides, with each type providing different environmental benefits to different extents (*ibid.*).

In 2007, the EC reduced the set-aside requirement due to high international prices for cereal crops in response to global shortages, and later abandoned the scheme altogether. There is little evidence, so far, of the impact of the discontinuation of the scheme, but it is widely assumed that it will cause a major loss of environmental benefits if it is not substituted with other measures (IEEP 2008b). A recent study (Levin & Jepsen 2010) found that the re-cultivation of set-aside land in Denmark had negatively affected the spatial structure of semi-natural habitats. Another study (Gillings *et al.* 2010) concluded that the zero set-aside rate rapidly reduced fallow land in the UK; as a result, 25–50% of farmland bird populations could be affected, and birds, such as skylark (*Alauda arvensis*) and yellowhammer (*Emberiza citrinella*), would be required to migrate to other habitats in winter, causing a small increase in the rate of population decline.

Agri-environment schemes have been the main supporting mechanism for protecting and enhancing the environment. Farmers are paid to manage the land to provide specific environmental benefits. Agri-environment schemes were launched in the UK in 1987, under the banner of Environmentally Sensitive Areas (ESAs), in response to marked declines in environmental quality and wildlife.

In 1991, this was supplemented by a national scheme, Countryside Stewardship Schemes (CSS), which targeted those areas that fell outside of ESAs.

In 2005, Environmental Stewardship succeeded these early schemes in England, although many farms are still managed under the old schemes. Agri-environment agreements total more than 58,000 (**Figure 27.21**) and cover over 66% of English agricultural land (6 million ha). Environmental Stewardship has two tiers of management. Entry Level Stewardship (ELS) is open for entry to all eligible applicants for supporting sustainable land management with a focus on short-term results. Farmers can select any land management options from a scheme menu. While this has made overall uptake of Environmental Stewardship more attractive, it has resulted in a tendency for the less arduous options to be implemented, and prevents a more systematic, or ecosystem, approach to farmland management. Higher Level Stewardship (HLS) is a competitive scheme that has a greater number of management options, but choice is restricted to those options stipulated in a farm management plan (Natural England 2009a). It is particularly targeted at delivering significant environmental improvements, over the long-term, on farms with SSSIs and BAP targets. Unsurprisingly, HLS has greater potential to deliver a wider range of ecosystem services than ELS. There is also an equivalent two-tiered agri-environment scheme for organic farms.

Similar schemes are run in Wales—Tir Gofal is the more rigorous scheme level, and Tir Cynall is the Welsh entry-level scheme. They will be replaced by a single scheme, Glastir, in 2012, which aims to address challenges, such as climate change, outlined in CAP Health Check proposals. Interestingly, the upper level element of Glastir considers land-water interactions through prescribed actions that aim to work at a collaborative or catchment-scale (WAG 2011).

In Northern Ireland, 39% of farmland is registered in an agri-environment scheme, with the Countryside Management and Organic Farming schemes being active since 2008.

In Scotland, previous agri-environment schemes were incorporated into the Scottish Rural Development Programme in 2007, which also contains schemes for forestry, rural enterprise and business development. The Scottish Rural Development Programme offers non-competitive rural development contracts where land managers apply for

funding for a range of options under Axis 1, 2 and 3 of the CAP; these are called Land Manager Options. In addition to LMOs, land managers can apply for competitive funding for options that meet 'Rural Priorities' which indicate outcomes that are considered to be of greatest importance to the region. Sections 27.4.3.2 and 7.2.2.9 discuss the schemes of each country in more detail.

Each of the four governments and assemblies have given different attention to agri-environment schemes within their rural development programmes. In England, Environmental Stewardship is the most dominant component of its rural development programme, and even received an increase in funding in the Comprehensive Spending Review in 2010. The Scottish Rural Development Programme (2007 to 2013) places, perhaps, more importance on social and economic concerns. Specific support, for example, is available for crofting, an historic form of agriculture that it describes as being "of major cultural importance". Upper and entry level tiered schemes operate in Northern Ireland, Wales, and England, whereas Scotland has a single scheme which covers Axes 1, 2 and 3 of the CAP Pillar 2.

The mitigation of climate change has already been identified as a new policy imperative of the CAP, and will play an increasing role in agri-environment schemes across the UK. Notably, the Welsh Glastir agri-environment scheme will include an Agricultural Carbon Reduction and Efficiency Scheme, which will provide capital grants for energy efficiency improvements and the installation of renewable energy technologies (Cardwell 2010).

Box 27.17 illustrates the impact of agri-environment schemes on ecosystems services and human well-being, taking the English Environmental Stewardship scheme as an example. An evaluation of the Scottish Rural Stewardship Scheme found that farms participating in the scheme had greater biodiversity than those that were not. While some management prescriptions did enhance wildlife populations, the higher biodiversity on scheme farms is likely to be due to the farms that signed up to the scheme already having prescribed habitats (Scott Wilson Scotland Ltd. 2009). The RSPB (2007) cites the lack of investment in the Rural Stewardship Scheme as a major reason for biodiversity objectives not being met. Scott Wilson Scotland Ltd. (2009) conclude, however, that there is insufficient evidence and it is

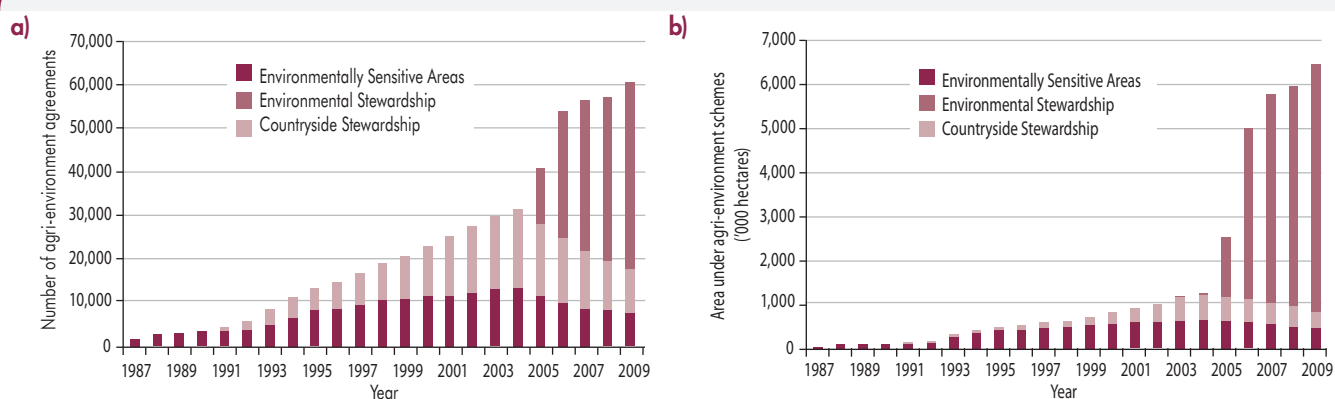


Figure 27.21 a) Number of agri-environment agreements; b) Total area under agri-environment schemes. Source: data from Defra and Natural England (Defra 2010q). © Crown copyright 2010.

too early to draw meaningful conclusions about biodiversity improvements since the scheme began. McCracken (2010) acknowledged that designated sites and targeted actions have improved the habitats for particular species, but that these gains have been offset by continuing declines in the quality of much of Scotland's farmland.

Despite indications of some successes achieved by agri-environment schemes, there are likely to be opportunities to improve their design in the future. **Box 27.17** includes some suggestions made to improve the English Environmental Stewardship scheme, indicating that there is scope to design agri-environment options which deliver objectives like climate change mitigation, resource protection and flood mitigation in synergy with more established priorities such as biodiversity, landscape and public access.

Embedding the ecosystem services approach into the design of agri-environment schemes—which might better deliver this wider range of services—would require the assessment of the extent to which current scheme options recognise and reward the full range of potential

ecosystem services, and would require adjusting the schemes appropriately (RELU 2010a). The schemes could also be adapted so that payments are made to farmers for achieving biodiversity objectives rather than being paid to adopt management options that are assumed to deliver environmental benefits. Payments-by-results could be more cost-effective at delivering biodiversity actions on the ground (McCracken 2010).

Findings of the RELU programme (RELU 2010a) suggest that while improvements in biodiversity for some groups of species, such as plants and butterflies, were consistent in different localities, for others, such as solitary bees and birds, the impact of options varied considerably between regions. This suggests that agri-environment schemes could be more effective if they were more flexible, allowing management options to be adapted to regional conditions and targeted species types. In this respect, payments could be linked to the provision of ecosystem services in places that are best placed to deliver them. For example, in the case of farmers located in Less Favoured Areas (designated under

Box 27.17 The ecosystem service impacts of the Environmental Stewardship scheme in England. Source: Natural England (2009a); LUC (2009).

Environmental Stewardship was launched in England in 2005, as a response to learning from the earlier Environmentally Sensitive Areas and Countryside Stewardship Schemes. It is a multi-objective scheme with primary objectives of protecting wild species diversity, increasing soil and water quality, and providing cultural benefits from, and public access, to agricultural landscapes. It also has secondary objectives for flood management and conserving genetic resources, and climate change mitigation and adaptation was a recent addition in 2008.

Natural England's (2009a) Review of Results and Effectiveness of Agri-environment schemes reports considerable biodiversity improvements. Arable options, for example, have increased breeding populations of scarce farmland birds. There has also been a notable slowing and, in some cases, reversal of declines in UK BAP priority butterfly species. In addition to an increase in wild species diversity, landscape and habitat enhancements by Environmental Stewardship have improved access for education and recreation, and improved countryside aesthetics. In 2007, there were 6,800 education visits which resulted in 170,000 people visiting farms.

Despite the multifunctional intent of Environmental Stewardship, there has generally been a focus on biodiversity objectives until recently (also see Section 27.2). A review of the Provision of Ecosystem Services Through the Environmental Stewardship Scheme (LUC 2009) found that most Environmental Stewardship options have significant potential to deliver a greater range of ecosystem services than they were originally designed for (**Table 27.10**). The review found, for example, that 120 different Environmental Stewardship options can prevent soil erosion, yet only four options were actually designed to deliver this service. It also found that Environmental Stewardship options for woodlands, hedgerows, upland moorland, semi-natural grassland and blanket bogs already impact over 15 services (**Table 27.10**). Detailed evidence of improvements to these other ecosystem services is lacking, however. Water and soil protection, for instance, have only been addressed since 2005, and there is little evidence, so far, of the effect of agri-environment schemes on them. Although climate change mitigation only became an objective in 2008, according to Natural England (2009a), Environmental Stewardship management options indirectly reduced greenhouse gas emissions from the agriculture, forestry and land management sector by 11% in England. This represents a saving of 3.46 million tonnes of carbon dioxide equivalent emissions through the promotion of lower intensity farming practices.

In future, there needs to be greater targeting and monitoring of improvements of non-biodiversity related ecosystem services if the multi-objective emphasis of Environmental Stewardship is to be realised (LUC 2009). Although Environmental Stewardship supports a range of ecosystem services already, the current option menu may benefit from it being systematically designed for broad, multi-service delivery. The latest integrated, map-based targeting of ecosystem services delivery launched by Natural England in 2008 demonstrates a movement in this direction. **Table 27.9** shows the ecosystem services that agri-environment schemes have the most potential to enhance, but actions to optimise the delivery of these services are required, particularly to achieve results at landscape-scales.

The Department for Environment, Food and Rural Affairs (Defra 2008d) has already adapted Environmental Stewardship based on early evaluations in order to increase overall uptake, encourage the uptake of in-field options, provide more advice to farmers, and improve the appropriateness of choices made by farmers in relation to geographic priorities. The continued monitoring and evaluation of schemes, fed into policy and scheme design, will be critical for their development and improvement in the future (Davey *et al.* 2010a).

Table 27.9 Ecosystem services that Environmental Stewardship has the greatest potential to enhance. Source: information from Land Use Consultants (2009).

Supporting	Provisioning	Regulating	Cultural
<ul style="list-style-type: none"> ■ Biodiversity ■ Protection of soil organic matter 	<ul style="list-style-type: none"> ■ Genetic conservation ■ Water supply 	<ul style="list-style-type: none"> ■ Water infiltration ■ Water quality ■ Flood regulation and coastal protection ■ Erosion control ■ Pollination 	<ul style="list-style-type: none"> ■ Recreation ■ Education ■ Cultural heritage ■ Aesthetics ■ Sense of place

Box 27.17 continued.

Table 27.10 The impacts of Environmental Stewardship on ecosystem service delivery. Green = positive impact; maroon = negative impact; orange = positive and negative impact. Source: reproduced from LUC (2009).

Feature type	Habitat or feature	Provisioning Services					Regulating Services							Cultural Services				Supporting						
		Food	Fibre	Fuel	Genetics	Fresh water	Air quality	Climate	Water regulation	Erosion	Water quality	Disease	Pest	Polination	Hazards	Recreation	Cultural heritage	Education	Aesthetics	Sense of place		Soil formation	Photosynthesis	Primary production
Boundary features	Hedgerows (basic)																							
	Hedgerows (enhanced)																							
	Stone faced hedgebanks																							
	Ditches																							
	Hedges & ditches combined (basic hedge management)																							
	Hedges & ditches combined (enhanced hedge management)																							
Trees & woodland	Stone walls																							
	In-field trees																							
	In-field trees (ancient)																							
	Woodland fences																							
	Woodland edges																							
	Wood pasture & parkland																							
	Woodland																							
	Scrub																							
	Orchards																							
	Historic & landscape	Archaeology under grassland																						
Archaeology under cultivated soils																								
Archaeology & high water levels																								
Designed water bodies																								
Water meadows																								
Buffer strips, field margins / corners	Traditional farm buildings																							
	Buffer strips (2 m and 4 m)																							
	Buffer strips (6 m)																							
	Enhanced buffer strips (with grazing)																							
	Enhanced buffer strips (without grazing)																							
	Buffer strips beside ponds & streams																							
	Uncropped cultivated margins																							
	Conservation headlands																							
	Conservation headlands (no fertiliser or harvesting)																							
Arable land	Field corners																							
	Seed mixtures sown for birds																							
	Fallow plots																							
	Low input cereals																							
	Undersown spring cereals																							
	Overwintered stubbles																							
	Whole crop silage & over-wintered stubbles																							
Grassland	Fodder crops & overwintered stubbles																							
	Beetle banks																							
	Low input grassland																							
	Species rich grasslands																							
	Rough grazing (basic)																							
	Rough grazing (enhanced)																							
	Rush pastures																							
Moor/ heath	Wet grassland																							
	Mixed stocking																							
	Rare breeds (supplement)																							
	Moorland																							
Coast	Shepherding (supplement)																							
	Lowland heathland																							
	Coastal saltmarsh																							
Wetlands	Sand dunes																							
	Ponds																							
	Reedbeds																							
	Fens																							
Soils	Lowland raised bogs																							
	Maize crops & resource protection (without cover crop)																							
	Maize crops & resource protection (with cover crop)																							
	Arable reversion to grassland (no fertiliser)																							
	Arable reversion to grassland (low input)																							
	In-field grass areas																							
	Intensively managed grassland & soils (low input)																							
	Seasonal livestock removal on intensive grasslands																							
Access	Watercourses & erosion																							
	Open access																							
	Linear access																							
	Educational access																							

EU regulations dating back to the 1970s), compensation is currently provided for the physical disadvantages of farming in the uplands. Instead, RELU (2010a) propose that farmers are rewarded in these areas for the provision of public goods,

and are supported in maximising the potential of the land to deliver them. Payments for such public goods could also benefit the local economies and create jobs in such areas (**Box 27.18**).

Targeting agri-environment schemes at multiple scales—farm, landscape, catchment and regional—could also yield improvements, as discussed above in Section 27.4.3.3. There may also be issues of temporal scale that need to be addressed in scheme design. Managing carbon and restoring or linking wildlife habitats, for example, require long-term commitments that may require new contractual mechanisms (RELU 2010b).

It has been estimated (Cao 2009) that overall annual payments in the UK through Pillar 2 may have to be in the region of £1–3 billion (compared to today's £3.9 billion allocated over seven years from 2007 to 2013) in order to achieve the environment policy objectives of the UK Government; this estimate is based on current indicator areas and agri-environment option payment rates. Additional challenges set out in future CAP reform would increase this figure further.

In addition to agri-environment schemes, the government has introduced incentives to promote the production of bioenergy crops. The Energy Crops Scheme provided grants for short rotation coppice willow and *Miscanthus* (Section 27.5.3.5). By 2006, when the scheme closed to applicants, 1,200 ha of willow and 3,400 ha of *Miscanthus* had been planted, accounting for 7% and 68% of the original targets, respectively (Sections 27.9.3.3, 7.2.2.9). Grants have also been used to encourage the establishment of farm woodlands on land that was formerly used for agricultural production. The 1998 Farm Woodland Scheme (now replaced with different schemes in the devolved countries) made annual payments to farmers to compensate for loss of income from converted agricultural land; while the Forestry Commission made payments to farmers for the initial set-up of woodlands under the Woodland Grant Scheme. Between 1988 and 2005, these schemes established 120,000 ha of new woodland across the UK (Chapter 7; Section 27.5.3.5).

Payment for some non-production services can be made through the markets, such as holiday accommodation in the countryside. The adding of value to food products through certification (e.g. organic, LEAF) can also compensate farmers for loss of productivity due to better environmental care. Offsets of greenhouse gas emissions may, in the future, be paid to agriculture from other sectors in return for carbon sequestration and storage services. This could be integrated into emission trading schemes and linked to payments for other services such as natural resource conservation

(Foresight 2010). Carbon offsetting schemes may provide a source of funding to manage and restore peatlands for carbon storage (CREDIT 2011). There is also scope for agri-environment schemes to include options that prevent the loss of carbon and/or support carbon sequestration (RELU 2010a).

The markets will continue to play a major role in the future. The food market dominance of supermarkets—accounting for 75% of sales of food in the UK—has favoured large, intensive farmers, but has also promoted some environmental improvements (Foresight 2010). As discussed in Section 27.4.3.4, if consumer awareness on environmental issues continues to rise, demand for sustainably produced food should rise as well.

27.4.3.6 Technologies and practices (instrumental)

Conventional farming practices still dominate UK agriculture, but a number of alternative farming systems are available that adopt practices with variable impacts on ecosystem services:

Integrated Farm Management (IFM) uses a whole farm system approach with an aim to be both profitable and environmentally responsible. It makes use of regulatory ecosystem services, traditional farming methods and the responsible use of technologies. LEAF is the main advocate of IFM in the UK and has a membership of 1,500 farms, covering over 707,000 ha of farmland (www.leafuk.org). Produce from their members carries the LEAF Marque Label. It differs from organic farming by not barring the use of artificial fertilisers, but instead encourages farmers to use them in a more targeted way, based on detailed information on farm soil structure and fertility. This gives greater flexibility than organic farming for site-specific characteristics (Trewavas 2001).

Typically, IFM includes mixed arable and livestock enterprises, fallow land, conservation headlands, bird cover crops, and sympathetic field margin and hedgerow management (Vickery *et al.* 2004). Nutrient management plans and auditing systems are characteristic of this farming approach (Burgess & Morris 2009). Vickery *et al.* (2004) found that IFM field management practices, such as crop rotation and use of manures, maintains crop structural diversity, soil organic content and biological activity (e.g. earthworms). A complex crop rotation can benefit farmland birds by providing more breeding and foraging opportunities, and IFM farming methods outlined above would also be expected to have benefits for water quality and pest regulation, and reduce soil erosion.

The distinction between 'intensive' and 'integrated' farming is becoming increasingly blurred as intensive farm systems adopt integrated practices that they perceive to be beneficial (Burgess & Morris 2009). Agri-environment schemes have also mainstreamed IFM practices by including them in the menu of land management options.

Extensification of production can include a reduction in inputs to crops, and/or sparser crop and livestock densities. This typically lowers productivity and increases the value of the produce—niche markets are willing to pay these extra costs, however, in return for higher quality products that have a lower impact on the environment (Section 27.4.3.4). Whether such systems can meet the needs of, and be

Box 27.18 Agri-environment payments can create local jobs. Source: ENRD (2010).

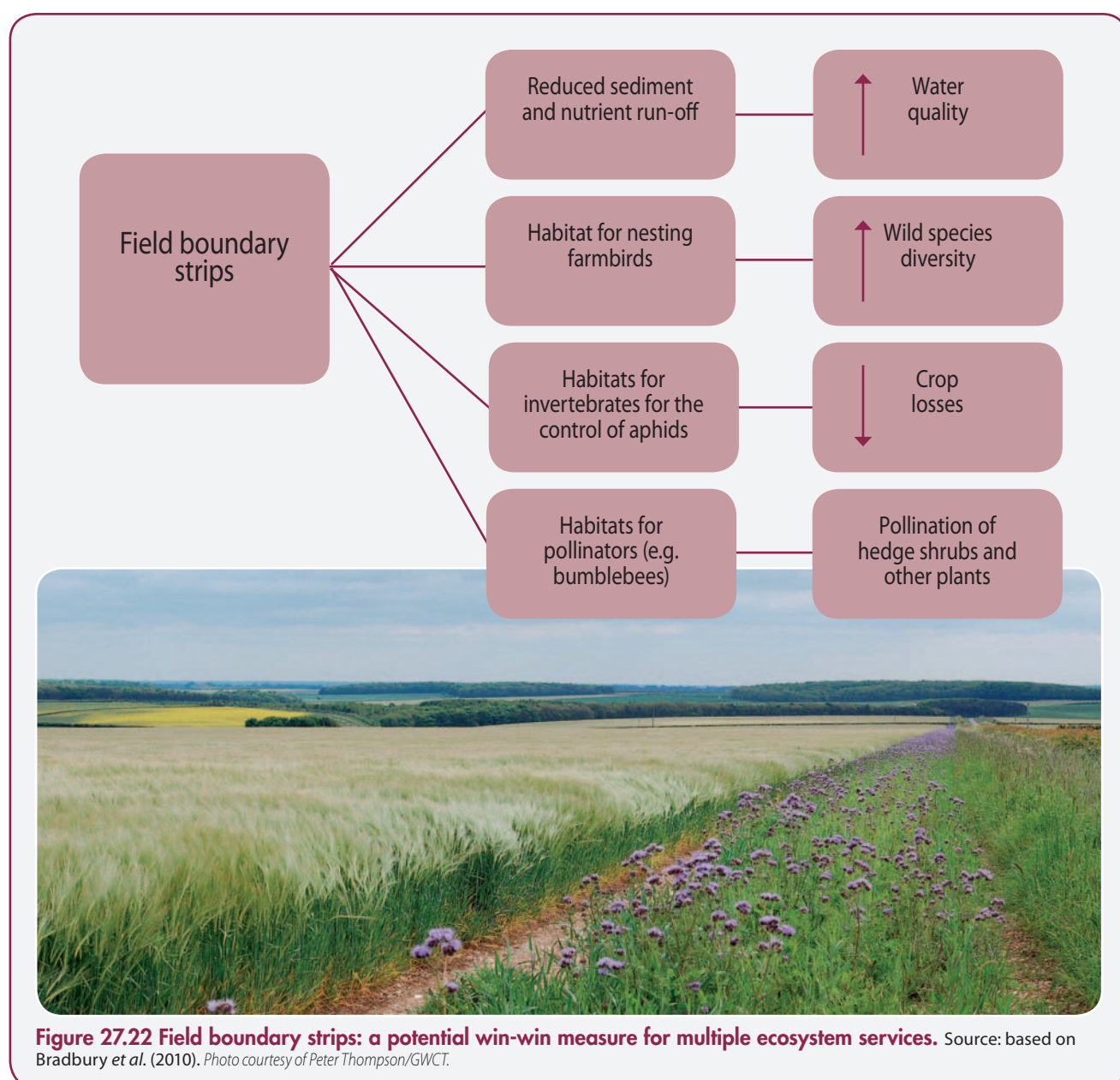
A farmer on a remote, 1,400 ha livestock farm in a Less Favoured Area in the north-west of England entered an agri-environment scheme. He reduced the number of sheep, and time they spent grazing, on moorland, and chose management options for drystone walls, hedgerows, woodland restoration, in-field trees, traditional farm buildings and the management of archaeological features on grassland. The farmer also used a specialist local contractor to restore moorland. For every £1 the farmer was paid by the scheme, the local economy benefited by £3.70. At least 10 new jobs were created in the local area, reflecting the growing jobs market for contractors specialising in landscape and habitat restoration work.

affordable to, all of society is widely debated (Section 7.5.4). Extensive systems are known to increase biodiversity and reduce pollution, but their overall effect on other ecosystem services can be variable. Although extensive cattle- or sheep-grazing in upland habitats, for example, can maintain biodiversity and may protect carbon stocks in soils, slower growth rates may result in higher methane (greenhouse gas) emissions over their lifetime than intensive production systems. High energy costs may encourage more farmers to be less intensive, which is likely to reduce yield per hectare (Foresight 2010).

Organic farming systems prohibit the use of external inputs such as artificial fertilisers and most pesticides; instead, they internalise inputs, especially nutrients, for crop and livestock production (Chapter 7). The integration of biological processes, such as pest control, and the rotation of crops, remove the need for external inputs, but result in organic systems normally having lower yields per hectare than conventional systems. Standards for organic production

are regulated by European law (EC Regulation 834/2007) and administered by non-government organisations; for instance, the Soil Association is the largest organic food certifier in the UK, accounting for 70% of all organic farmland (Section 7.2). Although it is widely agreed that organic farming methods offer benefits to biodiversity, intensive agriculture can arguably produce more food on less land and, therefore, create space for the delivery of other ecosystem services (Section 7.5.4). In this instance, agri-environment schemes can be used to encourage farmers to include wildlife habitat in field boundary strips (**Figure 27.22**) and non-cropped areas, leaving cropped areas to be intensively managed (RELU 2010a).

Government policy in the UK has increasingly promoted practices that are embodied in organic farming. However, due to fears over the need for more land to produce the same amount of food, and an unwillingness by the majority of consumers to pay more for their food despite the benefits, it is unlikely that organics will be adopted as a model for



a sustainable farming system (Tomlinson 2008). Organic systems are likely to be useful to extend into areas where environmental factors limit productivity and habitat needs to be protected from intensive agriculture. Reducing demand for food by, for example, reducing food waste or making improvements in organic technologies to increase yields per hectare, may make the widespread uptake of organics more attractive in the future.

The types of soil management employed on a farm can influence the provision of supporting, provisioning and regulatory services. Soil management strategies that better utilise natural processes offer opportunities for improving the sustainability of agro-ecosystems (Section 13.3.4). Bulk fertilisers (such as manures and composts) and crop rotations with ley crops (**Figure 27.23**) can improve soil fertility and structure, increase water and nutrient storage, remove pollutants that could otherwise enter the food chain or water supplies, and can improve soil biodiversity (Section 13.2.4). The use of bulk fertilisers can also reduce soil erosion and increase concentrations of soil organic carbon (SOC), although this generally does not constitute an additional transfer of carbon from the atmosphere to land (Powlson *et al.* 2011). Contour tillage can reduce surface runoff, and other tillage changes or no-till strategies can have benefits for soil quality, nutrient cycling and reduce erosion (Section 14.3.4.2). Reduced tillage, however, appears to increase SOC by much less than previously thought, at least in temperate regions such as the UK (Powlson *et al.* 2011). The more efficient use of fertilisers, the wider use of perennial crops and legumes, and rotational cropping can improve nutrient cycling and nutrient uptake by plants, and minimise losses of nitrogen from the farm (Section 13.3.4). There is potential for agri-environment schemes to better support farmers who adopt beneficial farming practices, including the biocontrol of soil-living pests through the provision of habitats for predators, as well as the other soil management techniques outlined here. **Table 27.11** shows

a selection of management options for lowland farmland that can influence regulating ecosystem services.

Moorlands and heaths are often burned for the rearing of sheep and red grouse, but little is known about the effects of this practice on ecosystem services. Importantly, there is contradictory evidence on the influence of burning on carbon sequestration and storage (Section 5.5.2.1). One alternative to burning is heather-cutting, which is often used in places where fire could pose a risk to people and property. While cut material can be used to regenerate heather restoration sites, this practice is deemed uneconomical by land managers and there is some evidence that it can reduce plant vigour over the long-term (*ibid.*). Reductions in the number of sheep grazing on moors and heathland can benefit some species in areas where there is high grazing pressure. The challenge is calculating the number of livestock that is sustainable in a specific location with specific conditions. Re-wilding initiatives allow natural processes to re-establish, but normally with a minimal level of grazing to maintain the existing ecosystem services (Section 5.5.2.2).

The increasing occurrence of drought and water shortages in the UK (especially in South East England), and concerns over energy security and climate change, are heightening the need for arable farming to become more water efficient. Many water-efficient technologies already exist, including water-efficient crop varieties, drip irrigation and low pressure sprinklers. Measures to reduce water loss, such as greenhouses and plastic tunnels, and the development of alternative water sources, such as rainwater harvesting, are also likely to become increasingly important (Section 7.2.2.7). The biggest greenhouse complex in the UK, Thanet Earth, is under development in Kent; once completed, it will increase salad crop production by 15% in the UK. It is heated and powered by a neighbouring combined heat and power plant (www.thanetearth.com).

Biotechnology has the potential to contribute to meeting future agricultural challenges. Crop and livestock breeding



Figure 27.23 Crop rotations can reduce weeds, pests and diseases by interrupting their lifecycles. They can also replenish nutrients and maintain soil fertility. Photo © Environment Agency (2008a).

Table 27.11 A selection of management options on lowland farmland that can influence regulating ecosystem services.Source: Bradbury *et al.* (2010). Copyright © 2010 British Ecological Society. Reproduced with permission of Blackwell Publishing Ltd.

Final Service	Benefit	Land management objectives	Management options
<ul style="list-style-type: none"> Carbon sequestration Greenhouse gas emission reduction 	<ul style="list-style-type: none"> Climate change mitigation 	<ul style="list-style-type: none"> Reduce soil carbon oxidation Reduce energy consumption Increase soil carbon sequestration Reduce nitrous oxide emissions Reduce methane emissions 	<ul style="list-style-type: none"> Convert arable land to permanent grassland, in particular on organic soils. Reduce cultivation intensity. Grow woody vegetation: hedgerows, woodland, biomass crops. Improve crop nitrogen use, manure nitrogen use, tailor nutrient supplied in feed to livestock nutrient requirement. Provide high quality feed, reduce stocking levels, digest manures anaerobically.
<ul style="list-style-type: none"> Water regulation Erosion regulation 	<ul style="list-style-type: none"> Usable water Flood risk management Hazard control 	<ul style="list-style-type: none"> Improve soil infiltration Reduce surface run-off 	<ul style="list-style-type: none"> Ameliorate soil structural damage and compaction. Create/restore semi-natural habitats including scrub, plant trees. Maintain/create flow barriers: hedgerows, earth banks, buffer strips, beetle-banks. Restore vegetation cover on bare soils, under-sow arable crops such as maize. Implement minimal cultivation or no-till techniques on arable land.
<ul style="list-style-type: none"> Water purification 	<ul style="list-style-type: none"> Clean water 	<ul style="list-style-type: none"> Reduce fertiliser leaching & pesticides 	<ul style="list-style-type: none"> Tailor nitrogen, phosphorus and potassium inputs to crop requirements. Use plants with improved nitrogen use efficiency. Use manure nitrogen efficiently. Create low input grassland and conservation headlands. Avoid application in inappropriate (e.g. wet / frozen) conditions. Prevent pollutant surface run-off, create physical buffer zones. Provide reed beds / wetlands to filter water before entry to water courses. Reduce / prevent soil erosion.

and selection can increase productivity and quality through improved strains. Sylvester-Bradley & Wiseman (2005, cited in Burgess & Morris 2009) estimate that current average UK wheat yields could be increased by about 50% by 2050 through genetic improvement; they also anticipate that breeders will produce varieties that require less agrochemicals, water and nutrients. The main focuses for livestock breeding will be to increase reproductive rates, and use genetic improvement, diet manipulation and containment to reduce greenhouse gas emissions (Section 7.2.2.7).

Genetic modification may be important for the development of new crop varieties with, for example, improved drought tolerance. Public resistance to GM crops has been extremely strong, with awareness of the potential risks greater than awareness of the potential benefits (Gaskell *et al.* 2000 in Burgess & Morris 2009). The use of GM crops is now considered on a case-by-case basis following the lift of the European moratorium in 2004.

Farmers receive advice and information on agricultural best practices and technologies from a variety of sources including: individuals and informal communication networks (perhaps the most significant source); non-government organisations, such as farmers associations and research organisations; commercial enterprises that provide inputs and services; and public bodies, such as the Environmental Agency and Natural England. The government and the industry have established a number of schemes to provide information and advice to farmers, including the Campaign for the Farmed Environment (Section 27.4.3.7) and the Catchment Sensitive Farming Initiative (**Box 27.19**).

27.4.3.7 Voluntary actions (instrumental)

Voluntary action by farmers is complementary to the growing burden of litigation, economic sanctions and government subsidies which they face (Sabatier *et al.* 2005 in Blackstock *et al.* 2010). Moreover, voluntary action is argued to be more likely to be embedded in social norms (Ayer 1997 in Blackstock *et al.* 2010).

Box 27.19 The Catchment Sensitive Farming Initiative.

The Catchment Sensitive Farming Initiative uses advice, regulation and various schemes to reduce the agricultural contribution of diffuse pollution to water. Farming is a significant source of diffuse pollution, especially nutrients from fertilisers and manure. The Initiative promotes land management that reduces diffuse sources of pollution to levels that maintain ecological quality in watercourses. A range of advice is given to farmers and land managers working in priority catchments, including guidance on the appropriate use of fertilisers, manures and pesticides, how to avoid runoff and erosion, and how to protect watercourses from diffuse pollution. The advice is complemented with management options delivered through the Environmental Stewardship scheme in England, and through the future creation of water protection zones—a new regulatory tool for protecting watercourses (Section 27.3.3).

In recent years, a trend for the agricultural sector establishing its own initiatives to tackle environmental issues has developed. The industry-led Voluntary Initiative led by the Crop Protection Association, aims to minimise the environmental impacts of pesticide use and make environmental improvements (EA 2007a). The scheme was established by the agricultural sector to avoid statutory controls on pesticide application through collective voluntary action (Blackstock *et al.* 2010); **Box 27.20** outlines some of the outcomes of the scheme since 2001. Furthermore, the industry has established its own Agriculture Industry Greenhouse Gas Action Plan 2010, which sets targets for reducing emissions (Box 27.16).

The Campaign for the Farmed Environment is a new industry-led initiative that aims to extend participation in ELS and offset the loss of environmental benefits from the abandonment of set-aside by encouraging voluntary environmental management outside of the agri-environment schemes. Supported by a large consortium of organisations, it has specific work themes for protecting water and soils, and for supporting bird species and other farmland wildlife. The Campaign was launched at the end of 2009, so it is too early to assess its impact on ecosystem services.

At a regional and local level, there are some examples of individual farmers voluntarily working together to achieve positive commercial and environmental outcomes (**Box 27.21**).

27.4.4 Agriculture Summary

Table 27.12 summarises the key insights from this review of responses in the context of agriculture, highlighting those that have been well-established, but also identifying a set of responses that are either in early implementation or are proposed. It is important to learn from these early pilots across all sectors to scale-up the adoption of an integrated ecosystem approach to the management of the UK's diverse habitats, which is one key policy direction that this review recommends.

27.5 Forestry

27.5.1 Forestry-related Ecosystem Services and Human Well-being

Throughout history, forestry has been a sector of high economic and cultural importance in the UK. Over the past 30 years, the key trend in this sector has been increased multifunctionality and the diversification of ecosystem services delivered by Woodlands or forests (synonymous for the purposes of this section). **Figure 27.25** summarises the key drivers impacting the forestry sector, and the resulting risks to ecosystem services.

Box 27.20 Outcomes from the Voluntary Initiative. Source: www.voluntaryinitiative.org.uk; Glass *et al.* (2006).

The Voluntary Initiative has had some successes since its inception in 2001: more than 2 million ha are covered by the Voluntary Initiative Crop Protection Management Plan, and 85% of the sprayed area in England and Wales is treated with machines tested under the National Sprayer Testing Scheme.

Although there is little evidence to attribute any reductions in pesticide use directly to the Voluntary Initiative, modelling in pilot catchments revealed that the potential for contamination before the initiative was greater than the post-initiative period. National water quality data showed that the occurrence of nine compounds associated with pesticides decreased (three by over 30%) in surface water, but herbicides used for oilseed rape production increased. Indeed, the specific target that no pesticide should be detected at concentrations over 0.5 µg/l in three pilot catchments was not achieved (Glass *et al.* 2006). The review by Glass *et al.* (2006) found the scheme to have had some positive impacts on biodiversity, although the extent of the Voluntary Initiative's contribution compared to agri-environment schemes is unclear. A study by Garrod *et al.* (2007) found that farmers believe the UK Government will eventually introduce a form of pesticide tax regardless of any successes the Voluntary Initiative or similar schemes may have in reducing pesticide use.

The Catchment Sensitive Farming Initiative complements the Voluntary Initiative by also considering diffuse sources of pollution such as nutrient leaching.

Box 27.21 Collective action by farmers: the Pontbren Initiative, Wales. Source: Posthumus & Morris (2010).

In the 1970s, the Farm and Horticultural Development Scheme encouraged farmers to increase production, which resulted in high stocking rates and, consequently, soil compaction. When the market price of their produce dropped in the 1990s, and labour shortages became a problem, three neighbouring farmers in Pontbren decided to extensify their farming system in order to lower production costs. Making use of destocking grants, they reduced stocking numbers on their farmland (an area of 380 ha) and switched to a hardier sheep breed which stayed outdoors all year round. They also planted trees and hedges to provide shelter. As the environmental benefits became apparent, the farmers initiated more activity, such as the creation of ponds and fencing-off watercourses (**Figure 27.24**).

In 2000, when more local farmers joined them, they established an informal cooperative: the Pontbren Group. The Group attracted grants from the Welsh Assembly Government, Forestry Commission and the Welsh woodland management charity, Coed Cymru, for hedgerow renovation, woodland establishment and a livestock extensification scheme. The size of the Group grew to ten farmers, who today collectively earn an income from a tree nursery, a wood chipper and a cooperative farm shop. Profits are allocated according to effort, or reinvested in Group activities.

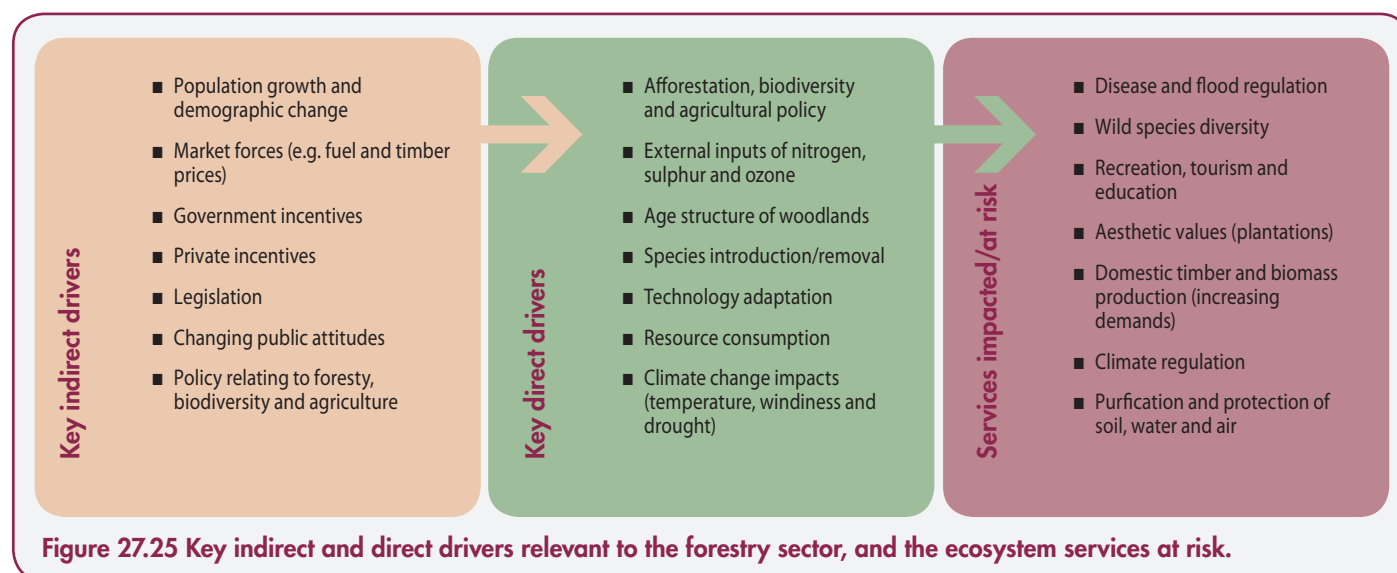
The Pontbren Group effectively carries out its own agri-environment scheme through collective action and the pooling of resources—finances, labour and knowledge. Because the farmers decide upon actions that they prefer and that are most suited to their situation, there is a sense of ownership of the environmental improvements. However, the scaling-up of such schemes would run the risk that some environmental issues would not be addressed without inspections by an external body. While some farmers may not be willing to participate in cooperative groups, Posthumus & Morris (2010) believe that there is sufficient evidence to show that providing support for collective action in environmental stewardship can produce positive outcomes.



Figure 27.24 A wetland managed by the Pontbren Group—a cooperative of neighbouring farmers—in Pontbren, Wales. Photo courtesy of Pontbren farmers and Coed Cymru.

Table 27.12 Agriculture Summary.

	Established responses	Early implementation, pilots	Proposed, under development
Knowledge	<ul style="list-style-type: none"> ■ Farm monitoring ■ Predicting impacts of climate change on agriculture 	<ul style="list-style-type: none"> ■ Research on climate change adaptations, e.g. development of resilient crop varieties ■ Collaboration between researchers and the farming community 	<ul style="list-style-type: none"> ■ Research on spatial optimisation of agriculture, and impact of different management practices on ecosystem services (ES) ■ Sustainable Agriculture and Food Innovation Platform ■ Creating resilient agro-ecosystems ■ Further development of low input crop varieties
Legislation	<ul style="list-style-type: none"> ■ Common Agricultural Policy (CAP) ■ Nitrates Directive ■ Habitats and Birds Directives 	<ul style="list-style-type: none"> ■ Water Framework Directive 	<ul style="list-style-type: none"> ■ CAP reform
Policies, institutions and governance	<ul style="list-style-type: none"> ■ Agri-environment policy ■ CAP Cross Compliance 	<ul style="list-style-type: none"> ■ UK Food 2030 Strategy ■ Agriculture Industry GHG Action Plan 	<ul style="list-style-type: none"> ■ ES approach to agri-environment policy ■ High Nature Value farming concept ■ Agri-environment schemes (AES) applied at multiple spatial and temporal scales ■ Collaboration between farmers to achieve objectives at landscape scale ■ Increased stakeholder engagement, especially farmers in the design of agri-environment schemes ■ Land use strategies to optimise delivery of ES
Changing social attitudes	<ul style="list-style-type: none"> ■ Food certification to encourage sustainable diets ■ Awareness raising, campaigns and advice on healthy and sustainable diets, and food waste ■ Advice to farmers ■ Enrolment of farmers in AES 	<ul style="list-style-type: none"> ■ Raising awareness of climate impacts of food ■ Advice given to farmers from trusted sources, e.g. from farming community 	<ul style="list-style-type: none"> ■ Segmented approach to changing farmer behaviour ■ Strengthening farmer group dynamics for collective action ■ Engagement of farmers in decision-making
Markets and incentives	<ul style="list-style-type: none"> ■ Removal of production-based incentives ■ Set-aside ■ AES 	<ul style="list-style-type: none"> ■ Competitive funding for options that meet 'rural priorities' (Scotland Regional Development Programme) ■ Integrated map-based targeting of ecosystem services delivery by AES ■ Restoration of peatlands funded by carbon offsetting schemes 	<ul style="list-style-type: none"> ■ AES adjusted to reward the full range of ecosystem services, and to encourage collaborative actions at landscape and catchment scales ■ In Less Favoured Areas reward farmers for providing public goods rather than compensating for physical disadvantages ■ Agricultural Carbon Reduction and Efficiency Scheme (Welsh Glastir AES)
Technologies and practices	<ul style="list-style-type: none"> ■ Integrated Farm Management ■ Extensification of production ■ Organic farming ■ Water efficient technologies ■ Biotechnology ■ Advice on best practice and technologies ■ Catchment Sensitive Farming Initiative 	<ul style="list-style-type: none"> ■ Re-wilding initiatives ■ Biotechnology ■ Genetic modification 	<ul style="list-style-type: none"> ■ Calculating the sustainable number of livestock for specific locations ■ Biotechnology to develop crop varieties that have higher yields and require less inputs, and to improve livestock breeding
Voluntary actions	<ul style="list-style-type: none"> ■ Voluntary Initiative (VI; pesticides) 	<ul style="list-style-type: none"> ■ Voluntary collective action by farmers ■ Campaign for the Farmed Environment 	



Forestry does not operate in isolation, but interacts with many other sectors. For the development of Green Infrastructure (GI; the green areas in both urban and rural places) and access to woodlands, forestry is integrated into planning and infrastructure and there is a growing need for spatial planning of forests at a landscape-scale. The role of forestry in the energy sector is ever-increasing, particularly with a resurgence of the use of wood biomass for heating and as technological advances increase the potential for electricity generation from biomass on a large scale. Forests have an important potential role to play in the mitigation of the impacts of climate change through carbon sequestration, and forest management will have to adjust to prepare forests to face a changing climate. Woodland recreation and tourism is in high demand, and forests are acknowledged for the benefits they provide to human health and well-being. Semi-natural forests are valued sites of high biodiversity, the preservation and appreciation of which needs to be promoted through the network of protected areas. Finally, trees and forests provide a number of regulating and supporting services which underpin activities outside the forestry sector. These include: the maintenance of water quality; the protection and formation of soil and the cycling of nutrients; disease regulation; the decontamination of air, water and soil; and the regulation of floods, local climate and noise.

27.5.2 Challenges for the Forestry Sector

In contrast to other sectors, forestry operates over long timescales, which creates a number of challenges. It can take time for changes in forestry management plans to match changes in societal attitudes and forest policy (Section 8.2.5). Instruments for change, such as incentives, need to be introduced with sufficient lead times in order to achieve their intended impact (Foresight 2010). In terms of provisioning services, it is anticipated that demand for forest products will increase in the coming decades due to population growth and trends favouring wood over more carbon intensive materials and processes (Section 15.7). Responses adopted in the near future will prepare the forestry industry for future change, and determine what proportion of this demand will be met through domestic production (Section 8.2.5.1).

In addition to meeting provisioning demands, there are increasing expectations for the delivery of multiple services from forests, and that these services are used sustainably (Section 8.4.1). Achieving multifunctionality will be a challenge in light of increased pressure on forests from climate change, settlement and infrastructure expansion, renewable energy development, the spread of invasive pests and diseases, and population growth. There is increasing demand for access to woodland for the achievement of human health benefits, and for woodlands to play a part in climate change mitigation; all in addition to the provisioning of timber and other wood products. Current and future financial pressures will further challenge the achievement of multifunctional forestry. As such, there is a need to strengthen policies which promote multifunctionality, especially regarding regulating services.

Woodland biodiversity is threatened by the impacts of deer, the intensity of provisioning and climate change

(Section 8.2.4.3). Functional connectivity of woodlands across the landscape to reduce the isolation of biodiverse fragments will be increasingly important in the face of a changing climate (Section 8.2.4.1). Expansion of our knowledge about the risks of climate change will potentially require forest managers to adapt their practices and also to improve the mitigation of climate change through carbon sequestration efforts.

Another challenge will be the development of a framework for landscape-scale planning involving coordination across land uses and collaborative management among diverse sectors (Section 8.5.5). The increasing devolution of the forestry sector could create further issues for landscape planning, hence it is anticipated that capacity-building at local levels will become a priority.

27.5.3 Forestry-related Response Options

27.5.3.1 Knowledge (foundational)

Knowledge and scientific evidence about forestry act as a foundation to inform developments in legislation, policy, institutions, governance and social attitudes. This process is not linear, as research priorities also respond to the experience of such developments and the instruments that they enable. Sustainable forest management and multifunctionality have been the dominant paradigms and focus for research over the past few decades. In 2005, the MA provided further foundational knowledge of the diversity of ecosystem services provided by forest habitat (MA 2005).

The Forest Research Agency, the research arm of the Forestry Commission GB, restructured their operations in 2009 into three research centres which reflect current priorities for knowledge and practical solutions in UK forestry (Forest Research 2010a). The Centre for Forestry and Climate Change investigates topics which include the interaction of climate change with pest and pathogen behaviour, the mitigation of the effects of increased greenhouse gases, adaptive forest management practices, and the development of GI (Forest Research 2010b). The Centre for Forest Resources and Management aims to understand and advise on the measurement and management of the UK's forests, and increasingly focuses on how forest management can minimise risks from climate change and sequester carbon. The Centre for Human and Ecological Sciences takes an interdisciplinary approach to researching and developing the role that trees and forests play within integrated, sustainable landscapes and within society.

In 2003, 'environment and health' was identified as a research priority by the Environment Research Funders' Forum (NERC 2004). The understanding of health benefits derived from natural environments and greenspaces, which include forests (Section 16.3.3), has since expanded through programmes such as NERC's Environment and Human Health Programme (2006-2009). There is some evidence suggesting trees capture pollutant particles and gases, with possible benefits for air quality (Section 14.8.1). Research has also begun to uncover the physical and mental health benefits of forests (Lovell & Roe 2009; **Box 27.22**, Section 27.5.3.4).

Previous chapters have identified some key knowledge gaps in the forest sector (e.g. Chapter 8). The evidence

base would benefit from the better incorporation of lessons learned from past responses and improved valuation methods (Section 8.3.7.3). There is also a need to support the coordination of land uses across landscapes through more interdisciplinary research.

We need to determine long-term rates of carbon storage and to model long-term future scenarios which integrate both socioeconomic and emission models (Sections 8.6, 14.3.5). Clearer scientific evidence is needed concerning changes in soil carbon, while mechanisms to increase the carbon-carrying capacity of different UK soils need to be further developed (Ostle *et al.* 2009). Biosecurity continues to be a serious threat to UK forests through the unintentional introduction of invasive pathogens as world trade expands, and especially through the importation of live plants (Brasier 2008). Continued investment into international procedures to prevent invasions is necessary. The wider implications of land use policy aimed at reducing emissions or conserving carbon sinks need to be more fully understood, as do the effects of land use management. In addition, there remains a need to quantify the regional-scale biophysical effects of climate change regulation.

Further research on the sustainable harvest of non-timber forest products (including knowledge about ecology, reproduction and population structures) is warranted, as is the development of markets for deer, orchard fruit, and other potentially profitable forest products (Section 8.6).

27.5.3.2 Legislation (enabling)

The Forestry Act 1967 is the statutory basis for forestry in the UK. Much of the legislation which governs forestry is cross-sectoral in nature and regulates other commercial enterprises, such as agriculture, which lie outside the scope of planning law (Forestry Commission 2009c). A list of some of the laws governing forestry in the UK can be found in **Table 27.13**.

An Environmental Statement is required under the Environmental Impact Assessment (Forestry) England and Wales Regulations (SI 1999/2228) and Scotland Regulations (SI 1999/43)—both of which were further amended in 2006—for any afforestation, deforestation, forestry road or quarry activity anticipated to significantly impact the environment (Forestry Commission 2009a). Consent for proposed activity is achieved through screening by the Forestry Commission, and parties carrying out work without prior consent will be served with an Enforcement Notice to stop the work, apply for consent, or restore land and alleviate damage caused. Failure to obey this notice carries a fine of up to £5,000 (Forestry Commission 2007b).

It is an offence to fell a tree without a licence to do so, unless the case falls under a number of exceptions: the tree to be felled is located in a garden, orchard, churchyard or designated open space (Commons Act 1899); activities to be carried out involve lopping, topping, pruning and pollarding; felling is under a specified volume and diameter; or if permission has been granted under a grant scheme or with planning permission (Town and Country Planning Act) (Forestry Commission 2007b). Exceptions are also made for the felling of dangerous or nuisance trees or to prevent the spread of pests and disease as stipulated by a Forestry

Table 27.13 A list of some of the laws governing forestry practice in the UK. Source: information from Forestry Commission (2007).

Forestry Legislation
Forestry Act 1967 as amended
The Forestry Regulations 1979 (SI 1979 No 792) as amended by the Forestry (Amendments) Regulations 1985 (SI 1985 No 1572) and by the Forestry (Amendment) Regulations 1988 (SI 1988 No 970)
The Forestry Regulations 1985 (SI 1985 No 1958)
The Plant Health (Forestry) (Great Britain) Order 1993 (SI 1993 No 1283, as amended by SI 1994 No 3094, SI 1995 No 1989, SI 1996 No 751, SI 1998 No 2206, SI 1998 No 3109, SI 2001 No 299, SI 2002 No 295)
The Watermark Disease (Local Authorities) Order 1974 (SI 1974 No 768, as amended by SI 1984 No 688, SI 1986 No 1342 and SI 1992 No 44)
The Dutch Elm Disease (Local Authorities) Order 1984 (SI 1984 No 687, as amended by SI 1988 No 604)
Nature Conservation (Scotland) Act 2004
Environmental Impact Assessment (Forestry) England and Wales Regulations 1999 (SI 1999/2228), as amended 2006
Environmental Impact Assessment (Forestry) Scotland Regulations 1999 (SI 1999/43), as amended 2006
Tree Preservation Orders
Habitats Regulations 2010
Wildlife and Countryside Act 1981
Habitats Directive (Directive 92/43/EC)
Birds Directive (Directive 2009/147/EC)
Countryside and Rights of Way Act 2000; Land Reform (Scotland) Act 2003; Access to the Countryside (Northern Ireland) Order 1983
Planning Policy Statement 9

Commission Plant Health Officer. The penalty for felling a licensable tree without prior permission is a fine up to £2,500 or twice the value of the trees (whichever is higher).

Tree preservation orders are made by a Local Planning Authority to prohibit the cutting down, uprooting, topping, lopping, wilful damage or wilful destruction of trees or woodland (DCLG 2000; DCLG 2009). The orders lie under the Town and Country Planning Act 1990, and the Town and Country Planning (Trees) Regulation 1999. Separate legislation (Environment Act 1995 and the Hedgerows Regulations 1997 (SI 1997, No 1160)) is in place to regulate hedgerow removal.

In the UK, the Habitats Regulations 2010 and the Wildlife and Countryside Act 1981, along with Natura 2000 protected areas under the Habitats Directive (Directive 92/43/EC) and Birds Directive (Directive 2009/147/EC) across the EU, provide legal protection SACs, SPAs, National Nature Reserves (NNRs) and SSSIs which include woodland. Improvements to the protection of SSSIs and ancient woodlands have been achieved through amendments to the Countryside and Rights of Way Act in 2000 (Pryor & Peterken 2001), and through Planning Policy Statement 9 (PPS9) (ODPM 2005).

Legislation from a number of other sectors also acts as an indirect driver of UK forestry. The smoke control provisions of the Clean Air Acts of 1956 and 1968 (subsequently consolidated into the Clean Air Act 1993) gave powers to local authorities to declare part or all of their region a

'smoke control area' in which coal, oil and wood could not be used unless burnt on an exempted fireplace without smoke emissions (Defra 2010g). Wood was preferred to coal as a fuel, but this placed a considerable restriction on the use of wood for heating and stove purposes, subsequently impacting forest management practices providing such fuels. More recently, greater take-up by heating appliance manufacturers and fuel producers of the exemption and authorisation provisions has led to a resurgence in the use of wood fuels in 'smoke control areas' (Figure 27.26).

Within the energy sector, the Renewables Obligation Order 2002 (as amended) (Wilson 2002) in particular has had a major impact on forestry. The order stipulated that from April 1st 2010 until March 31st 2027, 10.4% of the total electricity supplied must come from renewable sources, which includes wood biomass. Due to the many pressures on land in the UK, bioenergy can only act as a small part of the solution to climate change, and checks and balances are required to prevent inappropriate displacement of food production, sites for conservation and places for recreation (Woodland Trust 2010b). That being said, there is great potential for bioenergy development to offer co-benefits including: the expansion of native woodland and tree cover; buffering of sensitive woodland; bringing woodlands under appropriate management for biodiversity and social benefits; and the renewal of political and public appreciation of woodland value (*ibid.*). The overall purpose of the WFD (Section 27.3.3.2) is to prevent further deterioration, and protect and enhance the status, of aquatic ecosystems. Forests and their management have a positive role to play in regulating water quality and flood risk as outlined in the Forest and Water Guidelines (Forestry Commission 2003). River Basin Management Plans consider forest design, management and planning, which impact water quality, quantity and habitat structure.

27.5.3.3 Policies, institutions and governance (enabling)

In 1999, the UK Government devolved responsibility for forestry to the National Assembly for Wales and to Scottish Ministers; forestry in Northern Ireland has been fully devolved since 1922 (Interdepartmental Group 2002). The

Forestry Commission reports separately in each country to the respective ministry, each of which is responsible for developing a national Forest Strategy. A review conducted by an Interdepartmental Group (2002) concluded that there was a need to further integrate the Forestry Commission's National Offices with the rural departments in each country. In 2003, the Forest Enterprise agency of the Forestry Commission was devolved to separate bodies in England, Scotland and Wales. In Wales, the Forest Enterprise was reabsorbed into the Forestry Commission to form a single devolved body in 2004. The Forest Research agency has remained a GB entity, but the responsibilities of the Devolved Administrations in determining research priorities have grown.

In the UK, forest policy is devolved and outlined in the forestry strategy of each country. The UK Forestry Standard contains UK-relevant requirements and guidelines for woodland managers to achieve sustainable forestry management in line with international protocols (Forestry Commission 2004). Its most recent revision in 2009 strengthens the role of forest planning and incorporates developments in scientific understanding and international climate change initiatives (Forestry Commission 2009c). A revised edition of this document is due in 2011.

There is a continuous reassessment of forest policy in the UK to meet changing public attitudes and legislation. Carbon sequestration policy is likely to become a major driver of forest policy in the future (Section 8.2.5). The Scottish Forestry Strategy (Scottish Executive 2006b), for example, calls for an increase in area of new woodland and short rotation forestry to help achieve the targets set out in Scotland's Climate Change Programme through carbon sequestration (Scottish Executive 2006a). Forestry is also embedded in the Climate Change Strategy for Wales (WAG 2010c), while the Woodlands for Wales strategy (WAG 2009) outlines policy promoting the diversification of tree age and species in order to improve the ability of forests to survive climate change and pest and disease outbreaks. Site-appropriate management systems, such as continuous cover forestry, are encouraged by the strategy in place of clearfelling. The trade-off between the aim of diversifying plantation species and structure and the desire to maximise carbon sequestration needs to be addressed (Mason *et al.* 2009). Future planting programmes should consider species carbon content and the potential of new productive genotypes.

Biomass energy policy (DTI *et al.* 2007; Scottish Executive 2007; WAG 2010b) is likely to increase the management of previously unproductive woodlands and could have synergistic cultural, regulating and biodiversity benefits. Renewable energy requirements under the Renewables Obligation Order 2002 (Section 27.9.3.3; Wilson 2002) and wood fuel policy, such as the UK Renewable Energy Strategy (HM Government 2009b) and A Woodfuel Strategy for England (Forestry Commission 2007a), are driving increasing demand for domestically grown timber. In combination, issues of carbon sequestration and biomass production have led to renewed policy interest in forest expansion in GB.

At the other end of the spectrum, recent policy developments, such as the Open Forest Policy in England (Forestry Commission England 2010) and the Policy on



Figure 27.26 Wood is commonly used as fuel for domestic heating. Image © wiki2win, 2011. Used under license of Shutterstock.com.

Control of Woodland Removal in Scotland (Forestry Commission Scotland 2008b), outline regulations for the permanent conversion of woods and forest to restore priority open habitats, enhance populations of priority species, enhance important landscapes, or to improve the conservation of soil and water regulation services. These policies aid the achievement of UK BAP targets for priority open habitats (Section 8.1.3). Felling is regulated through licences and requirements for long-term Forest Plans, and Forestry Commission and Northern Ireland Department of Agriculture and Rural Development Forestry Service policy requires that all felled areas not authorised under planning regulations or for environmental improvement be replanted or naturally regenerated (Forestry Commission 2004).

Successful policy has driven a reduction in nitrogen oxides and sulphur and has subsequently decreased negative impacts on forests. However, nitrogen deposition is still above critical loads for lower plants, and remains a policy challenge (Section 8.2.5.2). Policy controls exist to reduce grazing pressure in forests (such as CAP reform which reduced the number of free-ranging sheep in the uplands and stocking level requirements within Environmentally Sensitive Areas); yet grazing and browsing by both wild and domestic herbivores remains one of the primary drivers of biodiversity change in UK forests (Section 8.2.5.4). Additionally, there remains a general need to strengthen policies which promote multifunctional forests, especially those supporting regulating services such as flood control and water quality (Foresight 2010).

There has been a general transition in the UK from public to private forest ownership. This was exemplified by the recent proposal by the Department for Environment, Food and Rural Affairs in England to fundamentally reform the ownership of the public forest estate (Defra 2010d). There were concerns that private industry would have the deepest pockets in terms of bidding for parts of the public forestry estate, and that local access could be negatively affected if such outside acquisition was widespread. There were also concerns about the safeguards (and their associated costs) needed to both secure the existing rights of those who enjoy access to public forests and woodlands, and to ensure that these areas continue to deliver a range of ecosystem services, many of which could prove difficult to measure, quantify and potentially transact over (Adams & Hodge 2010). Due to public unease and resistance during the consultation period, the government removed the forestry clauses from the Public Bodies Bill and established an independent panel to consider forest policy in England (Defra 2011b).

In general, there is an increasing reliance in the UK on NGOs, voluntary schemes and government partnerships which are experienced at engaging local communities and managing forest resources (Pryor & Peterken 2001; Defra 2007a). The key challenge, from an ecosystem services perspective, is to maintain the public benefits from forestry and woodlands (especially those that are difficult to monetise or quantify), while allowing a greater role for non-state actors (both in the private sector and local communities) to participate in forestry activity.

There is a trend towards greater community involvement in forestry decision-making and management, and this is

expected to continue (Moffat *et al.* 2009). Community Forests play an important role in raising the profile and relevance of greenspace and the countryside, and in influencing policy and planning of GI in England (Countryside Agency 2005). The Community Forest Programme involves working partnerships between public, private and voluntary sector actors at all levels. Successful examples of cross-boundary Community Forests which extend across multiple local authority areas exist, achieving strategic landscape- scale change. With increasing urbanisation, the Community Forestry movement will play an increasing role in the realisation of social, environmental and economic benefits (Moffat *et al.* 2009). Policy to improve public access to woodlands is enabled by the Countryside and Rights of Way Act 2000, the Land Reform (Scotland) Act 2003 and the Access to the Countryside (Northern Ireland) Order 1983 (Section 27.8.3.2). The Forests for People Strategy in Scotland (Forestry Commission Scotland 2008a), for example, outlines the recreation infrastructure that is provided by the Forestry Commission Scotland across the national forest estate to facilitate outdoor access (Forestry Commission Scotland 2008a). The principal priorities of this strategy are to promote outdoor recreation, provide facilities in order to improve local health and well-being, and support local economic development.

Planning for sustainable forest management occurs at a number of scales, but there is a need for these levels to be better coordinated (Section 8.5.5). In Scotland, for example, the National Forest Estate Strategic Plan 2009-2013 (Forestry Commission Scotland 2009) provides the context for how Forest Enterprise Scotland contributes to the delivery of the Scottish Forestry Strategy (Scottish Executive 2006b). Ten District Strategic Plans further define how the national strategic plan will be implemented at a local level. In Wales, the Woodlands for Wales Action Plan indicates what needs to happen over the next five years in order to achieve the outcomes presented in the 50-year Woodlands for Wales Strategy (WAG2009). Forest Design Plans (Forest Enterprise) or Forest Plans (non-Forest Enterprise) are used in the UK for medium to long-term planning of public estate forests in the context of relevant national and district plans. Site-level planning (operational site assessment) is also carried out prior to the start of operations. Incentive schemes, such as the Woodland Improvement Grant in Scotland, encourage an increase in the coverage of Forest Plans; however, only half of UK Woodlands currently have a management plan, so “increasing the coverage of management plans is central to sustainable forest management and the delivery of ecosystem services.” (Section 8.5.5.3).

27.5.3.4 Changing social attitudes (enabling)

Forest extent, composition and structure across the UK are strongly influenced by changes in societal behaviour and the prevalent trends of the time. Historically, large-scale felling of forest during WWII stimulated extensive afforestation and the desire to increase the domestic timber market. Current concerns about the overexploitation of tropical hardwood forests, in addition to aspirations for self-sufficiency, support the need to maintain and increase domestic production of wood products; however, hardwood production has

declined in the UK over the past 40 years (Section 15.7). The motivations for hardwood afforestation tend to be the promotion of conservation, aesthetic, recreational and other public services, while the motivations for softwood afforestation are climate regulation through carbon sequestration and the provision of wood products including wood fuel. Increased societal understanding about species and habitat protection, and pressure from conservation organisations, have recently led to the formulation of policy to allow the conversion of selected afforested areas back to grassland, moorland and wetlands (Section 8.1).

Historically, provisioning landscape services dominated other concerns, resulting in the loss of non-woodland trees through agricultural intensification and mechanisation, and the abandonment of less productive, traditional forestry practices. The protection and conservation of semi-natural woodland and trees is increasingly being promoted as the role of multipurpose forestry gains social acceptance (**Figure 27.27**). The popularity and value of conservation is demonstrated by the considerable increase in membership of environmental NGOs and their subsequent increase in power and responsibility (Section 16.2). Governments now aim to further strengthen partnerships with these organisations.

The principles of sustainable forest management, multifunctionality and ecosystem service thinking have renewed interest in traditional forms of forest management and natural regeneration (Section 8.2.4.3). The appeal for increased recreational services from forests has acted as a driver for improved management and regeneration of mixed and broadleaved forests in place of commercial conifer plantations. Efforts have also been made to encourage the use of conifer woodlands for recreational purposes (Section 8.2.5.3). Local access to greenspace and sites of forest recreation are predicted to continue gaining importance as awareness about the health and well-being benefits of forests increases and as the UK makes the transition to low carbon living (Section 8.3.5.1). The popularity of woodlands

as a learning tool and site for education also continues to grow (**Box 27.22**).

Public awareness about climate change has generated interest in biomass as a source of energy and the use of wood fuel for heating. A five-fold increase in the area of short rotation coppice of *Miscanthus* and reed canary grass was recorded from 2005 to 2007 (Section 15.2.5). As the value of wood fuel continues to increase, it is likely that additional small, privately owned forests will be brought under management to increase production. The substitution of fossil fuel-derived materials with forest products is also becoming more commonplace in the construction and industry sectors. In combination, these trends act to increase the finance available from forests and should lead to higher numbers of people actively managing forests, providing gradual improvements in the state of many woodlands that were not previously managed due to financial constraints.

A number of organisations and agencies actively encourage community involvement with woodlands for the numerous benefits they provide. 'Community forestry', which differs among the devolved countries (Lawrence *et al.* 2009), has an important role in shaping social attitudes towards forestry by actively involving citizens with their local woods. In Wales, there are 138 active Community Woodland Groups undertaking a wide range of activities, such as environmental improvements, community regeneration and school visits or education, on a total of 1,795 ha of woodland (Griffiths 2010). These groups were found to work with elderly people, young offenders and people with health issues. Research about Community Woodland Groups suggests that there is scope for further development and that they provide a double benefit in policy terms because they play an important role in achieving both socioeconomic and woodland objectives (*ibid.*). Another example is the Tree Warden Scheme, which originated in England in the early 1980s, and has grown into a national scheme of 8,000 volunteer Tree Wardens (The Tree Council 2010).

27.5.3.5 Markets and incentives (instrumental)

International market forces strongly impact forestry in the UK. Anticipated increases in fuel prices are likely to raise the profitability of wood fuel, leading to the growth of local wood markets (Section 3.3.3). The relatively low current value of UK timber further encourages the transition to the management of woodland for conservation and recreation services. Certification schemes and standards are also influential market mechanisms to improve the quality and sustainability of woodland management: 45% of wood in the UK is now certified (Forestry Commission 2009b). The UK Woodland Assurance Standard (UKWAS) is a voluntary independent certification standard meeting international protocols and suited specifically to UK forestry. It was amended in 2008 to become more accessible for the small and low intensity managed woodlands (UKWAS 2008). The Forest Stewardship Council (FSC) is an international NGO that runs a global forest certification system for forest management and chain of custody (FSC 2011); it is a registered UK charity which supports the market-based instrument allowing businesses and enterprises to benefit from sound

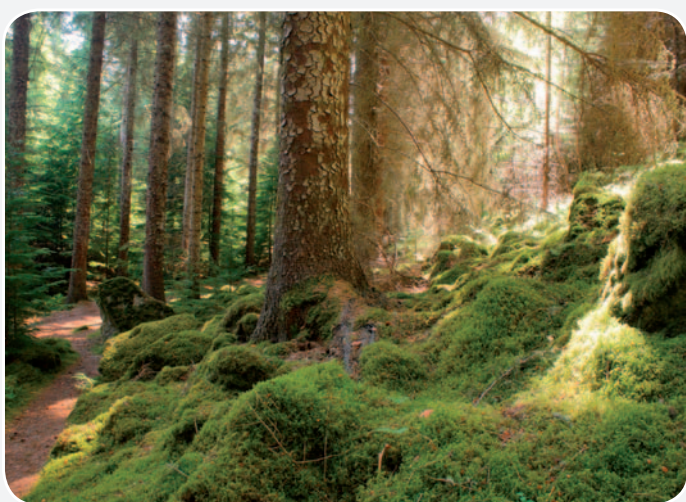


Figure 27.27 The native Scots Pine woodlands of Glen Affric National Nature Reserve in Scotland. Image © johnbraid, 2011. Used under license of Shutterstock.com.

Box 27.22 The physical and mental health benefits of Forest Schools. Source: Lovell & Roe (2009).

Forest School is an outdoor learning approach that has been used in the UK since the mid-1990s. Research commissioned by the Forestry Commission Scotland has shown that it “has the potential to significantly benefit children and young people’s physical health and mental well-being” (**Figure 27.28**).

There are currently about 140 Forest School programmes in the UK which are broadly defined by three common factors:

1. They take place within a forest or woodland which is ideally near to the participants’ school.
2. Participants at the school take part in activities which normally include small and achievable tasks, exploration of the environment and physically active games—all with an emphasis on education in the outdoors.
3. The learning experience is sustained over an extended period, for example once per week or fortnight for a minimum of 12 weeks.

The approach has proved to be advantageous to mood in all behavioural groups, but especially to adolescents suffering from ‘mental disorders’; it has also been found to be particularly effective at reducing anger levels. These findings support prior research which has shown that exposure to a park settings elevates attention performance in the general population and also in populations with Attention Deficit Hyperactivity Disorder (ADHD) (Faber Taylor & Kuo 2009). Another study has demonstrated a relationship between childhood visits to woodlands or greenspaces and preparedness to visit such sites alone as an adult (Thompson *et al.* 2008). Findings suggest that childhood experiences strongly reflect the physical and emotional benefits of accessing such places.



Figure 27.28 Children exploring a woodland habitat. Image © Morgan Lane Photography, 2011. Used under license of Shutterstock.com.

forest stewardship. There is little evidence, however, of the impact certification has on forest management and ecosystem services in the UK (Section 8.5.4).

It is well-established that the doubling of forest cover since WWII is primarily in response to incentives, in the form of grants, and favourable economic and tax conditions (Chapter 3; Chapter 8). In fact, the forestry sector is so reliant on incentives that between 1961 and 1986 expenditure in forestry exceeded income in all but two years, with a mean deficit over this period of £70/ha (Chapter 22). Incentive schemes have improved since the 1980s, when grants financially supported tree plantation with primary regard for timber production. Woodland creation grants now incorporate scoring and eligibility criteria in order to assess the delivery of the greatest public and environmental benefits (**Box 27.23**); however, there are still concerns that new planting could damage important sites of biodiversity such as Semi-natural Grassland (RSPB 2008). Forestry incentives intersect with incentive schemes from agriculture (e.g. agri-environment schemes), recreation and tourism (e.g. the Wildspaces! Scheme), biodiversity (e.g. support for SSSI management), and energy (e.g. biomass grants) sectors as grant schemes become increasingly integrated.

Devolved forestry grant schemes run by the Forestry Commission and the Northern Ireland Department of Agriculture and Rural Development incentivise action towards the aims of the Forest Strategy in each country: the Woodland Grant Scheme operates in England (Forestry Commission England 2009); Glastir Woodland Grants were recently introduced for woodland creation in Wales (replacing the Better Woodlands for Wales scheme; **Box 27.23**) (Forestry Commission Wales 2010); Rural Development Contracts—Rural Priorities are part of the Scotland Rural Development

Programme in Scotland (Scottish Government 2010g); and Forest Grants exist in Northern Ireland (Forest Service 2007). Common to all of these schemes is the availability of funding for woodland creation and for management improvements. Northern Ireland and Scotland both have grants available specifically for the planting of new woodland to be managed under short rotation forestry for the production of wood fuel and renewable energy (**Box 27.24**). In England, the Energy Crops Scheme supports the establishment of short rotation coppice (Natural England 2009c).

Outside the public forestry grants mentioned above, private forestry incentives are available. Some energy providers now offer contracts to local farmers who supply biomass (Section 15.2.5). Non-governmental organisations and charities are increasingly supporting tree planting initiatives privately through membership fees and donations. One example is the MOREwoods scheme of the Woodland Trust which offers finance and technical support for native tree planting to landowners across the UK (Woodland Trust 2010a).

Taxation is also used as an economic instrument to achieve desired policy objectives. In the UK, favourable tax conditions currently exist which encourage people to purchase woodland and to invest in forest management. All profits and income from timber sales are free from Income and Corporation Tax, and there is no Capital Gains Tax (CGT) on the increase in value of standing timber over time (Forestry Commission Wales 2003). Additionally, commercial woodland that has been owned for at least two years prior to being transferred or upon death qualifies for 100% relief from Inheritance Tax. While Inheritance Tax breaks are desirable, (Render 2004; Lawrence *et al.* 2010) found that grants “can be preferred to tax incentives for the

Box 27.23 Glastir Woodland Creation Scheme.

In Wales, the Better Woodlands for Wales grants scheme closed to new applications in 2010 (Forestry Commission Wales 2010). In its place, the Glastir Woodland Creation Scheme has been launched by the Forestry Commission Wales as an instrument to increase the area of native and mixed woodland as set out in the Woodlands for Wales strategy of the Welsh Assembly Government (WAG 2010d). Options for woodland management are currently under development and have been proposed for inclusion under the Targeted Element of the Glastir scheme which will be operational in spring 2013 (Forestry Commission Wales 2010).

Under the new Glastir Woodland Creation Scheme there are three grants available (Table 27.14): 1) establishment grants; 2) fencing grants (only available for new planting); and 3) income foregone payments. Establishment grants at various rates are available for five woodland categories as follows:

A collaboration of partners has worked to develop strategic woodland creation maps for both native and mixed woodlands. These indicate where planting can go ahead without consultation (green), where planting can go ahead without consultation, but with specific prescriptions (green hatched), where planting plans need to be further informed by local consultation or where other barriers need to be overcome (amber), and where sites are inappropriate and planting is not allowed (red).

The maps are available via a web-based mapping browser (http://maps.forestry.gov.uk/imf/imf.jsp?site=fcwales_ext&), allowing applicants to quickly check the eligibility of an area (Forestry Commission Wales 2011).

Table 27.14 Woodland category, specifications and grant rates under the Glastir Woodland Creation scheme. Source: reproduced from WAG (2010d).

Woodland Category	Specification	Grant £/ha (yr 1/yr 2/yr 3)
Small simple woodland	<ul style="list-style-type: none"> ■ No species restriction providing they are suited to site and woodland meets UKFS and environmental standards ■ Stocking density 2,500/ha 	500 / 150 / 150
Basic mixed woodland	<ul style="list-style-type: none"> ■ Minimum of 3 species with no more than 75% of any one species ■ Minimum of 25% broadleaved species inclusive of woody shrub element ■ Maximum of 10% woody shrub element ■ Stocking density 2,500/ha 	980 / 500 / 500
Enhanced mixed woodland	<ul style="list-style-type: none"> ■ Minimum of 5 major species (at least 10% of each) ■ Minimum of 25% broadleaved inclusive of woody shrub element ■ Maximum 10% woody shrub element ■ No more than 50% of a single species ■ Stocking density 2,500/ha 	2,350 / 500 / 500
Native woodland—carbon	<ul style="list-style-type: none"> ■ Native species mix should be site-native ■ Suitable provenance planting stock* ■ Maximum 20% woody shrubs allowed ■ Stocking density 2,500/ha 	3,500 / 500 / 500
Native woodland—biodiversity	<ul style="list-style-type: none"> ■ Native species mix should be site-native and largely conform to HAP types; however, local conditions may necessitate some variation from these ■ Suitable provenance planting stock* ■ Maximum 20% woody shrubs allowed ■ Clumped distribution of species with variable spacing ■ Stocking density 1,600/ha 	1,890 / 500 / 500

* Indications from research are that the use of locally native provenance alone may not be resilient enough to cope with predicted climate change. Guidance is being developed on widening the genetic material used within a species.

Box 27.24 The Big Tree Plant campaign.

The Big Tree Plant is a campaign to encourage people and communities to plant more trees in England's towns, cities and neighbourhoods. It is a partnership bringing together national tree-planting organisations and local groups working with the Department for Environment, Food and Rural Affairs and the Forestry Commission. The initiative has been launched in response to a decline in tree planting in urban areas. It is backed by funding of £1 million, but the emphasis is on community groups and organisations establishing or extending projects to plant and care for trees, in line with the 'Big Society' (localism) approach. Further information: <http://thegigtreetplant.direct.gov.uk>

provision of certain public benefits (particularly landscape protection and nature conservation)".

27.5.3.6 Technologies and practices (instrumental)

Intensive management made possible through the adoption of mechanisation in forestry operations, particularly timber harvesting, has allowed woodland enterprises to increase their profitability and domestic markets to grow

(Section 8.2.5.3). Intensive practices have affected the age-distribution, structural diversity, habitat quality and biodiversity of productive forests. Chemicals are used both to directly increase woodland productivity, and to allow growth of conifer plantations in areas where this was previously uneconomical (Chapter 3.3). Modern technology has improved harvesting practice to minimise impacts on regulating services by reducing sediment losses, nitrate peaks and other threats to water quality downstream of plantations (Section 14.9.4).

Tree development through breeding has a long history in the UK. The Forestry Commission established its first hybrid trial in 1926 and, by 1948, a research station was established to undertake work in forest genetics (Forest Research 1998). Biotechnological tools are used both for genetic conservation strategies and to increase the desirability of morphological traits. Applications have included biochemical and molecular studies to enable seed origin to be determined and the use of vegetative propagation techniques to genetically improve commercial

species (Lee *et al.* 2004). Biotechnology is used to increase the quality of commercially grown tree species through breeding and genetic conservation programmes use advanced molecular techniques to conserve native tree biodiversity (Wilson & Samuel 2003).

An important recent application is the use of genetic strategies to reduce the impacts of climate change on UK forests (Hubert & Cottrell 2007). Three potential strategies have been identified to accommodate climate change: 1) maintain genetic variation and promote natural regeneration; 2) adopt a portfolio approach and plant a mix of provenances alongside the current population; and 3) use assisted migration by planting a different provenance or species (*ibid.*).

There is also scope for the future development of a biochemical industry based on forest foliage compounds to produce products like essential oils, herbal supplements and resin acids.

Sophisticated technology, such as automatic, high efficiency boilers and power installations, can efficiently create energy from wood biomass as an economical and low carbon alternative to fossil fuels (Forest Research 2006). Wood fuel boilers can produce heat or electricity from logs, chips, or pellets with variable requirements for moisture content and consistency (**Box 27.25**). Combined Heat and Power (CHP) plants can produce both electricity and heat which can be used for hot water or district heating for industries or local communities. Electricity can also be generated through 'co-firing' where different techniques are used to combine up to 20% biomass with coal in existing power stations (Perry & Rosillo-Calle 2008). As the price of gas rises, wood fuel is an increasingly cost-effective source of heat.

An ecosystem service of increasing importance is noise regulation which can be moderated through tree planting, especially in the case of strip planting along motorways to minimise undesirable noise from road traffic (Section 14.6). Tree belts are also used in a regulating capacity to capture or reduce the transport of point source pollution (for example, ammonia from agricultural livestock production), reducing negative impacts on vulnerable habitat (Defra 2002a). When appropriately planned, trees and greenspaces can play an important role in controlling Urban climates by improving flood control and air quality, countering threats to biodiversity, and reducing Urban heat island effects (Wilby & Perry 2006). Tree planting in Urban areas has also become a commonplace activity for the benefits of human health and recreation opportunities. The realisation of these benefits from trees is dependent on species choice used and where they are located.

There is a need for the development of decision-analysis tools which account for ecosystem services. Multi-criteria decision analysis is a subjective method for decision-makers to evaluate alternative courses of conflicting action (Section 8.5). Decision-support tools aid forest owners and managers to model different management options to determine the impacts of future climate change. Payments for ecosystem services involving forestry have high potential in the UK, and technological advances in remote sensing and GIS will be important in this field.

Box 27.25 Stevens Croft biomass power station, Lockerbie, Scotland. Source: Scottish Executive (2007); Perry & Rosillo-Calle (2008); Net Resources International (2010).

Commissioned in 2007, Stevens Croft biomass power station (**Figure 27.29**) is the largest plant in Scotland solely dedicated to burning wood biomass. The plant, which is carbon neutral, burns 480,000 tonnes of sustainable wood fuel in a year; it is capable of using a maximum of 95,000 tonnes per year from short rotation coppice in the blend of fuel. E.ON UK won Best Renewable Project 2007 at the Scottish Green Energy Awards for the project which cost an estimated €132 million. Each year, the plant will save up to 140,000 tonnes of greenhouse gas emissions.

Using new technology from Siemens and Metso Power, the power plant can reach full generating capacity (42.2 megawatts export) even with high moisture fuel, such as freshly cut small round wood, sawmill co-products, and short rotation coppice willow of different grades.

The site, which was already occupied by a sawmill, is near to densely forested areas, minimising the cost and emissions of fuel transport. The project has generated 40 direct jobs, and has created or safeguarded an additional 300 jobs in forestry or farming.



Figure 27.29 The Stevens Croft biomass power station in Lockerbie, Scotland: the UK's largest solely wood biomass-burning plant. Photo courtesy of E.ON UK.

27.5.3.7 Voluntary actions (instrumental)

Voluntary actions are increasingly powerful instruments of change in forestry. As public awareness about issues of climate change and habitat and species conservation expands, there is increasing incentive for businesses to adopt voluntary measures to improve corporate

social responsibility. One new example in the UK is the Woodland Carbon Code, a piloted standard for voluntary carbon sequestration projects (Forestry Commission 2010b). The code is designed to provide reassurance to businesses and individuals wishing to plant trees for the purpose of sequestering carbon by encouraging a consistent approach to woodland carbon projects. Projects meeting the requirements of a forestry standard, long-term management plan, and provide carbon benefits that are accurately measured, can carry the Woodlands Carbon Code label of approval. In doing so, the process also provides reassurance to carbon-conscious consumers.

Voluntary organisations also play an important role in encouraging the support of traditional forest management practices such as coppicing. Voluntary partnerships among government departments, organisations, businesses and individuals are becoming more common in the forestry sector (**Box 27.26**). In 1994, a National Native Woodland Accord was signed between the Association of National Park Authorities and the Forestry Commission to formally recognise the importance of semi-natural Woodlands to the landscapes and ecosystems of English National Parks (DNPA, *et al.* 2004). This was reinforced in 2002 with an Accord to widen the scope and depth of the partnership “to provide a framework for the two organisations to work together to enhance the contribution that trees and woodlands can make to society within some of the finest landscapes in England and Wales.” (Forestry Commission 2002). Another example is the Wales Forest Business Partnership, a voluntary group of businesses and organisations across the forestry sector in Wales (Wales Forest Business Partnership 2011). The aim of this partnership is to strengthen the forestry sector as a whole and to encourage forestry-related businesses to compete and be successful within a wider market.

27.5.4 Forestry Summary

Table 27.15 summarises the key insights from this review of responses in the forestry context, highlighting those that have been well-established, but also identifying a set of responses that are either in early implementation or are proposed. It is important to learn from these early pilots across all sectors to scale-up the adoption of an integrated ecosystem approach to the management of the UK’s diverse habitats, which is one key policy direction that this review recommends.

27.6 Fisheries

27.6.1 Fisheries, Ecosystem Services and Human Well-being

Fisheries benefit people in the UK and overseas through the provision of fish and shellfish for human consumption (sourced from wild capture and aquaculture fisheries), fishmeal for aquaculture, fish oil for food supplements, and bait for sea angling. The polyunsaturated fatty acids (e.g. omega-3 oils) contained in fish can contribute to a healthy

Box 27.26 The Treeregeneration project, North East Wales. Source: Forest Research (2008).

The aim of the Treeregeneration pilot project (2004 to 2008) was to determine the scope for a national urban forestry initiative in Wales. Funding for the project was attained through a partnership between: the Countryside Council for Wales, the two County Councils involved (Wrexham and Flintshire), and the Forestry Commission Wales. Partnerships were also made with other organisations, such as BTCV, the Groundwork Trust, schools, businesses and community groups, to provide match funding.

Treeregeneration was a grant-giving project for Urban tree planting, but also provided practical assistance and expert advice on other Urban planting schemes. A total of 20 projects were given financial assistance (totalling £113,000) and an additional six projects received non-monetary assistance. By the end of project delivery in 2008, 59,300 native and 308 non-native trees had been planted; by 2,200 people, and a total of 30 ha of Urban woodland had been created.

The project was found to be successful in promoting integrated working through direct partnerships; but these partnerships were found to be short-lived. A review of the project determined that it had been valuable and had played an important role in providing support and expertise for urban greening which was otherwise unavailable. Interestingly, the business community resisted the project, fearing that Urban tree cover would exacerbate anti-social behaviour and crime. Experiences from this project support recommendations to strengthen the partnership approaches of the Forestry Commission Wales.

diet (NHS 2011). Despite its declining contribution to the UK’s economy, it remains an important industry for some coastal communities, especially in remote areas of Scotland, Wales and south-west England. In 2007, the UK’s commercial marine fishery landed 611,000 tonnes of fish and shellfish into the UK and abroad, worth almost £650 million at first sale (UKMMAS 2010). The expansion of aquaculture in Scotland has been substantial—it is now the largest salmon producer in the EU and generates £327 million from farmed finfish alone (**Figure 27.30**). Recreational sea, coarse and game angling provides a valuable source of income for coastal and rural communities; recreational sea fishing generated £538 million for England and Wales in 2003 and £141 million for Scotland in 2008 (UKMMAS 2010); Section 27.8).

Marine ecosystems provide a number of services that support commercial fisheries (Section 12.3). They break down waste and purify water, ensuring seafood is safe to eat. Marine microbial organisms cycle nutrients (such as carbon, nitrogen and phosphorus) that are essential for the maintenance, growth and production of essential Marine organisms that underpin Marine food webs and commercial fisheries. Marine living habitats, such as mussel beds, form feeding, breeding and nursery grounds that are important for the recruitment of commercial species. Despite the importance of these services to the fishing industry, the general trend has been to unintentionally degrade the environment that delivers them. Seabed trawl nets and dredging gear destroy living reefs and deep-water corals, which have slow recovery times, and affect benthic invertebrate communities that are an important food source for commercial fisheries. Chapter 12 reports that several stocks in the North Sea and Irish Sea are fished beyond biological limits of exploitation. Not only does the

Table 27.15 Forestry Summary.

	Established responses	Early implementation, pilots	Proposed, under development
Knowledge	<ul style="list-style-type: none"> ■ Forest Research Agency ■ Environment and Human Health Programme (Natural Environment Research Council) 		<ul style="list-style-type: none"> ■ Research on physical and mental health benefits of forests
Legislation	<ul style="list-style-type: none"> ■ Forestry Act 1967 ■ Forestry Regulations ■ Environmental Impact Assessment (forestry) Regulations ■ Protected areas legislation (Table 27.5) ■ Countryside and Rights of Way Act 	<ul style="list-style-type: none"> ■ Renewables Obligation Order 	
Policies, institutions and governance	<ul style="list-style-type: none"> ■ National Forestry Strategies ■ UK Forestry Standard 	<ul style="list-style-type: none"> ■ Biomass energy policy ■ Open Forest Policy and Policy on Control of Woodland Removal ■ Grazing Policy 	<ul style="list-style-type: none"> ■ Carbon sequestration policy ■ Multifunctional forestry approaches ■ Public-private partnership
Changing social attitudes	<ul style="list-style-type: none"> ■ Tree Warden Scheme in England 	<ul style="list-style-type: none"> ■ Physical and mental benefits of 'Forest School' ■ Community Woodland Groups in Wales 	<ul style="list-style-type: none"> ■ Local access to greenspace
Markets and incentives	<ul style="list-style-type: none"> ■ UK Woodland Assurance Standard ■ Forest Stewardship Council UK 	<ul style="list-style-type: none"> ■ English Woodland Grant Scheme ■ Glastir Woodland Grants ■ Rural Development Contracts in Scotland ■ MOREwoods Scheme 	<ul style="list-style-type: none"> ■ The Big Tree Plant Campaign
Technologies and Practices	<ul style="list-style-type: none"> ■ Tree development through breeding ■ Biomass power station technology 		<ul style="list-style-type: none"> ■ Biotechnology improvements to reduce impacts of climate change ■ Biochemical industry
Voluntary actions	<ul style="list-style-type: none"> ■ National Native Woodland Accord ■ Wales Forest Business Partnership 	<ul style="list-style-type: none"> ■ Woodland Carbon Code ■ Treeregeneration Project 	

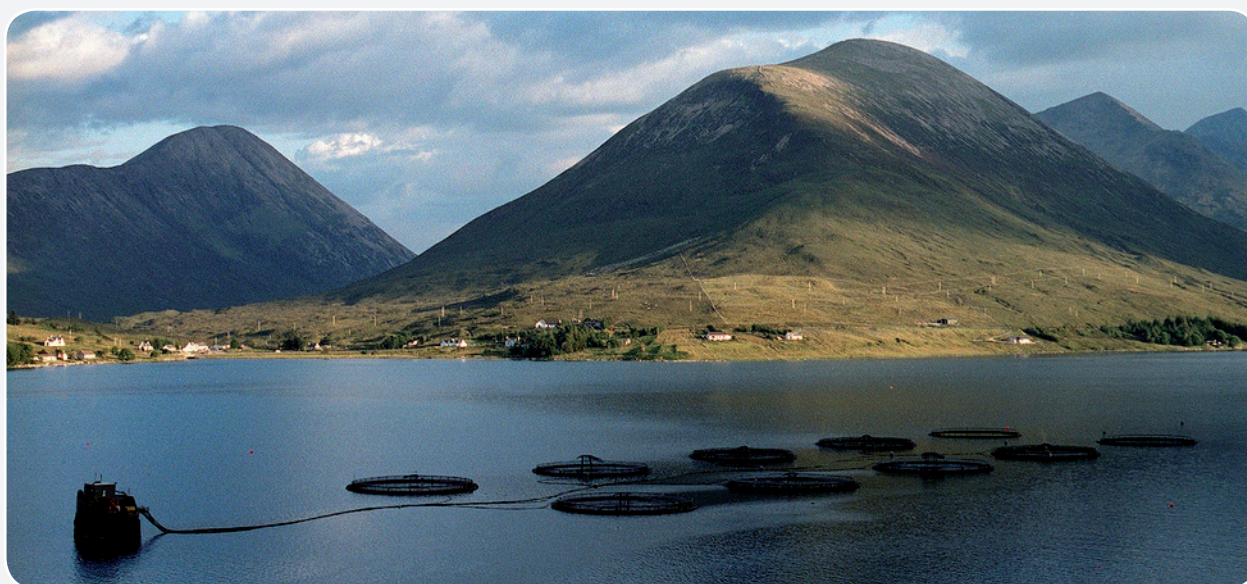


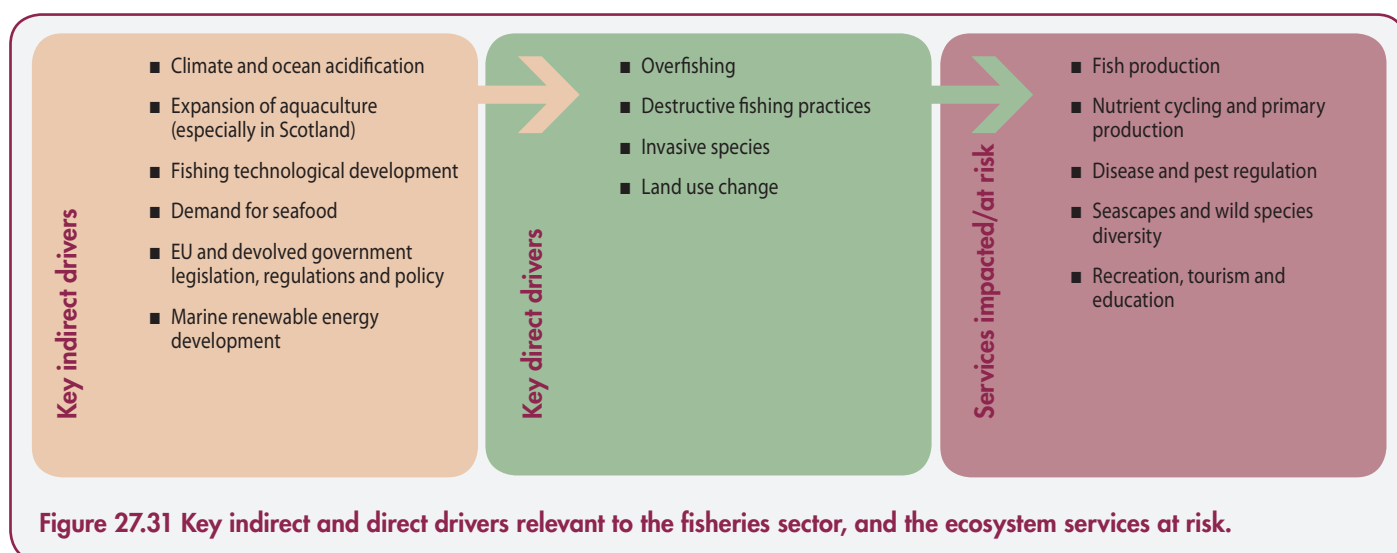
Figure 27.30 Scotland is now the largest salmon producer in the EU. Salmon farm on the Island of Skye, Scotland.
 Photo by Eric, available under a Creative Commons Attribution-NonCommercial-NoDerivs license.

unsustainable exploitation of the fisheries threaten the long-term survival of the industry, it also impacts the supporting and regulating services of the Marine environment.

Due to the interdependencies between the state of the fisheries and the Marine and Freshwater environment, responses need to be considered within the wider context of marine planning and river basin management. The fisheries also have a significant influence on Marine biodiversity, and marine energy development may impact the habitats of commercial species. The reader should, therefore, also refer to: Biodiversity (Section 27.2); Water (Section 27.3); Marine and Coasts (Section 27.7); and Urban Planning, Transport and Energy (Section 27.9).

27.6.2 Challenges for the Fisheries Sector

Figure 27.31 summarises the major fisheries-related direct and indirect drivers and their impact on ecosystem services. The major challenge for fisheries is to move towards a sustainable path where landings of fish fall within safe biological limits of exploitation, so an appropriately sized fishing industry can prosper. Some progress has been made towards achieving this aim. In the early 1990s, only about 10% of scientifically monitored fish stocks were considered to be at full reproductive capacity, but this rose to 50% by 2008 (Armstrong & Holmes 2008). While this is a positive trend, Chapter 12 reports that several stocks in the North Sea and Irish Sea are still overfished and subject to recovery



plans, while other commercial species have not yet been assessed due to sparse data. Fish mortality in most stocks remains above levels that would enable maximum sustainable yields in the long-term. The provision of food from Marine ecosystems is at its lowest in over 100 years (Chapter 12). Although regulations have protected some deep-sea corals, the use of seabed trawling is still widespread in UK waters and has a severe impact on benthic communities.

In the future, demand for fish is expected to increase globally, but remain stable in the UK and the rest of Europe; fish landings are likely to remain stable or decline if stocks remain overexploited (Delgado *et al.* 2003; Pinnegar *et al.* 2006). At worst, fish stocks could collapse, with widespread impacts on employment in the sector and their communities. But it is more likely that stocks will remain fairly stable or fall as trade barriers are removed (UK Cabinet Office 2004).

Aquaculture is set to expand to meet global demand for fish protein, with more farms in Scotland and the emergence of an industry in England and Wales. While this expansion could create 2,000 jobs and a first sale value of £100 million, it will also require more fish feed, putting pressure on wild species (Section 22). Care must be taken to manage the potential environmental impacts of this development.

Climate change impacts, including increased sea temperatures, ocean acidification and changes in primary production, may alter the Marine environment and fisheries in ways that are not yet known. By 2050, the warming of the seas may increase the abundance of warm water species, but some seas are likely to have lower yields (e.g. Irish Sea and English Channel). Stocks of cod could disappear completely by 2100 (Pinnegar *et al.* 2010).

The enactment of the Marine and Coastal Access Act (2009), and the creation of Marine Scotland, the Marine Management Organisation and Inshore Fisheries and Conservation Authorities in England, illustrate a shift towards a more integrated approach to managing the marine environment (Section 27.6.3.2; Section 27.6.3.3). This is likely to necessitate the rebalancing of fisheries exploitation and the delivery of other Marine ecosystem services. Enhancing the latter, however, is also likely to support the restoration of commercial fish stocks that are highly dependent on the

supporting services of these ecosystems. Creating adaptive systems of management will be important for responding to the uncertainty associated with environmental change. Regulations will struggle to achieve their intended goals without better compliance from the fishing industry.

27.6.3 Fisheries-related Response Options

27.6.3.1 Knowledge (foundational)

Since very few people actually get to see the underwater world, science has been the prevailing driver of policies to protect the fisheries. Knowledge of the status of fish stocks has been the subject of research for more than 100 years. The International Council for the Exploration of the Sea (ICES), established in 1902, is responsible for scientific assessments on the sustainability of European fish stocks. In the UK, the Fisheries Science Partnership and the Scottish Industry/Science Partnership provide national data on fish stock abundance and distribution, and various government agencies publish statistics on the UK fishing and processing industry.

In addition to recording landings and logbook schemes, fisheries observers are deployed on-board fishing vessels to record catches. For example, Marine Scotland Science observers record all catches of the whitefish and *Nephrops* fleets, data which is then fed to national scientists and ICES. A second observer initiative run by the Scottish Government and the Scottish Fishermen's Federation focuses primarily on cod catches, and has also trialled new gears. In place of observers, Closed Circuit TV is currently being trialled (e.g. on Scottish whitefish and *Nephrops* vessels, and in Devon, England) as a more economic and easier means of recording fishing activities. This system of observation has already proved effective during trials in Denmark (WWF 2009).

Recorded declines in fish stocks led to the development of approaches to calculate sustainable catch levels. Maximum Sustainable Yield is the largest size of catch that can be sustained by the fisheries for the foreseeable future. When there is adequate data on specific stocks, Maximum Sustainable Yield can be a useful point of reference for the recovery of a stock. Developments in science, however, have revealed the limitations to the concept. It does not consider environmental variability, the age and sex structure of

stocks, or by-catch. Each species is effectively managed individually under this concept, whereas, in reality, several species are caught together making it difficult to ensure all species are fished within Maximum Sustainable Yield (Horwood *et al.* 2006). Maximum Sustainable Yield has been improved to account for natural mortality by using mortality rates to measure Maximum Sustainable Yield rather than catch size (Natural England 2009h). The UK ratified the 1995 UN Fish Stocks Agreement, which contains a commitment to meet Maximum Sustainable Yield. The agreement stipulates that Maximum Sustainable Yield should be the upper limit for fishing, rather than a target; in doing so, it takes account of the uncertainties associated with natural variability and inaccurate stock assessments. The UK Government also has a commitment made at The World Summit on Sustainable Development (WSSD 2002) in Johannesburg to manage stocks at Maximum Sustainable Yield levels by 2015.

Increased knowledge is urgently required to support an ecosystems approach to marine resource management. Untangling human influences from natural variability and future environment change in Marine bioresources is a theme of research currently being undertaken by Ocean 2025, a multi-institutional and interdisciplinary project funded by the Natural Environment Research Council (Oceans 2025 2010). Any advances in knowledge need to be translated into policy-relevant advice and decision-support tools for marine and fisheries managers. The Centre for Environment, Fisheries and Aquaculture Science, an executive fisheries management agency of the Department for Environment, Food and Rural Affairs, is undertaking research on the ecosystem approach to fisheries management by developing a pilot for the south-west of England (Cefas 2011). Research in this area requires the integration of ecosystem knowledge and social and economic considerations to find effective solutions.

Chapter 12 (Section 12.6) identified many gaps in knowledge for marine resource management. Some of the most important challenges for researchers include quantifying the linkages between ecosystem functions and services, and the likely impact on fisheries from expected environmental changes (e.g. pH and temperature). The Chapter also emphasises the importance of research into tipping points and thresholds in the Marine environment, which could have indirect effects on fish population structure and abundance.

The availability and quality of credible scientific data is essential for achieving sustainable fisheries. In addition to stock assessments, better understanding of the impact of fishing on Marine ecosystems, and the basic biology, ecology and socioeconomics of fisheries, is needed. It will be necessary for scientists to work with fishermen and managers to collect and analyse this data (Defra 2009i).

27.6.3.2 Legislation (enabling)

The Common Fisheries Policy (CFP) was formally established in 1983. Its origins are in the assurance of mutual access by EU Member States to each other's territorial waters for fishing purposes. It was organised to reflect historical fishing patterns in European waters, and its underlying goal was to avoid territorial disputes.

Growing awareness of declines in fish stocks triggered attempts to use the CFP to manage fisheries more sustainably. This culminated, in 2002, with the most recent set of CFP reforms. These reforms acknowledged the growing severity of unsustainable and environmentally destructive fishing practices. They identified and attempted to address various long-standing, worsening failures of the CFP: the prioritisation of short-term objectives in decision-making over quota allocations; the complexity of technical regulations; fishing fleet overcapacity; and poor compliance and enforcement. Lack of stakeholder involvement was also tackled through the setting up of Regional Advisory Councils, consisting of representatives of the fisheries sector and other interest groups (but dominated by the former). The framework for the post-2002 CFP mechanisms is set out in the Basic Regulation (2371/2002/EC). Key elements of the framework are as follows.

1. Total Allowable Catches (TACs). These are agreed each December by the EU Council of Fisheries Ministers, and set an overall weight limit for the amount of a particular species which may be landed. This overall amount is then divided up by nation, according to a methodology (known as 'relative stability') which reflects historical catch levels. In theory, TACs are based on advice from the ICES regarding sustainable levels of catches. Since the 2002 reforms, in an effort to promote long-term management and avoid quotas being ruled by short-term economic interests, some TACs are subject to multi-annual management plans.

2. Technical regulations. These are described by the EC as the qualitative element of the CFP, and complement the quantitative limits it imposes in the form of quotas. They consist of a series of rules intended to encourage selectivity in fishing methods and prohibit particularly environmentally destructive practices. They include minimum mesh sizes for nets (to allow small fish below reproductive age to escape), minimum landing sizes, and limits on by-catch as a percentage of total catch.

3. Fleet overcapacity controls. Fisheries around the world, including in Europe, are under intense pressure because fishing fleets have grown so much in size and efficiency. Economic subsidies have exacerbated this. The CFP 2002 rules have attempted to restructure the EU fleet and reduce overcapacity by, for example, funding vessel-scrappping schemes, and banning using public money to add capacity to, or modernise, ships. Member States have flexibility as to how to carry out capacity reduction obligations. In addition, there are 'effort limiting' rules such as days-at-sea limits.

4. Enforcement. Compliance has been a major issue for the CFP, particularly as the combination of fleet overcapacity and diminishing stocks degrades the industry's competitiveness and pressure builds on fishermen to break the rules (EC 2008). National governments have responsibility for policing fisheries regulations (in England, the Marine Management Organisation is the main coordinator for this; in Scotland, Marine Scotland is the coordinator). The EU performs a role inspecting the standard of national enforcement activities: 'controlling the controllers'. If national-level enforcement is found to be falling short, it is possible for the EU Commission to bring infringement

proceedings; for instance, infringement proceedings were brought against Italy and France over failures to properly control their bluefin tuna fishing industries. Recently, new regulations have tightened enforcement procedures, such as the Control Regulation, and the Regulation on Illegal, Unreported and Unregulated Fishing. However non-compliance remains pervasive. A European Court of Auditors report (2007) criticised the UK (as well as five other EU countries) over incomplete and unreliable data collection, badly targeted inspection activities and failure to apply sanctions robustly enough to provide an effective deterrent (European Court of Auditors 2007).

Overall, the 2002 reforms have not succeeded, and it is now almost universally recognised that EU fisheries are in an extremely poor state. According to the EU Commission's Green Paper (2009) on CFP reform, over 80% of European fish stocks are over fished, and 30% of species assessed are outside safe biological limits (i.e. they may be incapable of replenishing). In ecosystem services terms, the provisioning services of EU Marine waters have been vastly overexploited, to the extent that future capacity is in grave doubt.

In short, a number of systemic failures mean that the CFP in its current form is incapable of delivering sustainability objectives. The Commission's Green Paper identified five structural failings: fleet overcapacity, short-term decision-making, imprecise policy objectives, poor compliance, and insufficient industry responsibility.

Efforts to take a more long-term stock management approach are consistently undermined. Short-term decision-making remains dominant, with economic, political and social objectives overriding ecological objectives (EC 2008). Fleet overcapacity creates a vicious circle, as competition among fishing businesses with very low economic resilience encourages ever-harder fishing (*ibid.*). Policies to reduce overcapacity have, so far, led to reductions of about 2% per year (EU Commission CFP User's Guide, 2009), but this is compensated for by technological advances. The system of technical regulations is complex, costly and, in some cases, contradictory. Methods are found by fishing fleets to counteract short-term negative economic effects of technical restrictions, leading to the imposition of ever-more detailed measures. The incentive for fishers to break the rules in the absence of efficient enforcement mechanisms is strong. Discarding is perhaps the most severe unintended outcome of the current CFP, an effect created by the combination of quotas and minimum limits on the size of fish which may be brought to shore. **Box 27.30**, Section 27.6.3.6 discusses the issue of discards in more detail and outlines options for tackling it.

There is agreement among government (at EU and national levels), environmentalists and the fishing industry that the CFP is not working. Likewise, it is agreed that the next round of reform must entail a comprehensive overhaul, not further piecemeal development of the current flawed system (OCEAN₂₀₁₂ 2011 ; ClientEarth 2009; CEC 2009; UKPREU 2009). A complete picture of proposals for a new framework is not possible in this space, but some of the essential elements can be outlined.

A reformed CFP should contain certain fundamental objectives and basic management mechanisms. In order to

ensure the system is applied consistently, these should be legally binding, not simply aspirational targets. They could, for example, be enacted in a new Basic Regulation. **Box 27.27** outlines some of the fundamental objectives that are being considered in the CFP reforms.

The Marine Strategy Framework Directive (2008/56/EC) was enacted in 2008. It follows a similar strategy to the WFD, obliging Member States to ensure the 'good environmental status' of all seas under their jurisdiction by 2020. The overall objectives of the MSFD are discussed in more detail in Section 27.7.3. The interaction of the MSFD with the CFP is of crucial importance.

The reformed CFP will need to include an obligation to manage resources so as to comply with the MSFD. This means taking ecological factors—such as the indicators of characteristics, pressures and impacts on marine environmental status set out in the MSFD—into account in fisheries management plans and when allocating fishing opportunities. In particular, this includes the consideration of the descriptors which help to establish good environmental status under the MSFD such as: biological diversity at a regional ecosystem level; populations of fish stocks within safe biological limits and with mortality levels equal to, or lower than, Maximum Sustainable Yield; all elements of Marine food webs (including large fish); seafloor integrity; and contaminants in fish (Section 27.7.3.2).

The Marine and Coastal Access Act 2009 has provided for the creation of a network of Marine Conservation Zones (MCZs) across the UK by 2012. They will protect nationally important Marine wildlife, habitats, geology and geomorphology. The sites of MCZs are currently being identified; Lundy Island became England's first MCZ in January 2010. They build on MPAs designated under the Habitats and Birds Directives, but also take account of social and economic considerations. Levels of protection for MCZs will range from highly protected areas where no extraction, deposition or other damaging activities are allowed, to areas where only minimal restriction on activities is required to protect features. Designation as a MCZ, therefore, does not mean a no-take zone unless it is required. Highly protected (or reference) areas, where fishing and other extractive and disturbing activities are prohibited, are intended to create reference, or near unimpacted, conditions. This will help MCZ managers to understand the value of intact Marine ecosystems compared to areas impacted by activities, including the benefits that closures offer the fisheries (Ashworth *et al.* 2010).

To date, there are only two statutorily designated MPAs within the area of influence of the Marine and Coastal Access Act: Skomer Island and Lundy Island. There are only three no-take zones (NTZ) in the UK: the east side of Lundy Island, in the Bristol Channel (established in 2003); Lamlash Bay, a community marine conservation area on the Isle of Arran in Scotland (2008); and Flamborough Head in Yorkshire, closed following the signing of a bylaw in 2010. While it is too early for there to be evidence of benefits of the Flamborough Head NTZ, an early study of the Lamlash Bay no-take zone by Howarth (2010) concluded that the NTZ does seem to be providing early scallop fishery benefits, but future monitoring will be needed to detect any substantial

Box 27.27 Fundamental objectives of a reformed CFP. Source: ClientEarth (2010a).

Sustainability. This must be the test for all aspects of the new framework, and ecological sustainability must be prioritised. This should mean incentives for sustainable practices, penalties for unsustainable practices and no subsidy systems which encourage (intentionally or otherwise) overfishing or overcapacity. Sustainability must dictate access rights and robust rules on fisheries closures.

Ecosystems-based approach. This would include granting access rights on the basis of ecosystem regions, and consideration of entire ecosystems (rather than just particular species of interest) in scientific data collection and setting access rights.

Integration. The CFP must comply in full with EU and international environmental laws. This is required by a fundamental principle of EU Treaty law known as the integration principle (Article 11 of the Treaty). This means that the CFP must apply the precautionary principle and comply with the obligations to achieve good environmental status contained in the Marine Strategy Framework Directive. It must also respect the provisions of the Birds and Habitats Directive, for example, by prohibiting damaging fishing practices in protected areas or requiring appropriate assessments.

Science. The commitment to set fishing opportunities in accordance with scientific advice must be legally binding, and overriding.

Basic management conditions should include:

Regionalisation. To ensure that an ecosystem-based approach is implemented, management units need to be defined in terms of ecosystem regions (for example, the marine regions and sub-regions of the Marine Strategy Framework Directive) rather than in terms of national boundaries.

Management by total catch. This should replace management by landings, as under the current CFP, which, as already explained, produces perverse outcomes. For a true picture of the state of the ecosystem to inform policy decision-making, the whole catch (including target species and by-catch) must be monitored and accounted for.

Discard ban. Along with management of by-catch comes a requirement for a total ban on discarding.

Scientific data collection. This should cover all marine resources, not just commercial species.

Robust enforcement. This must include a robust and targeted penalty system.

improvements in scallop stocks. Natural England have been monitoring the Lundy NTZ, the first of its kind in the UK, and found that, by 2007, lobsters were seven times more abundant inside the NTZ than outside, and that adjacent areas are benefiting from the higher number of lobsters (Natural England 2010c). Scientists are now tagging the lobsters inside the NTZ and fishermen are being encouraged to report catches of tagged animals. This will show how far the lobsters migrate from the NTZ and have implications for commercial fisheries. Closing areas to fisheries may provide benefits to biodiversity and even fisheries production, but there may also be trade-offs in terms of diverting fishing pressure to other localities (Section 27.6.3.6).

27.6.3.3 Policies, institutions and governance (enabling)

The current problem of overfishing originally stemmed from a history of fish being a common pool resource open to anyone to exploit (MA 2005). Without government intervention based on knowledge of the limits of exploitation, individual fishermen have little short-term incentive to limit the quantity of fish they harvest.

The introduction of quotas through the CFP to help stocks recover has resulted in landings of demersal fish decreasing by over 50%. Set by the EC, TAC limits (Section 27.6.3.2) control the amount of fish that can be removed from a stock. Total Allowable Catches should be based on assessments by ICES that draw from scientific surveys by Member States on the estimated size of the fish stock and the size of total landings that will not place stocks outside of MSY limits.

Today, 88% of European quota stocks are still overfished, suggesting that the current TAC quota system needs revision to deliver sustainable fisheries (Roberts *et al.* 2005). The

drawbacks of the system include its targeting of specific species, problems associated with its high information requirements, that it does not consider by-catch and damage to habitats, and it fails to protect the genetic and population structure of stocks. Precautionary quotas recognise the uncertainties in stock assessment and reduce the risk of exceeding sustainable catch levels, but still have the same inherent drawbacks (Roberts *et al.* 2005). Because of these reasons, quota systems are not compatible with an ecosystems approach.

The principle of relative stability in the CFP divides quota rights proportionately between nations who have historically exploited the fishery. Nations are able to negotiate for changes in their allocation to ensure the quota can support their fleet or at least its managed downsizing. If the EC agree to an increase in quota size, then the quotas of the nations with rights to the fishery will also increase to maintain the same ratio as before the CFP, even if this goes beyond the agreed TAC. This makes the system biased to economic sustainability at the cost of ecological sustainability and the long-term viability of the fisheries (WWF 2007). Fisheries Ministers also tend to set TAC levels higher than that recommended by scientists to protect fishing communities (Figure 27.32; Roberts *et al.* 2005). In the long-run this will only jeopardise the viability of the industry.

The fall in domestic fish landings due to quotas has shifted demand for popular fish species to import markets (Figure 27.33): imports of fish into the UK increased by 46% from 1998 to 2008. This shifts the pressure on fish stocks to other parts of the world with often weaker regulations and management of fisheries than in European waters.

With growing acknowledgement that the current quota system is not achieving its objectives, and perhaps has the

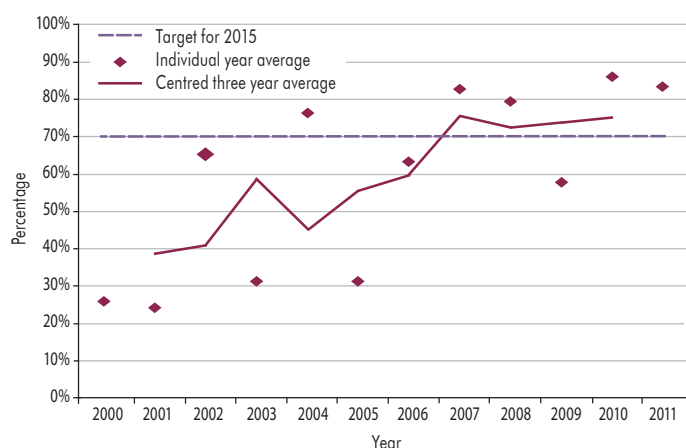


Figure 27.32 Percentage of key stocks where the Total Allowable Catch (TAC) limit is consistent with scientific advice.

Source: data from Scottish Government Marine Directorate (2010).

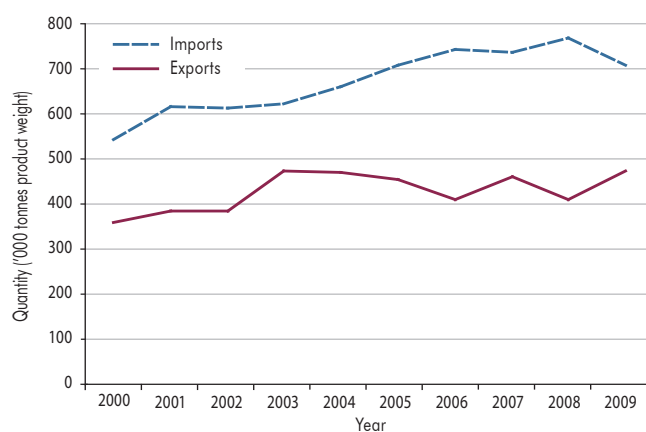


Figure 27.33 UK imports* and exports* of seafood. *Excludes fish products. Source: data from MMO (2010c).

least conservation value out of any of the management options available, alternative policies and measures are being considered including incentive-based schemes (Section 27.6.3.5), effort and spatial management alternatives, and gear restrictions (Section 27.6.3.6). Fisheries management is moving away from conventional approaches that focus on target species with little consideration of species with limited or no commercial value. The realisation that the entire Marine food web sustains commercial fish stocks has led to the acceptance, in principle, of the ecosystem approach in the management of fisheries, whereby the whole system is assessed and managed. More research and applied management is needed to explore how it could be attained in practice; one current example is the Centre for Environment, Fisheries and Aquaculture Science's Ecosystem Approach to Fisheries Management Project which is working to develop knowledge in this area.

A true ecosystem approach requires that the fisheries are not managed in isolation from other marine activities such as renewable energy, recreation and aggregate extraction. All these activities compete for space, and they impact on the ecosystems that support the fisheries and vice versa.

Decisions made by the fisheries sector, therefore, need take account of the environmental effects of fishing (FAO 2008). The Marine and Coastal Access Act (MCA 2009) aims to create a strategic planning system that provides for a more integrated approach to Marine management and the sustainable use of marine resources including fisheries (Section 27.7). Recent changes to UK fisheries management, such as reforms associated with the Marine and Coastal Access Act and new inshore fisheries arrangements (see below), have the potential to improve the status of commercial fish stocks. Chapter 12 expressed concern, however, that these measures may not address the disturbance of benthic habitats. Targeted measures may be required to protect the seabed, especially where environmentally sensitive or functionally important species are present.

The fisheries were previously managed by the Scottish Fisheries Protection Agency and Marine and Fisheries Agency in English and Welsh waters who were responsible for enforcing seas fisheries regulations, licensing UK fishing vessels and enforcing quotas. Marine Scotland and the Marine Management Organisation assumed their responsibilities in 2009 and 2010, respectively, including fisheries management activities related to the CFP, fisheries data collection and Marine nature conservation. Their jurisdiction is beyond six nautical miles offshore, with the inshore fisheries controlled by differing institutional arrangements in the four countries of the UK (e.g. Inshore Fisheries and Conservation Authorities (IFCAs) in England; **Box 27.28**). The Marine Management Organisation and Marine Scotland both also hold responsibility for the planning and management of the full range of marine activities to ensure that the integrated approach called for in the Marine and Coastal Access Act and Scotland Marine Act is met. The Marine Management Organisation has new responsibilities including the power to establish nature conservation bylaws that will have implications for the fisheries sector.

A consensus is now emerging among fishers, processors, retailers, consumers, conservation organisations and governments that something has to be done to increase the abundance and diversity of fish and improve the health of the Marine environment (Natural England 2009h). This shared objective creates an opportunity for collaborative action to address overfishing and destructive practices. It is argued that 'top-down' fisheries approaches associated with the CFP have not been effective at achieving either ecological or social sustainability (Thompson 2008b). In the Green Paper on CFP reform (EC 2009a), a lack of stakeholder engagement in decision-making was highlighted as a key failure of the CFP. The centralised approach, where regulations apply a 'one size fits all' approach, failed to take account of local circumstances (*ibid.*).

Allowing fishers to be more involved in the management of the resource upon which they depend is seen as one way to correct this. Co-management is thought to provide several benefits such as providing opportunities for social learning (Section 27.6.3.4), building trust and improving compliance with regulations and reducing enforcement costs (Pinkerton 1989; Borriani-Feyerabend & Borriani 1996; Schusler *et al.* 2003). Fisheries organisations at a local level can provide a useful forum for knowledge generation and cooperation

to solve problems through deliberation and joint learning (Berkes 2009). Inshore fisheries management in England and Wales is one of the oldest examples of co-management of fisheries, but is currently being reformed (**Box 27.28**).

Furthermore, since there are significant knowledge gaps in and uncertainties about the linkages between Marine ecosystem functions and services, and on the impact of environmental changes (Section 27.6.3.1), management needs to be flexible enough to be changed as information becomes available and the impact of fisheries and other Marine management actions become apparent ('learning by doing'). Adaptive management, whereby decision-makers continuously gather and integrate appropriate social, economic and ecological information to improve measures, is particularly relevant for the sustainable management of fisheries (Costanza *et al.* 1998).

27.6.3.4 Changing social attitudes (enabling)

Public awareness and consumer choice. In the past, raising public awareness of the threat to the UK's Marine ecosystem was problematic. Only a limited number of people, mainly SCUBA divers, have the opportunity to view and interact with the UK's underwater seascapes. The decline of UK fish stocks is also masked by the industry shifting fishing effort to other fish stocks and species further from land, and using more sophisticated technologies. Imports and aquaculture make up the shortfall from wild capture fisheries. These innovations prevent the reduction in supply from UK waters being represented in the price of fish.

The British do, however, have a strong affinity with the sea, and seaside leisure activities continue to grow in popularity. The media, particularly natural history documentaries, enable people to experience the underwater world for themselves. Recent environmental documentaries (e.g. *The End of Line*) and televised campaigns (e.g. Channel 4's *Fish Fight*) have been instrumental in raising awareness about the plight of the fisheries. Section 12.3.3 highlights the importance of membership in recreational clubs for engaging users of the sea, such as sea anglers, in conservation activities that benefit Marine ecosystems. Educational programmes and aquariums help children and adults to learn about Marine ecosystems and fisheries (Section 27.7.3.4).

Influencing consumer choice can alter the market for fisheries products by, for example, reducing demand for the most overfished species, reducing consumption of seafood overall, and raising demand for fish caught in a more sustainable manner. In 2008, consumers in GB bought 385,000 tonnes of seafood from retail outlets. According to research by the Seafood Choices Alliance, in 2007, 74% of those consumers believe environmental considerations to be important, and 90% would be more likely to buy seafood that is labelled as 'environmentally responsible'. More than 50% would pay 5–10% more for sustainable seafood (Natural England 2009h).

Certification schemes help to respond to consumer demands for sustainably sourced seafood. The certification of fish products by the Marine Stewardship Council (MSC)

Box 27.28 Inshore fisheries management in the devolved UK context: decentralised management in practice. Source: Phillipson & Symes (2010).

Two different systems of inshore fisheries management had emerged in the UK by the 2000s. England and Wales decentralised responsibility to twelve Sea Fisheries Committees (SFCs) over a century ago with jurisdiction up to six nautical miles offshore for regulations, stock management, monitoring and enforcement. This exemplifies one of the first cases in Europe of co-management between the local fishing industry and local government. The strengths of SFCs were in their local knowledge of the fisheries, the ability to design management appropriate for local circumstances, and the engagement of the fishing industry. Giving responsibility to the committees for the management of their inshore fisheries broadly aligns with current notions of localism. Since the mid-1990s, the remit of SFCs in England and Wales expanded to include environmental management as well, but insufficient funding and inflexible regulations have been attributed to slow progress in this area. In Scotland, a more centralised approach to inshore fisheries management emerged. This has been attributed to opposition to local management stemming from conflicts of interest between local, small-scale fishing fleets in the west, and larger, capitalised fleets in the north-east. Few local management arrangements existed.

The Marine and Coastal Access Act triggered a reorganisation of inshore fisheries management in England with the replacement of SFCs with Inshore Fisheries and Conservation Authorities (IFCAs) in 2011. The IFCAs will not be significantly different, but will have changes to structure, duties and powers to address identified weaknesses. The environmental management representation will be strengthened on these authorities. The aim of the IFCAs is to ensure sea fisheries are "carried out in a sustainable way", and balance the "social and economic benefits [...] with the need to protect the marine environment". They are also responsible for meeting the conservation objectives of MCZs. The Department for Environment, Food and Rural Affairs will announce further reforms of inshore fisheries management in 2011 based on the research and consultation undertaken in the Sustainable Access to Inshore Fisheries project (Defra 2010h). It is expected that these reforms will attempt to address issues relating to the displacement of inshore fisheries due to the increasing number of MPA designations.

In Wales, SFCs were abolished in 2008 and management responsibilities were assumed by the Welsh Assembly Government. Following sustained opposition to the changes from environmental and fisheries organisations, a stakeholder advisory group was established in 2009 that recommended the establishment of three Inshore Fisheries Groups for South, Mid and North Wales, and a national advisory group of stakeholders (e.g. commercial sea fishing, aquaculture, recreational fishing and nature conservation). The Inshore Fisheries Groups will represent the interests of local fisheries.

In Scotland, the drawbacks of the centralised approach were exposed by an inquiry in 2005. The inquiry led to the establishment of six Inshore Fisheries Groups who are developing local management plans to cover stock management, market initiatives and local development. The Inshore Fisheries Groups are voluntary groups with no environmental management responsibilities. Within the Groups there is an Executive Committee representing fishing industry interests, and a separate advisory group where other stakeholders represent a diverse range of interests including fisheries research and environment and conservation concerns.

It is too early to conclude how each system of inshore fisheries management will influence the provisioning service of fish or change the impacts of the industry on Marine ecosystems. Each places differing degrees of power and responsibility with various actors with an interest in coastal zone resource management.

enables consumers to be confident that they are buying from sustainable fisheries, and allows fisheries to prove their practices are more sustainable than alternatives. In addition to fish stock considerations, the MSC also uses Food and Agriculture Organization (FAO) guidelines to set standards for its eco-label to minimise impacts on wider ecosystems, including impacts on habitats from fishing gear. Transparency in the supply chain is critical in maintaining consumer trust in such schemes. In 2010, a total of 101 fisheries were certified by MSC (and a further 131 were undergoing assessment), including 13 of the UK's fisheries (18 under assessment; MSC 2010). The higher market-value of these products can encourage fishers to become certified, thereby bringing benefits to the long-term sustainability of fish provision and a reduction in harm to Marine ecosystems. Although awareness of MSC eco-labels has grown, Kaiser & Edwards-Jones (2006) identified barriers that may prevent its wider uptake including: a lack of concern by the public for marine fish or the need for sustainable fisheries; whether fishers will continue to receive added financial rewards; and difficulties of quality assurance.

Businesses, particularly supermarkets, can play an important role in reducing demand for depleted fish species through their purchasing policies (for example, only stocking fish certified from sustainable fisheries) and through their advertising (**Box 27.29**). These purchasing policies typically respond to the attitudes and values of their customers. The media is extremely powerful in changing shopping behaviours, at least in the short-term, as evidenced by soaring sales of sustainable fish following Channel 4's *Fish Fight* television series (Smithers 2011). Purchasing decisions in the public sector can also stimulate markets for sustainable fisheries. The MSC's Fish & Kids project is working with schools in England to serve MSC certified food. Since the project began in 2007, demand for, and supply of, MSC fish in the food service sector has dramatically increased. The Fish & Kids project assists nearly 4,000 primary schools to serve MSC fish, and the world's largest contract caterer recently achieved MSC certification for all its UK sites (more than 700) (MSC 2010).

27.6.3.5 Markets and incentives (instrumental)

Incentive-based schemes are beginning to emerge as an alternative to regulations that control effort and gear (Section 27.6.3.6). The Scottish Conservation Credits Scheme, the first of its kind in the EU, aims to reduce cod

mortality and whitefish discards by providing incentives, in the form of extra days at sea, to fishermen who adopt best practice in stock conservation (Seafood Scotland 2010). The scheme is run by the Scottish Government, but has been successful at securing the support of the industry (**Figure 27.34**). It is focused on meeting the requirements of the EU Cod Recovery Plan of December 2008. It provides credits to fishermen for the adoption of a variety of practices that avoid catching cod, such as closures and gear restrictions. These measures are complemented with effort management and a ban on 'high grading', whereby only larger, fresher fish are retained and less valuable, but still marketable, fish are discarded (WWF 2009). The measures implemented under the Scottish Conservation Credits Scheme have already reduced cod discards in the North Sea, but other stocks, such as haddock and whiting, remain at risk (WWF 2009). The scheme could be extended to target these in the same way that cod has been protected. Several other countries have replicated the scheme in part or completely.

The Marine Conservation Society and ClientEarth (2010b) have developed proposals for an alternative Fishing Credits System. The system is built on an ecosystems approach, which means (among other things) rules reflect ecosystem regions and up-to-date scientific advice. At its core is a credits allocation system for sustainable mixed catch quotas. The Fishing Credits System would assign credits annually to all species likely to be impacted within a particular marine region (including by-catch species). Different species and stocks are given differing credit weightings according to sustainability (ecosystems) criteria, such as the species' ecological vulnerability and stock level. Each fisher is given a credit allowance per licence, and everything caught (including by-catch) is counted towards that maximum credit allowance. Therefore, the entire catch will need to be landed (with very limited exceptions). Fishers can choose what they catch, and in what quantity for each species, as long as it does not exceed their total credit allowance, so discarding and over-quota issues are eliminated. Micromanagement and detailed technical rules are abolished under the Fishing Credits System. 'Results based management' means only an outcome is specified and it is left to the fishers to decide how they achieve that (i.e. what gear is used, and what mesh size and twine thickness is preferred). To provide more flexibility, part of each fisher's annual credit allocation will be transferable. The Fishing Credits System incentivises and rewards best

Box 27.29 Supermarkets sourcing sustainable seafood. Source: Natural England (2009h).

Supermarkets control the majority of the UK market for fish. The purchasing decisions they make can, therefore, have a tremendous influence on the fishing industry and, ultimately, the ecosystems that they impact. Consumers are increasingly concerned about where fish products are sourced and many want to purchase and pay more for sustainable seafood. In a bid to demonstrate their 'green' credentials, and in response to high profile campaigns by environmental organisations, especially Greenpeace, several supermarkets have stopped the sale of some species and/or are stocking more eco-labelled products.

For instance, Waitrose "does not take any flatfish caught from beam trawlers, which are inefficient in terms of fuel consumption and potentially damaging to the marine environment" (Waitrose 2011). Marks & Spencer claim to ensure that all their seafood is traceable to the vessel that it was caught on and that it was caught within their quota. It has also banned undeclared landings (Greenpeace 2006). Sainsbury's, which has a 21.4% market share in fresh fish, had pledged to stock only MSC certified fish, but was unable to source adequate quantities of fish to meet demand. Instead, they use a traffic light colour-coded scheme to indicate which fish are sustainably sourced, and stocked over 80 products with an MSC label by early 2011. At the beginning of 2011, Tesco announced that, by 2012, it will only be sourcing tuna caught by line or pole.

practice in order to encourage fishers to target species deemed sustainable in a selective manner. For example, fishers are rewarded with extra catch allowances for using and/or developing best practice (such as improved selective gear technology and avoiding closed areas) and there is preferential access for those with a good compliance record (ClientEarth 2010b).

27.6.3.6 Technologies and practices (instrumental)

Management of fishing effort. The failure of the quota system to make the fisheries more sustainable and the urgent need to reduce fishing effort, especially to help the recovery of North Sea cod, led to the introduction of 'days at sea restrictions' in 2003 for the North Sea and Irish Sea as part of cod recovery plans; as a result, Roundfish vessels were limited to 16 days at sea per month (**Figure 27.35**). Restricting the time spent at sea by fishers has merely encouraged more intensive fishing and incentivised the fishermen to improve catch efficiency by using larger nets, more hooks and faster tows (Catchpole *et al.* 2005). Concentrating fishing effort into shorter, intense periods not only risks the safety of crews, but also floods the market with fish, thus driving prices down (Roberts *et al.* 2005).

Decommissioning schemes were introduced to reduce the capacity of the UK's fishing fleet. The number of UK fishing vessels fell by 17% between 2000 and 2009 in the UK, and the number of fishermen decreased by 22% over the same period (**Figure 27.36**; (MMO 2010c). While this has made important reductions in fleet size, technological improvements to maximise efficiency, such as detection and capture advances, have largely offset reductions in fishing effort resulting from the downsizing of the fleet. In fact, the scheme may have inadvertently enabled fishing companies to receive compensation for decommissioning older vessels, allowing them to invest in the modernisation of their remaining vessels (Natural England 2009h).

Gear restrictions aim to control the types of fishing gear that is used in designated locations and/or for certain species. Improvements in the selectivity of gear can reduce by-catch and other modifications can reduce impacts on Marine habitats. The adoption of such gear usually results in

decreased catch efficiency, so either it needs to be enforced by law, or added value is given to fish caught using the gear through certification schemes. Mesh size restrictions can avoid the capture of young fishes, but such nets can become ineffective if towed in such a way that the mesh closes when they are full, and when the fishermen are targeting species of different sizes. **Box 27.30** describes the problem of discards and ways to tackle it. The banning of gear can remove destructive fishing practices, but can be met with resistance from the fishing industry if there has been considerable investment in the technology.

Research conducted for the Centre for Environment, Fisheries and Aquaculture Sciences (Corporate Culture 2010) on increasing the uptake of more sustainable gear and practices by fishers recommended conducting local trials to test solutions, making it as easy as possible for them to adopt new behaviour (e.g. they do not lose money), and communicating progress along the way. One way to encourage wider adoption of new gear is to reward fishers who adopt selective fishing gear with more days at sea, and penalise those with more intensive fishing technologies by deducting days.

Spatial management options. In addition to spatial restrictions on gear use, a number of other spatial options exist for fisheries management. The cessation of fishing in



Figure 27.34 Fishing boats in Kirkwall harbour, Orkney Islands, Scotland. Photo by joeri-c, available under a Creative Commons Attribution-ShareAlike license.



Figure 27.35 Sussex Inshore Fisheries and Conservation Authorities Patrol. Photo courtesy of Sussex IFCA.



Figure 27.36 The number of fishermen in the UK from 2000 to 2009. Source: data from MMO (2010c).

certain areas can protect or increase the abundance of fish that are particularly susceptible or overfished. Permanent closures of such areas are expected to protect habitats, but can also benefit surrounding fisheries as fishes increase and leave the closed area. Meanwhile, temporary or seasonal closures control fishing effort on migratory species at certain times of the year or in certain locations. Closures can be a highly effective way of reducing fishing mortality and improving spawning (Gell & Roberts 2003). In the Barents Sea, the Norwegian Government enforce temporary closures that have helped with the recovery of cod and haddock. In this case, the government conduct real-time sampling of fish size to judge whether to close an area. In contrast, a pilot of the closure method in Scotland gave responsibility to fishers to call for closures instead (**Box 27.31**). One of the main benefits of schemes such as that in the Barents Sea is that an economic incentive is provided for fishermen to adopt selective fishing gear that allows them access to closed areas.

Area closures can also have consequences for other species and habitats. The displacement of trawling (for example, from

Box 27.31 Scottish real-time closures pilot. Source: Catchpole & Gray (2010).

In 2007, real-time closures were piloted in the North Sea by Scottish skippers in partnership with the Scottish Government and scientists from the Fisheries Research Services. The fishermen agreed that they would record when they caught more than 60 fish smaller than 35 cm in length in one hour. If this happened three times over a 48-hour period, an area of 15 x 15 miles would be closed for 21 days. There was a maximum of nine closures at a time and no more than three within a 45 x 45 mile square. The fishers were responsible for notifying the authorities of the need for the closures and for abiding the closure in return for extra days at sea and an 11% increase in cod quota.

An estimated 300,000 juvenile cod avoided capture. During the pilot, however, the minimum fish length was increased from 35 to 50 cm and the schemes objective changed to protect spawning stock rather than juveniles. It is unclear whether discards were reduced as a result of the pilot.

According to a study of 15 different discard pilot projects from across Europe by Catchpole & Gray (2010) there are seven important determinants of improving the viability of projects: fisheries crises, incentivisation, funding, expertise, leadership, and enforcement. The Scottish pilot met all of these criteria except for enforcement.

Box 27.30 What can we do about discards?

Discarding—when fish are thrown back to the sea dead or alive—is perhaps the most perverse outcome of the current CFP, an effect created by the combination of quotas and minimum limits on the size of fish which may be brought to shore. Both of these measures were intended to assist sustainability by making sure that not too many fish, particularly those which have not had a chance to reproduce, are taken out of the ecosystem. In fact, they have created the opposite effect. Discarding occurs in mixed fisheries, such as those in the North Sea, where boats fish for a number of different species. Once a vessel runs out of quota for one species (e.g. cod), it continues fishing for another species (e.g. haddock), but because it is not possible to fish completely selectively it also catches more cod. It is illegal for this cod catch to be brought to shore, so instead it is thrown overboard. Likewise, prohibiting fish below a certain size from being landed may not prevent them from being caught—they are simply discarded. The extent of discards depends on the fishery and the type of gear used. It has been estimated that for beam trawl catch in the North Sea, as much as 60% is discarded (EC 2007). Overall, in the North Sea mixed fishery, nearly a third of the total weight landed is discarded annually, which amounts to 10% of the estimated total biomass of fish in the North Sea (Catchpole *et al.* 2005).

Days at sea and decommissioning only serve to reduce discards by reducing the proportion of fishing effort; instead, they create an incentive to fish less selectively in the limited time available (Catchpole *et al.* 2005). Because the rate of discards is not reduced, any increase in fishing effort will also increase discards.

Using more selective fishing gear, such as different mesh sizes and escape panels for non-target species, can lower by-catch rates. The fitting of square mesh panels onto *Nephrops* trawls, for example, can enable juvenile and non-target fish to escape. The modification of North Sea *Nephrops* trawls in such a manner was legislated in 2002. If a second square mesh is fitted, however, by-catch of undersized fish can be reduced by an extra 43%, and there is potential to increase its efficiency further (Revill *et al.* 2007). Such gear modifications have their limitations. If non-targeted species have a similar habitat range, morphology and size as catch species, selective gear can be ineffective.

Project 50%, piloted by the Centre for Environment, Fisheries and Aquaculture Sciences and fishermen, aimed to reduce discards from 12 Devon beam trawlers by 50%. The vessels involved in the project fitted new trawl nets with larger meshes, square mesh escape panels and novel headlines in their construction. Each skipper designed their own trawl to meet their fishing patterns, but with the aim to allow juvenile fish to escape. The results from the project are impressive: the fishermen participating in the scheme threw an average of 52% fewer fish back into the sea, with some in the trial reducing their discards by over 65% compared to traditional nets (Cefas 2010; **Figure 27.37**).

Another option that takes the opposite approach to the CFP (under which it is illegal to bring discards ashore) is the banning of discards. The Norwegian Government has been operating this policy since 1983. All commercial fish species caught in Norwegian waters are landed and deducted from quotas with the aims of making use of the food source and better recording catches. Because smaller fish have a low value, it provides an incentive for fishers to find ways of reducing the capture of non-target and juvenile fish. On the downside, it can encourage capture of smaller fish if there is profit to be made. The ban is also difficult to enforce, and some compensation is required to encourage fishers to comply with it (Catchpole *et al.* 2005). In March 2011, the EC Fisheries Commissioner proposed the possibility of a European-wide discard ban as part of CFP reforms in 2013 (BBC 2011b).

2½ baskets of discards from new nets **4 baskets of discards from old nets**



3 baskets of discards from new nets **6 baskets of discards from old nets**



Figure 27.37 Fishermen participating in Project 50% threw an average of 52% fewer fish back into the sea. Source: Cefas (2010), photos courtesy of Simon Armstrong.

overfished and degraded habitats to other areas) can often have a significant impact on benthic communities in the new fishing grounds since these areas were previously less disturbed (Hiddink *et al.* 2006). To avoid such incidents there is a need to have a sufficient understanding of the region's biology, benthic habitats and the effects of shifting fleet pressure and trawling to elsewhere (Catchpole *et al.* 2005; Hiddink *et al.* 2006). In the North Sea, a 12-week closure to protect spawning cod inadvertently redirected fishers to areas with high juvenile haddock stocks. Fishers reported a 95% discard rate which led to them voluntarily suspend fishing. Unfortunately, they set to sea again after three weeks when compensation was refused in favour of long-term decommissioning (Catchpole *et al.* 2005).

Marine reserves have received increasing attention recently as an effective response for achieving both fisheries management and conservation objectives. Reserves offer permanent protection from fishing to sensitive habitats and vulnerable species. They can also support surrounding fisheries by providing a refuge for stocks to replenish and migrate outside the Marine reserve (Roberts *et al.* 2005). Within 5–10 years, stocks of commercial species can increase by 3–5 times (Gell & Roberts 2003). Marine reserves are known to redevelop natural age structures, protect genetic diversity and provide a safety net for management failures (*ibid.*). In addition to commercial benefits, reserves can restore ecosystem functioning and be highly valuable for biodiversity conservation, as well as providing tourism and educational opportunities. The UK has three no-take zones, where fishing is prohibited, which are discussed, along with MCZs, in Section 27.6.3.2.

27.6.3.7 Voluntary actions (instrumental)

There are a number of options for changing the behaviour of fishers which complement co-management and decentralised fisheries management approaches. Public pressure for certified fish products encourages fishers to meet this demand through the adoption of sustainable fishing practices (**Box 27.32**) (Natural England 2009h).

Box 27.32 The North Sea Haddock Fishery. Source: Moody Marine Ltd. (2010).

The MSC certified the North Sea Haddock Fishery in 2011, which became the first Scottish whitefish to receive certification. The fishery supports 192 vessels which fish offshore using seine and trawl nets. In 2009, 27,507 tonnes of haddock were landed.

The North Sea Haddock Fishery is a large-scale, industrial fishery which has invested heavily in sustainable gear and equipment for monitoring and targeting haddock. The fishery was assessed as being well-managed and effective management strategies are in place to assist the recovery of two (cod and whiting) out of the five retained by-catch species which are currently outside safe biological limits. However, to continue being certified after 2015 the fishery must address a number of conditions. These include implementing further mitigation measures to reduce by-catch, such as working with research organisations to find and use more selective gear, and to provide accurate quantitative information on total catch including discarded catch. By setting such conditions, the MSC can ensure improvements continue to be made by the fishery and best practices are adopted as they become available.

Education and social learning are important attributes of the co-management of natural resources (Schusler *et al.* 2003). Environmental education programmes for fishers aim to build their capacity to make informed decisions. Social learning involves the participation of a diverse range of stakeholders in a process of open communication and deliberation whereby multiple sources of knowledge are used to solve problems. Such processes in the co-management of fisheries allows the fishing industry, environmental agencies and NGOs, government representatives and other stakeholders to share their perspectives, experiences and knowledge, and develop a common understanding for joint action. Social learning involves learning-by-doing and, given time, can become adaptive management where management changes in response to lessons learnt from previous actions (Berkes 2009). There is also some scope to use these consultative mechanisms to explore new alternative livelihood opportunities for fishers and boat owners, such as through marine-based wildlife tourism (Section 27.8).

Fishermen have shown a commitment to improve the sustainability of the fisheries through a number of voluntary codes of conduct; for example, within the Loch Torridon *Nephrops* creel fishery a code of conduct has been agreed in order to increase the size, and improve the quality, of the shellfish caught (Gray & Hatchard 2007). The industry and Seafish developed the Responsible Fishing Scheme in 2006, whereby fishermen sign a commitment to fish responsibly. Responsible Fishing Scheme certified fishing vessels minimise discards of non-target species and the impact of fishing gear. They also commit to ensuring their activities do not result in by-catch of seabirds and dolphins (Seafish 2011). Although these measures do not address fundamental issues of overfishing, they demonstrate the industry's willingness to move towards more sustainable fishing. Unfortunately, the benefits of this scheme for ecosystems have not been quantified.

27.6.4 Fisheries Summary

Table 27.16 summarises the key insights from this review of responses in the fisheries context, highlighting those that have been well-established, but also identifying a set of responses that are either in early implementation or are proposed. It is important to learn from these early pilots across all sectors to scale-up the adoption of an integrated ecosystem approach to the management of the UK's diverse habitats, which is one key policy direction that this review recommends. A number of proposals focus on the future direction of the Common Fisheries Policy, which is currently under discussion.

27.7 Marine and Coasts

27.7.1 Marine and Coastal Ecosystem Services and Human Well-being

The Marine and Coastal Margin habitats of the UK provide a variety of valuable ecosystem services and benefits to society. In addition to the food provisioning services discussed under Section 27.6, Marine ecosystems provide

Table 27.16 Fisheries Summary.

	Established responses	Early implementation, pilots	Proposed, under development
Knowledge	<ul style="list-style-type: none"> ■ Fish stock assessments ■ Monitoring of landings ■ Logbook schemes ■ Calculating Maximum Sustainable Yield 	<ul style="list-style-type: none"> ■ CCTV monitoring onboard fishing vessels ■ Applied research on the ecosystem approach to fisheries management ■ Research collaborations between scientists and fishermen 	<ul style="list-style-type: none"> ■ Quantify linkages between ecosystem functions and services ■ Research on tipping points and thresholds ■ Better understanding of the impacts of fisheries on marine ecosystems
Legislation	<ul style="list-style-type: none"> ■ Common Fisheries Policy ■ Total Allowable Catches ■ Regulations governing fishing practices ■ National level enforcement ■ Conservation bylaws 	<ul style="list-style-type: none"> ■ Marine Strategy Framework Directive ■ Marine Conservation Zones 	<ul style="list-style-type: none"> ■ Common Fisheries Policy reform: prioritisation of ecological sustainability; full adoption of ecosystem approach (based on ecosystem regions); integration of the Common Fisheries Policy with the Marine Strategy Framework Directive; setting of legally binding fishing opportunities based on scientific advice; management of total catch (not landings); discard ban.
Policies, institutions and governance	<ul style="list-style-type: none"> ■ Sectoral management of fisheries ■ Management of target species ■ Fisheries agencies ■ Co-management of inshore fisheries (England and Wales) 	<ul style="list-style-type: none"> ■ Ecosystem-based approaches ■ Management of fisheries with other marine activities (integrated) ■ Coordination through Marine Management Organisation, etc. ■ New inshore fisheries (co-) management arrangements 	<ul style="list-style-type: none"> ■ Greater involvement of fishermen in decision-making ■ Adaptive management
Changing social attitudes	<ul style="list-style-type: none"> ■ Media, e.g. documentaries, raising awareness ■ Membership in recreation clubs ■ Educational programmes and aquarium ■ Certification schemes 		
Markets and incentives	<ul style="list-style-type: none"> ■ Fishing vessel decommissioning schemes 	<ul style="list-style-type: none"> ■ Scottish Conservation Credits Scheme ■ Extra 'days at sea' awarded for adoption of more sustainable practices 	<ul style="list-style-type: none"> ■ Fishing Credits Scheme
Technologies and practices	<ul style="list-style-type: none"> ■ Days at sea restrictions ■ Selective fishing gear ■ Closure of areas to fishing (seasonal, permanent, and temporary) 	<ul style="list-style-type: none"> ■ Trials of new selective fishing gear ■ Participation of fishermen in developing selective gear (e.g. Project 50%) ■ Real-time closures ■ No take zones and marine reserves 	
Voluntary actions	<ul style="list-style-type: none"> ■ Fisheries joining certification schemes ■ Voluntary codes of conduct, e.g. Responsible Fishing Scheme ■ Voluntary involvement in decision making processes 		

industrial inputs (e.g. blue biotechnology) and fertiliser (e.g. seaweed), regulate the climate, breakdown waste and detoxify pollution. Coastal ecosystems protect coastlines from flooding and erosion: a service that will be increasingly tested under rising sea levels and increased storm activity. Both the coast and sea are popular for recreation, leisure and tourism—over 250 million visits are made to the coast every year—providing physical and mental health benefits for visitors (Section 27.8; **Figure 27.38**). Coastal Margin and Marine habitats are also likely to store and sequester substantial amounts of carbon, but this has yet to be quantified (Thompson 2008a). In the future, marine sources of energy are expected to account for a larger proportion of the UK's energy mix, both from physical processes (e.g. wave and tidal) and biofuels (e.g. algae; Section 27.9). The total value of services provided by coastal habitats is estimated to be £48 billion (Chapter 11).

The way we plan our coastlines and seas, and the human activities that operate on and in them, affects the ability of ecosystems to provide services. Human activities have impacted the seafloor by, for example, extracting aggregates



Figure 27.38 Southwold Beach, Suffolk. Photo by Gerry Balding available under a Creative Commons Attribution-NonCommercial-NoDerivs license.

and constructing offshore windfarms, coastal defences, ports and coastal developments. The disturbance of the seabed has had localised impacts on benthic organisms and the regulating and supporting services they provide (Section 12.3). The value of coastal protection afforded by ecosystems has been overlooked in coastal planning until recently. The building of sea defences replaced multifunctional ecosystems with single service structures (Chapter 11.3). Some infrastructure developments, however, such as offshore windfarms and artificial reefs, can create habitats that provide benefits for conservation, commercial fisheries, recreation and tourism. **Figure 27.39** summarises the major marine and coastal-related direct and indirect drivers and their impact on ecosystem services.

27.7.2 Challenges for Marine and Coastal Planning

The challenge for coastal and marine planners is to manage the demands of multiple users of the UK's increasingly crowded coasts and seas—a highly dynamic and complex environment which is continually changing in response to weather variations, sediment supply, land use and other human influences (Section 11.2). Coastal planning must address threats from sea-level rise, as well as pollution and continued development pressures. These pressures are compounded by the position of the coast between rising seas and encroaching land uses, which leaves little space for safe coastal habitat except at protected sites. Sea-level rise is likely to result in increased wave energy reaching shorelines (Section 11.2.3), thus impacting on the sea defence services of Coastal Margins. Shoreline planning decisions made now can, therefore, have long-term repercussions.

Managing trade-offs between marine activities competing for space and resources, while minimising their impacts on Marine biodiversity is the task of marine planners. Leisure and commercial uses of the Marine environment continue to expand and include renewable energy development, increasing shipping traffic, further gas pipe and cable-laying, and the growing popularity of marine recreational activities.

Marine and coastal planning is in a period of massive transformation in response to new marine and coastal legislation across the UK (Section 27.7.3.2). The challenge is to ensure that the ambitious goals of this new legislation are met.

27.7.3 Response Options for Marine and Coastal Planning

27.7.3.1 Knowledge (foundational)

Knowledge of the Marine environment has typically trailed behind our understanding of terrestrial systems. Charting Progress 2 (UKMMAS 2010), the most comprehensive report of the state of the UK's seas, prioritised several areas where efforts are needed to improve understanding of the relationships between pressures and impacts:

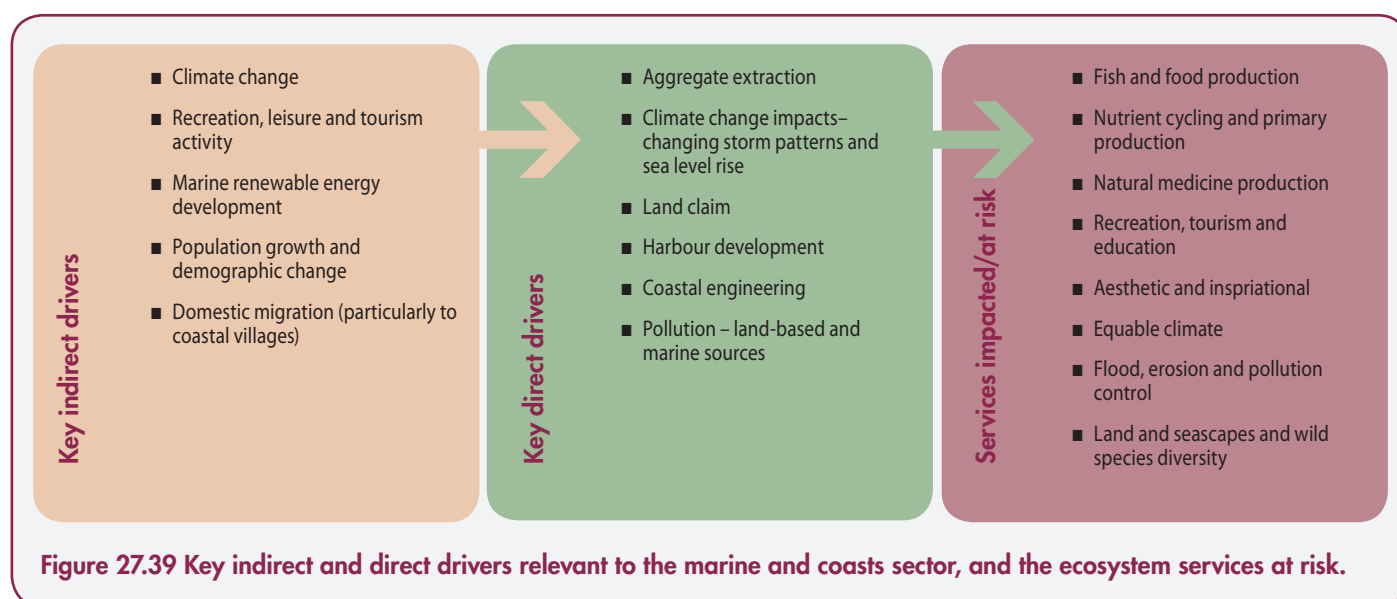
Better criteria to determine whether the seas are clean, healthy, safe, productive and biologically diverse. Clearly defined criteria are needed of what 'good' status of the Marine environment means under the MSFD (Section 27.7.3.2).

Setting appropriate baselines and targets. Some targets use the state that was 'natural' before human pressures were introduced (e.g. MSFD); others use sustainable levels (e.g. Maximum Sustainable Yields in fisheries management).

A truly integrated approach to assessments remains a challenge. Progress has been made understanding the impacts of specific pressures on the sea, but the impact of multiple, interacting pressures is problematic. Adopting an ecosystem approach requires an understanding of how the various pressures change the structure and functioning of ecosystems.

More data coverage. Expert judgement and inadequate datasets were used to make assessments of the state of the sea. More detailed knowledge would enable more informed marine planning.

The ecosystem approach to Marine management, where human activities and the supporting ecosystems are managed together, is embodied in current initiatives under the MSFD (Section 27.7.3.2). It requires that both ecological



health and human well-being be optimised. This approach, however, needs a stronger science base and the testing of practical tools to make the concept operational. In marine planning, conflicts between the multiple uses of the Marine environment are common, requiring improved criteria for analysing the costs and benefits of measures. KnowSeas, a collaborative project under the EC's Seventh Framework Programme (FP7), aims to strengthen the science base for managing European waters based on the ecosystems approach and systems thinking (KnowSeas 2011).

Chapter 12 highlights sparse mapping of the biodiversity and habitats of the UK's seabed as an impediment to quantifying ecosystems services in a meaningful way that supports policy and the implementation of marine spatial planning. Only 10% of the UK's continental shelf is mapped (UKMMAS 2010). New marine legislation has not provided for the establishment of a marine information network to support the new marine planning regime (WWF 2010). The Department for Environment, Food and Rural Affairs has established, however, the Marine Environmental Data and Information Network and the UK Directory of Marine Observing Systems to better coordinate knowledge generation.

Major knowledge gaps also exist with regards to Coastal Margins (Section 11.6). Consistent survey methodologies for each coastal habitat would allow a more coherent analysis of trends. The lack of a national perspective of the expected impacts on geomorphology and ecosystems from higher sea levels and greater storm activity presents a major hindrance for coastal planning. Chapter 11 (Section 11.6) recommends the identification of priorities for a national strategic monitoring programme and the testing of management options, such as managed realignment, in different coastal habitat types.

Chapter 12 emphasises the importance of understanding and quantifying the ecological links between Marine biodiversity, ecosystem function and goods and services, and the effects of human impacts on these. Although the Charting Progress 2 and State of Scotland's Seas assessments collated significant evidence, there remain substantial data gaps in the Marine environment. The management of trade-offs between competing uses of the Marine environment would benefit from a stronger evidence base. Geographic Information System and spatial modelling tools are likely to play a constructive role in supporting participatory processes (Jude *et al.* 2006), and decisions on where and when activities take place, such as coastal and offshore renewable energy development.

27.7.3.2 Legislation (enabling)

A number of pieces of legislation already exist that are relevant to the protection and management of Marine ecosystems. The discussion below focuses on two recent and key legislative developments: the MSFD and Marine and Coastal Access Act 2009. A number of other laws with marine and coastal relevance, such as the Habitats Directive and the Flood and Water Management Act 2010, are covered in other sectoral discussions in this chapter.

The MSFD (Directive 2008/56/EC) was adopted in June 2008 and has as its overall goal the achievement of 'good environmental status' for all EU marine waters by 2020. It obliges Member States to implement marine strategies with the aim of protecting, preserving and restoring the Marine

environment, and preventing or reducing inputs into the Marine environment with a view to phasing out pollution. It covers waters within Member States' exclusive economic zones (including the seabed and subsoil) as defined by the UN Convention on the Law of the Sea. It also covers coastal waters in so far as they are not dealt with under the WFD.

The MSFD sets out various actions to be taken towards the achievement of the 2020 goal, with legally binding deadlines. By 2012, Member States must carry out assessments of the current state of their marine waters, determine a set of characteristics for good environmental status, and provide a set of targets and indicators. A monitoring programme must be put in place by 2014, and by 2016, a programme of measures designed to take marine waters from their initial state to good environmental status must be implemented. Exceptions to the deadline are permitted for certain reasons: natural causes or conditions, factors for which the Member State concerned is not responsible, and overriding reasons of public interest which outweigh the negative impact on the environment. The Directive specifically demands that the programmes of measures include spatial protection measures, "contributing to coherent and representative networks of marine protected areas, adequately covering the diversity of the constituent ecosystems" (Article 13 (4) MSFD). This network can include SACs and SPAs designated under the Habitats and Birds Directives (Section 27.2.3.2).

In UK law the Directive was transposed by the Marine Strategy Regulations 2010, and is in the process of being implemented by the Department for Environment, Food and Rural Affairs and the Devolved Administrations. Recognising that transboundary efforts are required to control the Marine environment, the MSFD contains express duties of regional cooperation. Existing regional institutions and Regional Seas Conventions are to be utilised. For the UK, the OSPAR Convention is the key regional mechanism, and the OSPAR Secretariat is taking on the role of facilitating MSFD commitments. Under the OSPAR Convention, the UK has committed to a number of marine environmental protection objectives, particularly tackling various forms of marine pollution. The MSFD should assist by effectively bringing these international law obligations into a more rigorously binding, EU law basis.

Integration of environmental concerns into other policies and laws is another key aim of the MSFD. It states that it shall "contribute to coherence between, and aim to ensure the integration of environmental concerns into, the different policies, agreements and legislative measures which have an impact on the marine environment" (MSFD Article 1(4)). The EU Commission describes it as the environmental component of the EU's Integrated Maritime Policy (EC 2011). It has been designed to dovetail with the WFD, and employs similar mechanisms including assessments, monitoring, and integrated programmes of measures towards a target environmental status.

Also of crucial importance is the interaction of the MSFD with the CFP (Section 27.6.3.2). Descriptors of good environmental status in the MSFD include that commercial fish stocks should be within safe biological limits and that the integrity of seafloor ecosystems is maintained. The MSFD's preamble states that the "Common Fisheries Policy,

including in the future reform, should take into account the environmental impacts of fishing and the objectives of this Directive". In addition, paragraph 39 of the preamble notes that fisheries measures can be taken in the context of the CFP, based on scientific advice aimed at helping to achieve the MSFD's objectives. In order to ensure policy consistency with the MSFD, the reformed CFP will need to make sure fish stocks are able to recover by 2020 and fisheries management is coherent with the ecosystems approach of the MSFD. The full closure of certain areas to fisheries, to enable the integrity, structure and functioning of ecosystems to be maintained or restored, is specifically foreseen. The reformed CFP should also secure some degree of regional cooperation to manage fisheries within the areas identified in the MSFD.

The MSFD is clearly designed to safeguard the future economic potential of the oceans, as well as to protect habitats and species in their own right. The EU Commission notes that one of its purposes is protecting the resource base on which marine-related social and economic activities depend (EC 2011). Economic analyses are incorporated into the directive as part of its ecosystem approach, and the potential economic cost of degradation of Marine ecosystems is expressly acknowledged. Guidance produced for the Department for Environment, Food and Rural Affairs (Turner *et al.* 2010) on the economic and social analysis required as part of the initial assessment of marine waters under the MSFD details various approaches to ecosystem service valuation in the marine context. It highlights various examples of the most prominent Marine ecosystem services for which valuation has been attempted, such as food provision, amenity and recreation, carbon storage, and raw material provision (*ibid.*). The MSFD will be one of the first pieces of legislation to apply such ecosystem service valuation techniques.

The Marine and Coastal Access Act 2009 creates an overarching framework for marine planning in the form of a Marine Policy Statement. This will be a strategic and coordinated programme for future marine development. Prior to the Marine and Coastal Access Act, there was no comprehensive planning regime for UK marine waters. It is being formulated by all four Devolved Administrations to ensure there is consistency at the UK-level, and is expected to be released in spring 2011, having undergone a consultation which finished in October 2010. The MPS will apply to all UK territorial waters and, therefore, must be jointly adopted by the UK and Devolved Administrations. The Marine and Coastal Access Act also sets up marine planning regions. For each of these regions there will be a marine plan identifying activities, resources and impacts for the area (Section 27.7.3.3). The planning provisions in the Act apply to the English inshore and offshore regions, the Welsh inshore and offshore regions, the Scottish offshore region and the Northern Ireland offshore region. The Scottish inshore region is covered by the Marine (Scotland) Act 2010, and provisions for marine planning and marine nature conservation in Northern Ireland's territorial waters will be contained in the Northern Ireland Marine Bill, due to come into force in 2012.

In addition to the new planning framework, the Marine and Coastal Access Act contains important new nature

conservation provisions. It requires the setting up of MCZs in offshore waters around the whole of the UK, plus in inshore waters for England and Wales. The Marine (Scotland) Act 2010 sets up equivalent designations for Scottish inshore waters. Legislation for Northern Ireland's inshore waters is expected to follow. The MCZ designations are to be made on the basis of conserving Marine flora, fauna or habitats, or geological or geomorphological features. The designation order must set out conservation objectives for the area. The overall objective under the Marine and Coastal Access Act is to create an 'ecologically coherent network' of MPAs, including both MCZs and other protected areas (e.g. Natura 2000 marine sites), taking into account that the conservation of certain features may require their protection in more than one designated area. The sum total of the network should add up to more than the benefits provided by individual protected areas. One design principle is that MPAs are spaced appropriately to ensure connectivity between them (Ashworth *et al.* 2010), which will be paramount if the initiative is to be successful (WWF 2010).

Public authorities whose actions are capable of affecting an MCZ are under a duty to exercise their functions in a manner which furthers the conservation objectives of the MCZ, or if that is not possible, in a manner which least hinders those objectives. There are similar duties in respect of the authorisation of activities which may hinder the achievement of MCZ conservation objectives. Public authorities must not issue such licences unless it can be demonstrated by the licence applicant that there is no significant risk of damaging the conservation objectives of the site. If this is not possible, the licence must only be granted if it is shown that there are no alternatives to the proposed activity, that the benefit to the public of proceeding outweighs the risk of damage, and the licensee will undertake measures of equivalent environmental benefit. This system of protection has parallels with the development control provisions of the Habitats Directive. The Marine and Coastal Access Act also makes it an offence to knowingly perform a prohibited act which may significantly damage the achievement of the conservation objectives of an MCZ. Prohibited acts include killing or destroying animals and plants, or taking or damaging features which are protected within that MCZ.

The process of designating the MCZs is ongoing via a series of stakeholders such as environmental groups, scientists and industry. The RSPB (2010a) has raised concerns about the role of socioeconomic factors in determining the designations. Consideration of such factors is permitted by the Marine and Coastal Access Act, but conservationists stress that science must be the overriding consideration or important conservation sites may be lost (*ibid.*). Finalised recommendations for the network will be submitted to the government by the end of November 2011.

Another important legislative development, the Flood and Water Management Act 2010 aims to provide a more comprehensive management framework for flood risk. Of relevance to coastal zone management, the Act gives the Environment Agency in England and Wales overall responsibility for flood and coastal erosion risk management and local authorities responsibility for managing the risk of local floods. The Environment Agency in England and Welsh

Ministers in Wales have a duty to develop and implement a strategy for flood and coastal erosion risk management.

27.7.3.3 Policies, institutions and governance (enabling)

Marine planning policy. The establishment of marine planning arrangements as a result of the Marine and Coastal Access Act and the Marine (Scotland) Act has the potential to make positive changes to the delivery of ecosystems from both Coastal Margin and Marine environments. The Marine Policy Statement, expected to be released in Spring 2011, is the first step towards implementing marine planning in the UK (Section 27.7.3.2). The vision of the government for the Marine environment is for “clean, healthy, safe, productive, and biologically diverse oceans and seas”, and the draft Marine Policy Statement identifies the following aims:

- promote sustainable economic development;
- enable the UK’s move towards a low carbon economy, in order to mitigate the causes and adapt to the effects of climate change and ocean acidification;
- recognise that the demand for use of the seas, and the resulting pressures on them, will continue to increase;

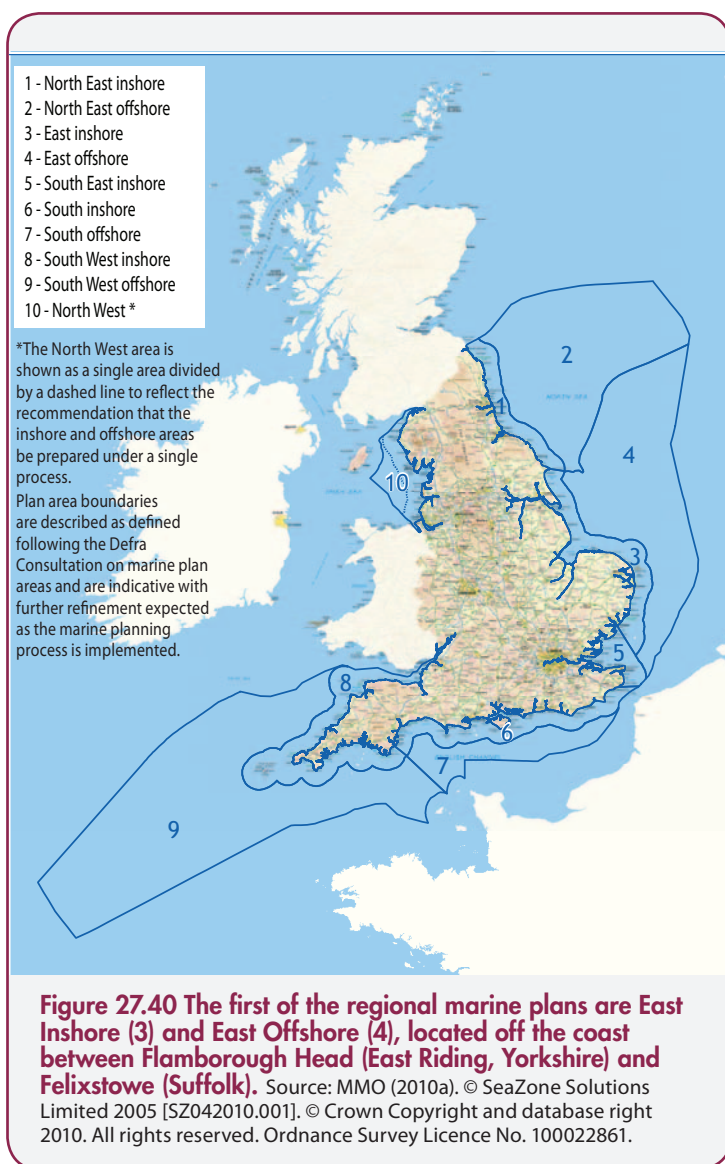
- manage competing demands on the marine area, taking an ecosystem-based approach;
- enable the coexistence of compatible activities wherever possible; and
- integrate with terrestrial planning.

The Marine and Coastal Access Act and Marine (Scotland) Act also set up marine planning regions. For each of these regions there will be a marine plan identifying activities, resources and impacts for the area. Each regional marine plan must take into account sustainable development objectives and must conform to the Marine Policy Statement. The regime will function in a similar fashion to terrestrial planning, in that individual licence applications will be decided within the parameters set down in the regional plans. So far, two areas have been selected to be the first to have regional marine plans developed: the coast around Flamborough Head in East Riding, Yorkshire, named East Inshore; and Felixstowe in Suffolk, named East Offshore (MMO 2010b) (see also **Figure 27.40**). It is critical that the marine plans address not only Marine biodiversity and habitats, but also the fundamental functioning of ecosystems (Section 12.5).

While it will be some time before the impact of the UK’s marine planning system on ecosystem services can be assessed, lessons can be learnt from earlier adopters of spatial marine planning in other regions of the world. An evaluation by WWF-UK (2010) of the implementation of marine spatial planning in Canada, Australia, New Zealand, the United States (California) and Belgium (**Box 27.33**) led to a number of recommendations of relevance to the UK:

- deliver an ecosystem-based Marine Policy Statement;
- ensure ecologically sustainable development;
- ensure clear accountability;
- develop open and transparent processes;
- deliver effective and frequent communication;
- facilitate early stakeholder engagement;
- provide ongoing political leadership; and
- provide adequate funding and resources.

The new marine planning regime will particularly affect offshore renewable energy developments, such as windfarms and wave power projects. Commercial commentators have received the new regime positively because it will increase certainty for developers and should also simplify licensing processes, although concerns exist as to how MCZ designation will restrict development (Norton Rose 2010). From a conservation viewpoint, there are also concerns about whether the plans will be capable of dealing effectively with cumulative development effects, and how far the precautionary principle will be applied in areas where there may be scientific uncertainty about the effects of marine development or the state of Marine resources. Application of the precautionary principle is not an express requirement of the legislation, but consideration of sustainable development objectives is, and this should incorporate a precautionary approach (WWF-UK 2010). The benefits of marine planning are expected to be substantial. In 2007, a Regulatory Impact Assessment of the then Marine Bill found that the costs of implementation over a 20-year period would be considerably



Box 27.33 Lessons learnt from marine spatial planning in Belgium (North Sea). Source: WWF-UK (2010).

The North Sea is one of the most intensively used seas in the world, and the Belgium portion is at the core of marine activity. Historically, a top-down approach to marine management prevailed in Belgium, with little common understanding and weak interaction between stakeholders, and lacklustre political will within the Belgium Government. In 1999, this began to change following the enactment of Belgium's Marine Protection Act which established a master plan for Belgium's North Sea marine area, making it one of the first countries to develop an operational, multi-use planning system. **Figure 27.41** shows a map of the master plan.

Stakeholder engagement and a transparent system were considered to have been fundamental in making the planning process effective. The management of land-based activities has had a beneficial impact on the quality of coastal waters, and strict Marine reserves forbid all activities. Including zoning and seasonal closures within the marine plan was also found to be valuable. However, user agreements to avoid the Marine reserves are voluntary and thus have the potential to unfold. In the early stages, discontinuity within government departments also slowed progress. Given the dynamism of the North Sea as a whole, an international approach would bring advantages, whereby issues are considered within the context of the entire sea.

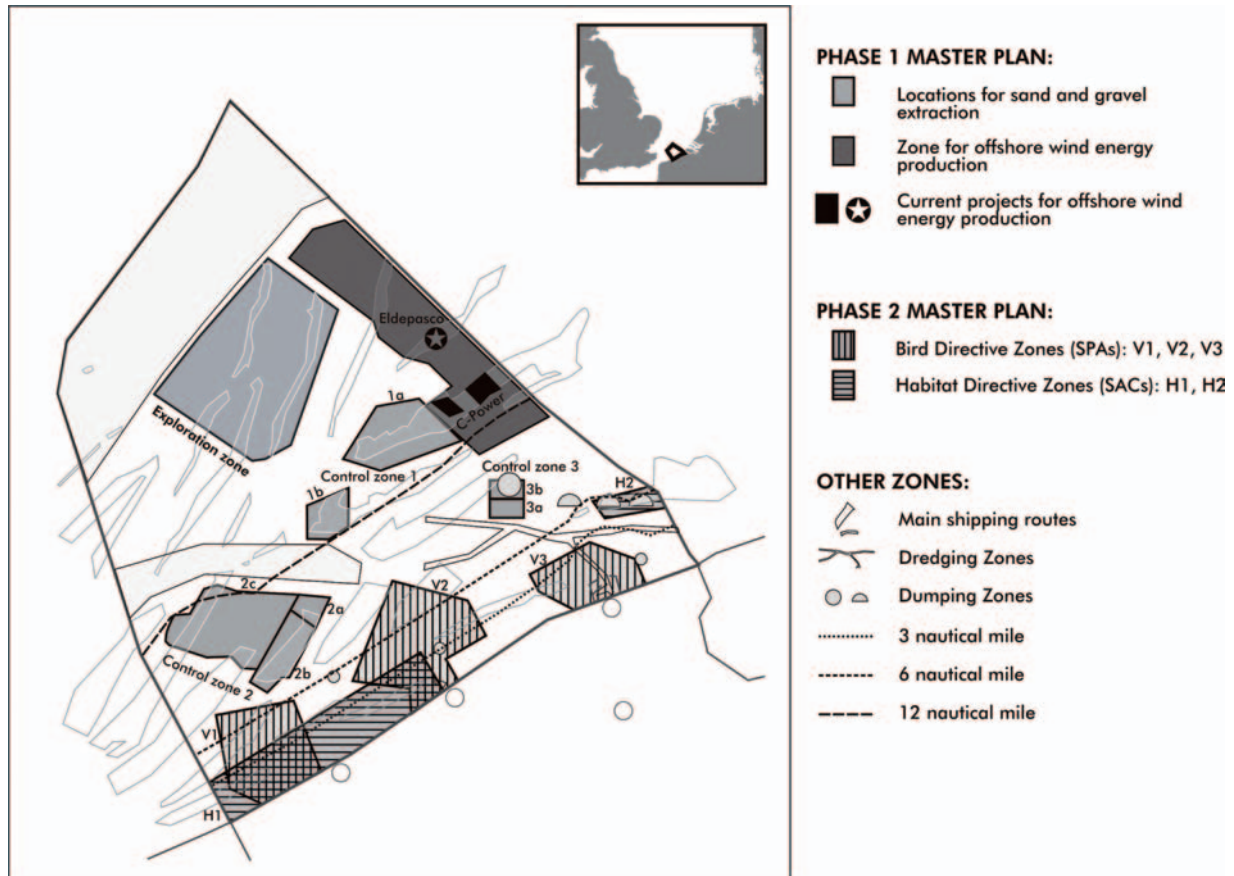


Figure 27.41 Phase 1 and 2 of the master plan for Belgium's North Sea marine area. Source: reproduced from Douvere *et al.* (2007). Copyright (2007), with permission from Elsevier.

outweighed by benefits expected to accrue over the same period (ABP 2007).

The Marine and Coastal Access Act and Marine (Scotland) Act led to the creation of the Marine Management Organisation and Marine Scotland. The Welsh Assembly Government has equivalent responsibilities as the Marine Management Organisation in Welsh waters, but at the time of writing the Northern Ireland Government had not made any commitments to establish a Marine Management Organisation equivalent to manage their seas. Each country has responsibility for planning in their inshore and offshore waters. Marine planning at a regional scale is not addressed in the new legislation, but in the future it may be beneficial to coordinate and implement planning between all countries that share a common body of water.

The Marine Management Organisation, Marine Scotland, Welsh Assembly and Northern Ireland Assembly are responsible for preparing the marine plans in their respective seas. They will regulate most activities in their country's territorial waters, including fisheries (Section 27.6.3.3), dredging, aggregate extraction, laying of submarine cables, marine renewable energy development and environmental protection. A key responsibility will be to ensure stakeholder buy-in from the full range of marine activities. The Marine Management Organisation must work closely with Welsh and Northern Ireland Ministers and Marine Scotland to manage the linkages between reserved and devolved responsibilities to ensure ecosystem-based management is joined up throughout the UK's Marine environment. The Marine Management Organisation, and

its equivalent authorities in Wales, Scotland and Northern Ireland, are expected to be the centre of marine expertise, provide a consistent and unified approach, and coordinate information and data. In England, Natural England and the Joint Nature Conservation Committee will work with the Marine Management Organisation to integrate marine planning with MCZs (WWF-UK 2010). Although the Marine Management Organisation has significant powers, since the discontinuation of the Infrastructure Planning Commission (IPC), the Secretary of State makes the final decision on large-scale infrastructure projects in the UK including major offshore developments, ports and harbours.

Coastal zone management. Historically, coastal management policies and decisions in the UK were made by the sector involved, for example, transport, environment, economic growth or waste management. Responsibilities for marine and coastal management remain dispersed across a variety of government agencies and departments. This traditional sectoral approach to management and planning is being modified due to growing pressures on the coastal zone from competing human activities.

Integrated Coastal Zone Management (ICZM) provides a holistic approach to management that acknowledges natural dynamics and the interdependence of the Coastal Margin with other habitats such as the Marine environment. It also means adopting a joined-up approach to the management of many different interests in coastal areas. Although the principles of ICZM are broadly accepted in the UK, implementation has been a slow and long-term process (Defra 2006).

An audit (called the Stocktake) of the framework for coastal management of the UK was commissioned by the Department for Environment, Food and Rural Affairs and the Devolved Administrations following a Recommendation by the EU in 2002 to adopt a strategic approach to the management of the coastal zone based on a number of key principles. The Stocktake (Atkins 2004) looked at current practices, legislation, institutions and stakeholders, and reported that there was a mixed picture of how the principles of ICZM were being implemented in the UK in 2004. While there were good examples of local-level voluntary initiatives that successfully supported integrated approaches to resolve conflict, the dominant framework reflected sectoral approaches. Coastal forums were highlighted in the report as a way of involving stakeholders, facilitating exchange of information, breaking down sectoral barriers and moving ICZM forward at a local level.

The findings of the report were fed into the development of different coastal zone management strategies in England (Defra 2008f), Wales (WAG 2008b), Scotland (Scottish Government 2005), and Northern Ireland (DOE 2006). Although the coastal policies of the four countries differ somewhat as a result of devolution, they are all influenced by European legislation, including the Habitats Directive, the WFD, Flood Directive and the EU Recommendation on Coastal Zone Management (Section 11.2). Based on a set of common guiding principles, the Department for Environment, Food and Rural Affairs is committed to achieving a strategic framework for ICZM that recognises UK-wide policy objectives, but that can be applied in a

flexible manner within each Devolved Administration. As well as the individual strategies of the four nations, actions will also be taken at a UK-level to achieve the aims of ICZM.

Chapter 12 (Section 12.5) emphasises the importance of considering the linkages between deep-sea, shelf, coastal, estuarine, freshwater and terrestrial systems in marine plans. In this respect, the new marine planning regime may provide an opportunity to reinvigorate coastal zone management so that marine and coastal management are aligned. The Marine and Coastal Access Act incorporated principles of ICZM, providing an opportunity to link together marine management with existing terrestrial arrangements, and the act will be the key vehicle for delivery of many of the actions within the coastal zone management strategy for England.

A review of progress in implementing ICZM between 2006 and 2010 was submitted to the EC (Defra 2010f). Wales is reported to be making good progress, but integration remains a challenge; the Welsh Assembly's development of marine planning in Wales will attempt to address this issue. The Scottish Strategy has included significant coastal partnership work on ICZM, and the Scottish Sustainable Marine Environment Initiative involved pilots in Firth of Clyde, Sound of Mull, and the seas around the Shetland Islands (**Box 27.34**). The continued development of voluntary partnerships was highlighted as important to progressing the ICZM agenda.

Shoreline Management Plans (SMPs) are the primary strategy for coastal flood and erosion risk management in England and Wales, and some also exist in Scotland. Northern Ireland does not have a strategic approach to shoreline management (Section 11.2). Shoreline Management Plans assess risks associated with coastal processes and provide a strategic and long-term policy framework to reduce risks to people, property, and the historic and natural environment. The SMPs support decisions on which sections of coastline should be defended and which should be left to more natural processes. Coastal groups, comprising of local authorities and other bodies with coastal defence responsibilities, discuss options and contribute to the formulation of SMPs. Because the plans are updated every five years, new scientific research and national policy guidance can be incorporated (Hewett & Fletcher 2010).

Box 27.34 Scottish Sustainable Marine Environment Initiative. Source: Defra (2010f).

The Scottish Sustainable Marine Environment Initiative involved four pilot projects which considered spatial planning, habitat mapping and conflict resolution. The Shetland project ran from 2006 to 2010 and developed a Marine Spatial Plan to create a more integrated and robust framework for wider marine planning and management in Shetland. The plan provides guidance for the positioning of different marine activities and reflects extensive public involvement, consultation and consensus to ensure that communities understand and participate more effectively in decision-making. In contrast, the Berwickshire pilot focused primarily on the socioeconomic benefits of a high quality Marine environment on the local economy through work packages that address fisheries, and integrated harbour and visitor management. The Firth of Clyde and Sound of Mull pilot projects prepared, and are implementing, Marine Spatial Plans with a view to deliver more integrated and sustainable management of their marine and coastal areas.

The first SMPs were produced in the mid-1990s and set out how each length of shoreline is managed. Several major studies since then, including Futurecoast, Foresight and UK Climate Impacts Programme, Catchment Flood Management Plans, and Strategic Flood Risk Assessments (by local authorities), have provided evidence that the original SMPs may not be practical in the long-term. These reports highlighted the threat of sea-level rise and that maintaining and improving current defences may not be economically or environmentally viable in the future. To account for these risks, a second generation of SMPs are currently being prepared to cover the entire coast of England and Wales. The new plans will outline approaches to managing the risks to the coast in the short (0–20 years), medium (20–50 years) and long-term (50–100 years). Again, coastal groups, mainly made up of the Environment Agency and local authorities, will develop the SMPs.

In Northern Ireland, flood and coastal erosion risk management operates without statutory guidance, and without formal shoreline management plans. Dodds *et al.* (2010) attribute this to the fact that Northern Ireland receives less frequent, and less severe, flooding than other parts of the UK. The EU Floods Directive has recently helped to highlight and identify policy and knowledge gaps. Northern Ireland's Rivers Agency has now moved directly to flood risk management. However, flood management remains focused on asset and sector-based coastal protection, with limited consideration of the cross-cutting nature of coastal hazards. Climate change and associated changes to coastal processes are likely to require a more integrated, strategic approach to increase coastal resilience in the future (Dodds *et al.* 2010).

In England and Wales, the Environment Agency and local authorities have various responsibilities for coastal management, but there is not one institution with overall responsibility for coastal management, although SMPs are intended to provide some coordination (**Figure 27.40**). It is now increasingly recognised that more transparent decision-making processes are needed—involving participatory approaches—given the complex coastal management arrangements and many stakeholders involved.

Coastal partnerships have been the main champion of ICZM since the early 1990s—there are now over 60 voluntary coastal partnerships around the UK (Stojanovic & Barker 2008). The partnerships involve a variety of stakeholder engagement activities including coastal fora, networks and partnerships. They all aim to promote integrated approaches to regional or local coastal management, but have differing concerns and activities. The partnerships facilitate cooperation and resolve conflicts, and disseminate information among stakeholders (**Box 27.35**). Initially, the partnerships were supported solely by local authorities and statutory conservation bodies, but now a wide range of stakeholders participate, including sea fisheries committees, port authorities, energy companies, local voluntary groups and NGOs, reflecting a broader remit than purely conservation. The partnerships operate at a variety of scales, from local (e.g. Hamble Estuary Partnership), to regional (e.g. Devon Maritime Forum) to national (e.g. the Scottish Coastal Forum) (Hewett & Fletcher 2010).

The extent to which coastal partnerships have made a positive contribution to ICZM is contested. A study by Stojanovic & Ballinger (2009) found that the partnerships enhance local decision-making processes, and they are also good value for money (Entec 2008). They can assist in integration, share information, and their officers can provide specialist advice and local knowledge (Entec 2008). The ability of the partnerships to provide engagement with local stakeholders from a platform perceived as independent and neutral is seen as a key strength and benefit by the UK Government (Defra 2010f). Nevertheless, others (Hewett & Fletcher 2010) report that partnerships suffer from a lack of financial and sometimes political support due, perhaps, to the non-statutory basis of the bodies, uncertain success, and the mismatch of expectations between funders and partnership officers. Potential internal failures include: problems with communication and engagement, especially with the private sector; variable performance in achieving aims; and the challenge of undertaking a resource intensive, consensus approach (Stojanovic & Ballinger 2009).

Box 27.35 Tay Estuary Forum.

Coastal partnerships are defined by Fletcher (2003, p.229) as:

“voluntary groupings of stakeholders and lay public bound together by a shared sense of place concerning a discrete coastal area. Such groups use the rationale of deliberative consensus building to develop and implement broadscale coastal management strategies”.

Coastal partnerships emerged as a key mechanism to address the concerns of coastal management in the UK in the early 1990s; however, a survey found that unclear decision-making procedures and representative structures can lead to misrepresentation and poor inclusivity (*ibid.*). Some coastal partnerships have addressed these issues, and one such positive example is from the Tay Estuary in Scotland.

The Tay Estuary Forum was established in 1997 to promote the wise and sustainable use of the estuary and adjacent coastline (Booth & Duck 2010). Central to this partnership has been community engagement and voluntary partnership, and the forum has acted as a local mediator to resolve coastal issues. The area covered by the Tay Estuary Forum (including three major estuaries) is designated as an SPA because it is of national and international importance for populations of wildfowl and waders. It also includes the largest continuous stand of reedbed in Britain, and extensive dune systems. Maintenance of water quality is a priority for the Tay Estuary Forum which operates in an area that is under pressure from local population, environmental and economic demands.

The Tay Estuary Forum is made up of a membership over 450 organisations, groups and individuals. The organisation is neutrally housed at the University of Dundee, and the Steering Group comprises representatives from four local authorities. While early studies of the Tay Estuary Forum reported a lack of representation and participation, awareness of the forum has been raised through events, workshops and the media, and participation and representation have been improved through the Annual Conference (with audiences consistently reaching more than 65 since 2005) and through the quarterly newsletter.

Following discussions at the Annual Conference and subsequent consultation, the Tay Estuary Forum launched its non-statutory five-year Management Plan in 2009 to guide the work of the Forum from 2009 to 2014. The Plan aims to remain dynamic in reflecting the changing needs of stakeholders around the estuary over time.

27.7.3.4 Changing social attitudes (enabling)

It is argued in Chapter 12 that the introduction of new marine legislation (Marine and Coastal Access Act 2009) signals an increasing awareness of the cultural and societal importance of the Marine ecosystem, habitats and biodiversity. Marine flagship species, including cetaceans (whales, porpoises, dolphins), turtles and seals, are commonly used for public awareness and fundraising purposes (Section 12.3.5). Raising awareness about the Marine environment is challenged, however, by the relative difficulty in accessing some Marine habitats.

Educational programmes present opportunities for children and adults to learn about Marine ecosystems and the impact of humans upon them. The National Curriculum covers Coasts and Coastal management in the Geography syllabus, and the use of coastal education packs by teachers can further encourage coverage of marine issues (Defra 2008f). Chapter 12 discusses a number of education programmes run by environmental NGOs such as the Marine Conservation Society's Cool Seas programme which has reached over 120,000 school children since 2006. School trips to the coast and aquaria can also nurture interest in children for the Marine environment. Natural England's marine campaign Under England's Seas aims to raise awareness and excitement about Marine environments among the public using maps, videos, events and children's activities (Natural England 2010b). On the other hand, some campaigns arise from target groups with an interest in the health of the UK's seas. Surfers Against Sewage (**Figure 27.42**) gathered significant public support to pressurise water companies and the government to properly treat wastewater before its discharge to rivers and coastal waters.

A study looking at human and wildlife coexistence in the Marine environment of the Moray Firth in Scotland found that the public were highly concerned with factors that directly harmed Marine animals such as fishing gear, oil spills and litter entanglement (Zapponi 2006). Local community support for conservation of the Marine environment was demonstrated through public participation in voluntary beach-clean operations. While more than 70% of the inhabitants and visitors interviewed were aware of the three main cetacean species in the area (bottlenose dolphin,

Minke whale and harbor porpoise), most did not know the protection status of these species, nor did they identify the Inner Firth SAC as an example of a MPA.

Policies are now actively seeking to change social behaviours towards Marine environments. The Strategy for Promoting an Integrated Approach to the Management of Coastal Areas in England (Defra 2008f) recognises the importance of promoting awareness to encourage participation in the management process. It highlights the progress made in raising public awareness through coastal partnerships that have organised events, conferences, educational websites, and guided tours and walks. The Strategic Plan for Water-related Recreation in Wales (Church *et al.* 2008) encourages increased participation in water-related recreation for the economic, social and health benefits such activities provide. In many cases, public perception is as, if not more, important than actual conditions. In a study of perceived welfare benefits resulting from policy and legislation to improve bathing water quality, it was found that perceived water quality, as opposed to actual water quality, affected the number of trips people plan to the coast (Hanley *et al.* 2003).

A body of research has explored social acceptance of offshore renewable energy development (Wüstenhagen *et al.* 2007; West *et al.* 2010; Haggett 2011), acknowledging the power of social behaviour to constrain the achievement of government renewable energy targets. Haggett (2011) argues that the role of the public should not be underestimated, and that they should be involved in decision-making about offshore windfarm development. The designation of MCZs across British waters has been met with some resistance from fishermen. They are concerned about issues of displacement for fishermen, the consequences for their communities, and the knock-on effects on adjacent or distant fisheries (NFFO 2011).

27.7.3.5 Technologies and practices (instrumental)

Several alternative coastal management practices are available to decision-makers, and are under consideration for the development of revised SMPs.

Hold the line. The traditional approach to flooding and erosion has been to 'hold the line' through sea defence and coastal protection. These responses have been effective at addressing the problem locally, but, due to downdrift of the built structure, there are typically adverse effects as previously eroded sediments are unable to supply beaches, dunes and saltmarshes which are then not able to fulfil their protective role. Sea-level rise and declining sediment supply is leading to a decrease in intertidal habitats that defend the coast from storm surges and erosion (Natural England 2009g). Sea defence and stabilisation measures should, therefore, be deployed sparingly. In the 2009/10 financial year, a total of £349 million was spent on capital investments in defences and projects, yet it is not enough to keep up with increasing rates of erosion (Defra 2009f). Second generation SMPs need to assess the impacts of their package of measures on soft cliffs, and sediment supply and dynamics. In the future, holding the line is likely to become increasingly untenable in many cases given the severe effects of changing sediment dynamics and the prospect of sea-level rise. The coast will not be confined to its current configuration.



Figure 27.42 Surfers Against Sewage: a special interest group that campaigns for cleaner seas. Photo © David/Flickr.com.

Nowadays, there is recognition of the role of cliff erosion supplying sediments to beaches and shorefronts, and ultimately their role in flood and erosion mitigation. This has led to a wider spectrum of options being considered in shoreline management, with a focus on working with natural processes.

Saltmarsh restoration and protection. Chapter 11 (Section 11.3.2.1) reports on the effectiveness of Saltmarshes in regulating flooding and coastal erosion—pioneer Saltmarsh was found to reduce wave energy by up to 82% and Saltmarsh could bring a capital cost saving of £2.17 billion for sea defence in the UK. Given that Saltmarsh is rapidly declining across the UK, there is an urgent need to protect and restore this habitat (**Figure 27.43**). Managed realignment has proved to be an effective and simple response to restore Saltmarshes while providing several additional environmental benefits (**Box 27.36**).

Beach nourishment. A shortage of sediment in many coastal systems has increased the risk of erosion, overwashing and breaching (Section 11.2.1); hence, artificial protection is now not seen as the only coastal protection option. Instead, coastal managers have increasingly turned to beach nourishment schemes. The additional sediment provided to the system affords coastal protection, has a lower impact than permanent constructed defences, and can help create conditions for vegetation to develop and provide further protection to the coastline. The sustainability of sediment supply to beach nourishment schemes, and the impacts caused by extraction of sediments off- and onshore, should be considered carefully in SMPs. There are also variable impacts on components of beach ecosystems such as microphytobenthos and terrestrial arthropods (Speybroeck *et al.* 2006).



Figure 27.43 Saltmarsh habitat created by the National Trust at Northey Island, Southeast Essex. Photo © Natural England.

The south-east of England, in particular, has seen a proliferation of beach nourishment schemes since the 1970s. The volume of cliff erosion in this region is insufficient to make up for losses of beach sediment, with beach nourishment used to reduce the deficit. The costs of such schemes have increased five-fold since the late 1980s. Expected rises in sea level due to climate change could make this practice too costly and/or ineffective in the medium to long-term (Moses & Williams 2008).

Box 27.36 Alkborough Flats: managed realignment delivering multiple ecosystem services.

Alkborough Flats, on the south bank of the Humber Estuary, is the UK's largest realignment scheme, covering 440 ha of low-lying land. In 2006, a 20 m-wide breach was made in the flood defence bank, converting 170 ha of land into intertidal mudflat, Saltmarsh and reedbed; the remaining land was made available as storage capacity during extreme storm surges. The project has created many valuable ecosystem services (**Figure 27.44**).

There are now 23 coastal realignment projects in England and three in Scotland, delivering a range of cost-effective ecosystem services.

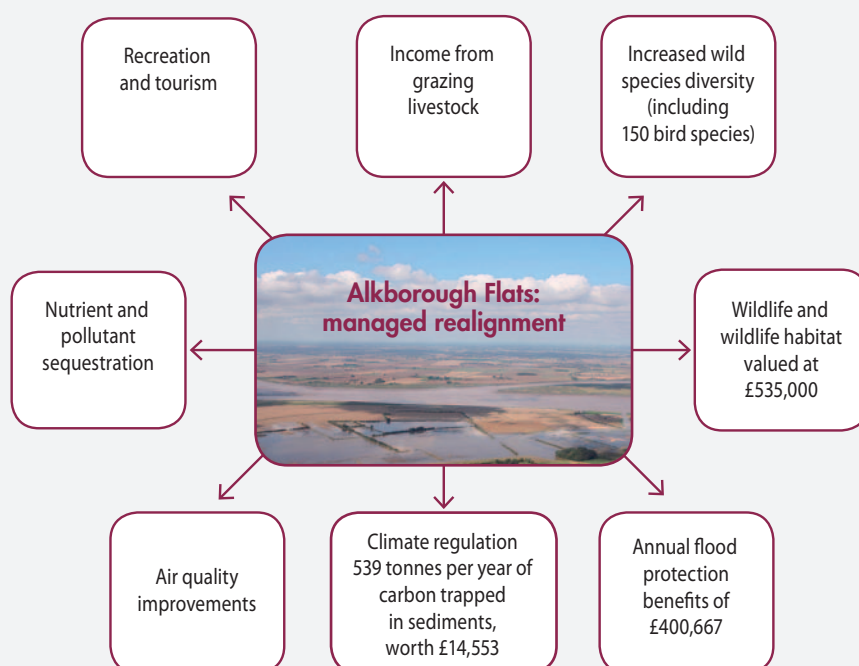


Figure 27.44 Alkborough Flats: managed realignment delivering multiple ecosystem services. Source: information adapted from (Natural England 2009g); Photo © Environment Agency.

Managed realignment. Managed realignment (adaptive management) has become an important management option. Flooding and erosion threaten coastal habitats, such as Saltmarshes and Sand Dunes. By recreating these habitats landward of their existing position, the coast can retreat in a sustainable manner and continue to dissipate wave energy and protect against floods. Although these habitats could migrate landward on their own if given space, active realignment is often necessary given the pace of climatic changes. This approach allows coastal geomorphology and habitats to respond dynamically to environmental changes such as sea-level rise and increased storm activity. To date, coastal realignment schemes have predominantly involved recreating Saltmarsh, but could be extended to other habitat types, including Sea Cliffs and Coastal Lagoons.

Managed realignment schemes have been found to reduce the cost of hard defences. An 80 m-deep zone of intertidal habitat fronting seawalls can save £4,600 per metre in sea defence costs (Natural England 2009g). However, such schemes do not only have sea defence and coastal protection benefits, but also provide a range of other valuable services demonstrated by the Alkborough Flats managed realignment scheme in the Humber Estuary (**Box 27.36**). Saltmarshes and mudflats store substantial amounts of carbon. Shepherd *et al.* (2007) recorded 0.44–1.7 tonnes of carbon per ha per year could be stored by recreating intertidal habitats in the Blackwater Estuary, Essex (Natural England 2009g).

Managed realignment can be controversial since it sacrifices land that provides its own range of ecosystem services (e.g. food from agricultural land) (Luisetti *et al.* 2011). Low-lying, sparsely populated areas that would once have been protected by coastal defences may not be protected in the future, raising issues about balancing efficiency in the use of public resources with the equity of changing the coastal management arrangements that local people have come to rely upon (RCEP 2010). The wider deployment of a managed realignment strategy in the UK will inevitably involve complex trade-offs, particularly where productive farmland or valuable property and infrastructure assets are located. A complex mixture of political, social, economic and ethical concerns will need to be considered in such strategies (Luisetti *et al.* 2008). Where there are significant numbers of people, property and other assets, cost-benefit analyses can be useful, but should not be decisive in managing trade-offs (*ibid.*).

27.7.4 Marine and Coasts Summary

Table 27.17 summarises the key insights from this review of responses in the marine and coastal context, highlighting those that have been well-established, but also identifying a set of responses that are either in early implementation or are proposed. It is important to learn from these early pilots across all sectors to scale-up the adoption of an integrated ecosystem approach to the management of the UK's diverse habitats, which is one key policy direction that this review recommends.

Table 27.17 Marine and Coasts Summary.

	Established responses	Early implementation, pilots	Proposed, under development
Knowledge	<ul style="list-style-type: none"> ■ Charting Progress (report of the state of UK seas) 	<ul style="list-style-type: none"> ■ Knowseas project (ecosystem approach to marine management) ■ Marine environmental data and information network 	<ul style="list-style-type: none"> ■ Integrated approach to marine assessments ■ More data coverage, with use of GIS to support participatory decision-making ■ National strategic monitoring programme
Legislation	<ul style="list-style-type: none"> ■ Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) ■ Common Fisheries Policy 	<ul style="list-style-type: none"> ■ Marine Strategy Framework Directive ■ Marine Conservation Zones ■ Water Framework Directive ■ EU Floods Directive and national flood legislation 	
Policies, institutions and governance	<ul style="list-style-type: none"> ■ Sectoral management of marine and coastal activities ■ Integrated Coastal Zone Management ■ Coastal forums and partnerships ■ Shoreline Management Plans 	<ul style="list-style-type: none"> ■ Marine planning regions ■ Marine Management Organisation, Marine Scotland, etc. ■ National coastal zone management strategies ■ Strengthening of Integrated Coastal Zone Management ■ Scottish Sustainable Marine Environment Initiative 	<ul style="list-style-type: none"> ■ Marine Planning Policy Statement ■ Integrating coastal zone management and marine management ■ Second generation Shoreline Management Plans
Changing social attitudes	<ul style="list-style-type: none"> ■ Educational programmes (in National Curriculum and by non-governmental organisations) ■ Special interest campaign groups ■ Coastal partnerships raising public awareness 		<ul style="list-style-type: none"> ■ Greater involvement of public in decision-making
Technologies and practices	<ul style="list-style-type: none"> ■ 'Hold the line' (sea defences) ■ Managed realignment ■ Saltmarsh restoration and protection ■ Beach nourishment 	<ul style="list-style-type: none"> ■ Managed realignment in habitats other than saltmarshes 	

27.8 Recreation and Tourism

27.8.1 Recreation and Tourism-related Ecosystem Services and Human Well-being

“Recreation in the countryside is a widespread activity and continues to be an important policy objective, especially within the ecosystem services approach..., being one of the benefits of the natural environment” (CRC 2010).

As defined in Chapter 16 (Section 16.3.2), “‘recreation’ describes what we do with, or at, our ‘leisure’, while tourism encompasses the travel and accommodation required to gain access to some recreation and leisure activities”. Put differently, ‘tourism’ is the economic consumption and production of services to support ‘recreation’. There is a broad range of outdoor recreation activities undertaken in the UK as listed in **Table 27.18**. Recreational ecosystem services, classified as cultural in nature, are often associated with meaningful landscapes of aesthetic or social value—the places where people choose to spend their leisure time. Local places of

recreation are of particular importance because they foster a sense of place, and because they are easily and frequently accessed, thereby enhancing benefits to well-being. The appeal of certain landscapes may also be dependent on the presence of rare species (such as birds, flowers or amphibians) or high levels of biodiversity or geodiversity. For this reason, there will be overlap of this sector with Biodiversity, especially concerning the protection and enjoyment of biodiversity and habitats in designated areas. There is also a close relationship with Urban planning, Transport and Energy because tourism involves transport to preferred locations, and planning is required to maximise the utility of greenspaces for recreational purposes, and to avoid or minimise adverse impacts on our most valued natural assets.

A broad set of direct and indirect drivers impact recreation and tourism, which, in turn, affects other ecosystem services. These are summarised from earlier chapters of the UK NEA in **Figure 27.45**.

The countryside is both actively managed to accommodate different recreational and tourism pursuits, and passively impacted by these activities. In this way, there may be trade-offs or synergies between recreation and tourism and other ecosystem services and sectors. For example, increased stocking density of sheep for the

Table 27.18 Popular outdoor recreation activities in the UK (listed from most to least popular from most recent survey sources). Source: * Natural England (2010d); † Forestry Commission Wales (2009); ‡ TNS Research International (2010); § LUC (2006).

England*	Wales†	Scotland‡	Scotland – specialist marine/coastal recreation§
Walking with a dog	Short walk	Walking (2–8 miles)	Sea angling
Walking	Dog walking	Walking (<2 miles)	Sailing/dinghy sailing
Playing with children	Long walk	Family outing	Birdwatching and wildlife tours
Eating or drinking out	Hill walking	Sightseeing/visiting attractions	Sub-aqua and snorkelling
Visiting an attraction	Visiting playgrounds	Other wildlife/nature-watching	Other specific activity
Informal games/sport	Wildlife-watching	Walking (>8 miles)	Speed boating/personal water craft/water skiing
Running	Sightseeing	Cycling on paths/tracks	Windsurfing
Wildlife-watching	Running	Picnicking	Land yachting
Road cycling	Informal games	Birdwatching	Motorbike scrambling/4x4 off-roading
Appreciating scenery from car	Picnicking	Cycling on public roads	
Picnicking	Road cycling	Running/jogging	
Visit to beach/sunbathing	Off-road cycling	Walking the dog	
Horse riding	Horse riding	Fishing	
Off-road cycling/Multi-Terrain Biking		Hill walking	
Fishing		Golf	
Water sports		Other sports	
Swimming outdoors		Swimming in sea/rivers/locks	
Field sports		Water sports	
		Horse riding	
		Shopping	
		Just a day out	
		Playing/watching football	
		Just a day out	
		Playing/watching football	

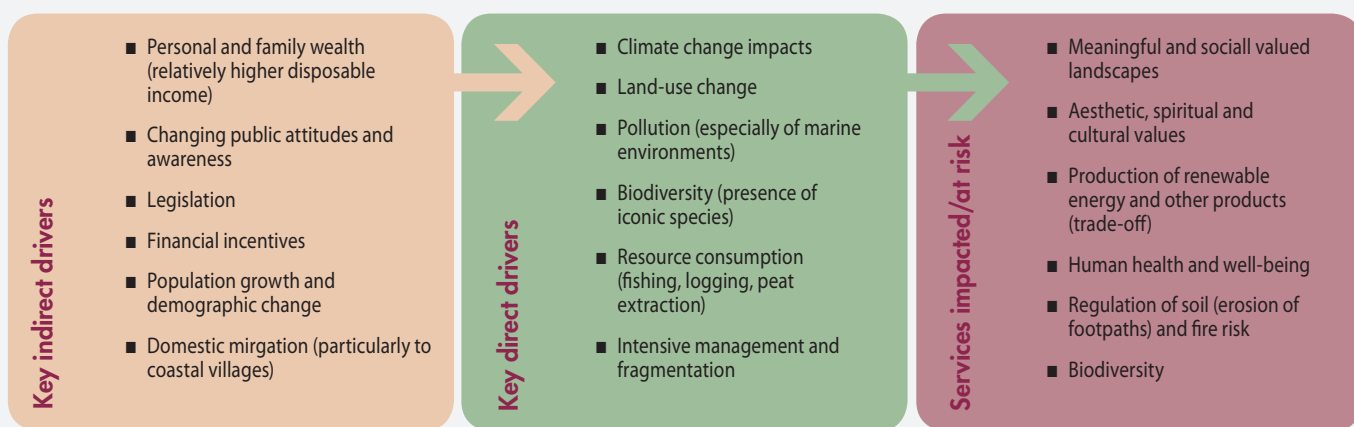


Figure 27.45 Key indirect and direct drivers relevant to the recreation and tourism sector, and the ecosystem services at risk.

production of lamb decreases the quality of that landscape as red grouse habitat, thereby impacting recreational hunting opportunities. Recreation and tourism are considered to be synergistic with the benefits of education, spirituality and physical health (Section 16.3.2). Certain habitats, such as mountains, crags, hills, limestone rocks, woodlands, lakes, upland streams, beaches, sea, parks and open spaces, are of great value for the unique recreational opportunities that they provide (**Figure 27.46**). Recreational activities can broadly be divided into ‘benefit enhancing services’ (such as biodiversity and aesthetic services) or ‘resource extractive services’ (such as fishing and hunting) (Chapter 22).

27.8.2 Challenges for the Recreation and Tourism Sector

With an increasing domestic population and international tourism to the UK predicted to double by 2020, it will be a challenge to manage a significant increase in demand for these outdoor services without adversely impacting the provision of other ecosystem services (Foresight 2010). As a result of the economic downturn and the increasing cost of international travel, there has been a shift from outbound to domestic tourism, also known as ‘staycations’;

meanwhile, the depreciation of the pound sterling has increased the financial attractiveness of UK tourism to foreigners (Webber *et al.* 2010). This will result in both opportunities for, and threats to, the natural environment, and management interventions will be key to ensuring that ecosystems are not over-used. “Physical development of resorts, consumption of fuel by buildings, aircraft, trains, buses, taxis and cars, overuse of water resources, pollution by vehicle emissions, sewage and litter all contribute to substantial, often irreversible, environmental degradation, as well as to dramatic social consequences” (Davenport & Davenport 2006, p.281).

More people will mean more pressure on transportation infrastructure to popular destinations, and increased congestion on road and rail networks could, in turn, discourage travel and have social and economic consequences (Section 27.9). Local recreation, reachable by foot, bicycle or public transport, directly reduces traffic and greenhouse gas emissions; however, these benefits need to be balanced against visitor impacts at these sites. Meeting increasing demands for Green Infrastructure will also be a challenge in increasingly dense urban areas where trade-offs will need to be made between greenspace and other forms of development. Appropriate planning and design for long-term management and development will be essential (Section 27.9.3.3).

As cultural services, recreation and tourism depend on a number of ecosystem characteristics that can be difficult to measure and quantify—especially aesthetic and spiritual qualities and biodiversity. Social attitudes about the characteristics which add value to recreational and leisure activities are generally poorly understood, posing a challenge for the improvement of these services. For example, provision of renewable energy from windfarms has been deemed by some to negatively impact the aesthetic value of the countryside, but further studies are needed to better understand these attitudes. Conflicts between users and between different uses of a location can arise, for example, between walkers, dog walkers, bicycle riders and horseback riders on trails. Activities undertaken by some visitors may adversely impact other visitors’ enjoyment of an area. In some cases, certain seabirds and mammals that are valued for recreation and leisure compete directly



Figure 27.46 The Carrick-a-Rede rope bridge in Northern Ireland allows coastal tourists, including fishers and climbers, to access the island. The site and surrounding area is recognised as a SSSI due to its unique geology, flora and fauna, which is also an attraction for tourists. Image © Joe Gough, 2011. Used under license of Shutterstock.com.

with humans for resources, such as fish and food, creating a trade-off between food provision, cultural services and conservation (Chapter 12).

Recreation and tourism activities often directly impact the ecosystems in which they take place. The development of infrastructure to support tourism has the greatest impact on the environment (Davenport & Davenport 2006); however, activities such as hiking and camping can also cause soil compaction through trampling, soil erosion, and disturbance to wildlife and vegetation (Cole 2004). Future climate change will exacerbate these impacts as habitats become more fragile (**Box 27.37**). The quality of bathing waters is predicted to be affected by impacts of both population growth and climate change, leading to increasing amounts of sewage and overflows as a result of heavy rainfall (EA 2010a).

27.8.3 Recreation and Tourism-related Response Options

27.8.3.1 Knowledge (foundational)

A large number of surveys about outdoor recreation and tourism have been conducted in the UK, providing a wealth of data and statistics (**Table 27.19**). Early surveys that recorded basic data about the location, frequency and cost of visits have been superseded by more advanced surveys which aim to provide information about the characteristics of visitors, their motivations for visiting, and patterns in

Box 27.37 The impact of visitors on coastal habitat under a changing climate. Source: Coombes & Jones (2010).

In their paper, Coombes & Jones (2010) make the argument that climate change will not only impact vulnerable environments, but a warmer and drier climate is also likely to increase participation in ecologically damaging activities. The study looks specifically at coastal recreation at two East Anglian beach sites where tourism is economically valuable and the coast is sensitive to climate change because it is low-lying and easily erodible should sea levels rise.

Using data from visitor surveys, the study predicts that climate change will generally increase both the numbers of visitors to these sites and their participation in activities promoted by dry, warm weather. Under a high emissions scenario, visitor numbers are predicted to experience a 46% net increase. However, impacts on biodiversity are not likely to be directly proportional to this increase since warmer temperatures are also likely to encourage low impact activities. In the case of shorebirds, increased visitor numbers will create disturbance irrespective of visitor activity level. Decreased beach width, as a result of climate change, might compound visitor impact as it is restricted to a reduced area and is, therefore, more concentrated.

The results suggest that additional management will be required to minimise trampling and bird disturbance in response to changes in coastal recreation. Recommendations include:

- restricting access to a single entrance point;
- targeting management strategies specifically to each user group such as birdwatchers, sunbathers, players/paddlers, walkers and dog walkers;
- preventing access to sensitive areas;
- creating defined paths to limit wandering and minimise trampling;
- raising environmental awareness (i.e. through information centres) to promote responsible use; and
- aligning coastal defence strategies to meet visitor preferences.

the use of the natural environment. VisitBritain (<http://www.visitbritain.com/en/GB/>), and its devolved partners VisitEngland, VisitScotland and VisitWales, are also a source of information about recreation and tourism in the UK.

Increased attention is being paid to research on the physical and mental health benefits of being outdoors and in contact with nature (Section 16.3). Physical activity in the presence of nature, otherwise known as ‘green exercise’, not only has positive health benefits, but also promotes ecological knowledge, fosters social bonds, and influences behavioural choices. Similarly, a growing body of empirical evidence supports the benefits of Urban greenspaces. In particular, research has shown that open greenspaces and access to nature promotes healthy development of children (Section 16.3.1).

Disadvantaged people often live in the worst environments, where air quality is poor and there is less access to greenspace (EA 2011a). Low income households are also less able to travel (due to lower car ownership, less disposable income for recreation, etc.) and are, therefore, more dependent on local greenspaces for the health and well-being benefits they provide (Mitchell & Popham 2008). A body of research about environmental inequality, transport disadvantage, and the relationship between greenspace, inequality, ethnicity, health and well-being exists in the UK (Defra 2008g; Mitchell & Popham 2008; CABE Space 2010; EA 2011a). Early research on this subject in England led to formal policy recognition by the Social Exclusion Unit, resulting in the internationally recognised Making the Connections (Social Exclusion Unit 2003) report and the subsequent development of cross-departmental policy guidance on the delivery of Local Transport Plans (Lucas & Currie 2011).

A number of important knowledge gaps remain, however. Generally speaking, knowledge about the impacts of drivers influencing cultural services is needed, as is a better understanding of the ways in which social and environmental systems interact (Section 19.7). Further investigation of public attitudes towards aesthetic values, especially concerning renewable energy production, is warranted (Section 19.5.3.12). The Foresight Land Use Futures Project (Foresight 2010) highlighted the need for policy-relevant research on the value of different landscapes for recreation and tourism in urban, urban fringe and rural settings—including consideration of their contribution to the UK economy and to individual and community well-being. Data on the capital and labour costs of deer stalking as a recreation activity is needed, along with primary data on the number of deer taken and the level of paid stalking (Chapter 22). Some form of hedonic or travel cost analysis is needed to identify features which add value to the stalking experience. This would allow a more accurate representation of the potential value of this service. Fuller data is also required for grouse shooting in England and Wales to ensure data comparability.

As the recognition of the importance of greenspace grows, additional research is required to improve the safety and design of these spaces, and to further explore green exercise as a therapeutic intervention in order to maximise its utility (Section 19.5.4.3).

Table 27.19 A summary of important sources of recreation and tourism-related data in the UK. This list is by no means exhaustive.

Survey	Scope and Latest Reference	Aims and Key Findings
Leisure Day Visits Survey	Great Britain (Natural England 2003)	Initiated in 1998 and repeated in 2002–2003 in Great Britain to measure the extent of, and participation in, leisure day visits, and to estimate their value.
UK Countryside Survey	UK and devolved areas (Carey <i>et al.</i> 2008a)	Reports on the state of the countryside and identifies change through comparison with previous surveys (1978, 1984, 1990, 1998, 2007).
UK Tourism Survey (UKTS)	UK (VisitBritain 2010)	This national consumer survey annually measures the volume and value of tourism trips taken by UK residents.
Monitor of Engagement with the Natural Environment (MENE)	England (Natural England 2010d)	This survey aims to understand how people use, enjoy, and are motivated to protect the natural environment, and to provide data about changes in the use of the natural environment at different spatial scales over time for key groups within the population.
State of the Countryside Report	England, 11th Edition (CRC 2010)	Covers official social, economic and environmental statistical and analytical evidence for rural England—now includes greater detail at smaller spatial scales, and information about the effects of the recession.
Countryside Quality Counts (CQC)	England (Haines-Young 2007)	Starting in 2002, this indicator of countryside quality was developed and monitored. It incorporates biodiversity, tranquillity, heritage and landscape character.
The Welsh Outdoor Recreation Survey	Wales (Forestry Commission Wales 2009)	This first survey presents findings on the use of the outdoors by Welsh residents, places visited, motivations and barriers to using the outdoors and 'latent demand' for outdoor recreation.
The Scottish Recreation Survey	Scotland (TNS Research International 2010)	Since 2003, this survey has provided information about levels of participation in outdoor recreational activities in Scotland including transport used and awareness of the Scottish Outdoor Access Code.
A Review of Marine and Coastal Recreation in Scotland	Scotland (Land Use Consultants 2006)	Using a web-based approach, this survey provided the first reasonably complete picture of marine and coastal recreation in Scotland.

27.8.3.2 Legislation (enabling)

The legislative framework in the UK has evolved to favour the protection of environmental and societal rights for the benefits of community good (Chapter 3). Since 1945, a large number of UK and EU statutory protection schemes have aimed to conserve socially valued landscapes, as shown in the biodiversity sector (Section 27.2). The 'access movement' in the 1950s, supported by parts of the urban working class, led to the formation of National Parks under the National Parks and Access to the Countryside Act 1949 (CRC 2010). This act has two statutory purposes (CNP 2010):

1. To conserve and enhance the natural beauty, wildlife and cultural heritage of the National Parks.
2. To promote opportunities for the public understanding and enjoyment of the special qualities of the Parks.

Since this time, the area open for public access and enjoyment outside National Parks has increased. In England and Wales, the Countryside and Rights of Way Act 2000 amends the law regarding public rights of way and strengthens wildlife enforcement legislation, including increased protection of SSSIs and improved management of AONBs (JNCC 2010b). Increased access to open land (mountain, moor, heath, down, and registered common land) is provided through a new right of public access under this act, which also contains provisions to safeguard landowners, occupiers and wildlife. The Land Reform (Scotland) Act 2003 established the rights to be on and to cross land for the purposes of recreation and educational activity if they are exercised responsibly (Scottish Executive 2003). This act imposes duties requiring local authorities to design and adopt a plan of core paths for access on and over their area, and requires Scottish Natural Heritage to draw up and issue the Scottish Outdoor Access Code. In Northern Ireland, district councils have the

authority to identify walking and horse riding routes, and the responsibility to maintain and signpost these public rights of way is legislated under the Access to the Countryside (Northern Ireland) Order 1983.

The Marine and Coastal Access Act 2009 sets out the legal framework for the provision of public access around the English and Welsh coastline. It makes provisions for the establishment of an English coastal walking route and rights of access to the English coast (EA 2010e). In Wales, the act enables Assembly Measures in relation to coastal routes for recreational journeys and rights of access to land near the Welsh coast. Under this act, marine planning and conservation of the offshore region surrounding Scotland (from 12–200 nautical miles) is devolved to Scottish Ministers; and the new Marine (Scotland) Act 2010 creates a system of planning, licensing and conservation for Scotland's territorial seas from 0–12 nautical miles offshore (Scottish Government 2010e).

Specific statutory instruments exist in Scotland to regulate recreational hunting activities. The Deer (Scotland) Act 1996 makes it an offence to kill a deer by means other than shooting, stipulates 'closed seasons' for each species of deer (during which they cannot be shot), and regulates the types of ammunition and guns permitted (SNH 2010c). The Deer Commission of Scotland, which recently merged with Scottish Natural Heritage under the Public Services Reform (Scotland) Act 2010, was assigned the role to coordinate action to implement the national strategy for wild deer (Scottish Government 2008). The Environmental Protection (Restriction on Use of Lead Shot) (Scotland) (no.2) Regulations 2004 (SSI No. 2004/358) (Scottish Ministers 2004) differs from legislation in place in England and Wales to restrict the use of lead shot for hunting in that it follows a habitat-based approach (BASC Scotland). In England and Wales, it is illegal to use lead shot on a number of SSSIs, or

to shoot any duck or goose; however, in Scotland, lead shot is permissible as long as shooting does not occur on, or over, Wetlands. This legislation prevents water pollution and the poisoning of waterfowl through lead ingestion.

Due to the increasing popularity and economic importance of angling in the UK as a recreational activity, legislation is in place to maintain sustainable fisheries (Aprahamian *et al.* 2010). In Scotland, fishing rights are private, and 14 Protection Orders under the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003 protect freshwater fish (Scottish Government 2011a). In England and Wales, national and regional rod fishing bylaws are implemented by the Environment Agency and applied to all waters to protect fish stocks and fisheries (EA 2011c). The use of lead sinkers in angling was banned in the UK due to detrimental impacts on mute swans (Cooke & Cowx 2006).

The EU Bathing Water Directives (76/160/EEC and 2006/7/EC) are administered by the relevant Devolved Administrations in the UK to protect the environment and public health from faecal pollution at popular bathing areas (Defra 2010c). As a result of this legislation, great progress has been made in improving the quality of bathing waters at coastal and inland sites, especially in Wales, where 96% of designated sites already meet the more demanding standards of the revised directive (EA 2010a).

27.8.3.3 Policy, institutions and governance (enabling)

The recreation and tourism sector involves a large number of government departments dealing with a broad range of interacting topics which include, among others: environment, sustainability, countryside and landscape, public access, protected areas, coastal issues, forestry, natural heritage, culture, land use strategy, communities, health, landscapes, recreation and sport, transport, climate change, planning, and rural affairs. Much of the work in this sector is devolved to reflect the specific characteristics of recreation and tourism in each country. The Department of Culture, Media and Sport is specifically responsible for supporting the British tourism industry in partnership with VisitBritain which is the national tourism agency responsible for the promotion of Britain globally (DCMS 2010).

The Countryside Recreation Network, covering the UK and the Republic of Ireland, has promoted research, cooperation and the development of best practice regarding countryside recreation since 1968 (CRN 2011). It publishes the journal Countryside Recreation twice yearly, which includes information from professionals in this field. The Tourism Alliance, made up of trade associations and bodies, influences quality standards and policy within the recreation and tourism industry (Tourism Alliance 2010b). It comprises almost 50 Tourism Industry Organisations that together represent some 200,000 businesses of all sizes throughout the UK. In Northern Ireland, the Countryside Access and Activities Network brings together actors with an interest or involvement in outdoor recreation to develop, manage and promote outdoor activities (CAAN 2010).

The institution of protected areas is discussed in the Biodiversity section (Section 27.2) In addition to protecting biodiversity, protected areas are designed to allow people to come into contact with the natural environment. The issue

most relevant to recreation and tourism is the public access afforded under each of these designations. Some protected areas, such as SPAs, prohibit public access during certain periods to protect or prevent disturbance to vulnerable bird species (UK Clearing House Mechanism for Biodiversity 2010). Other areas are designated specifically to actively encourage public access and recreation activities. Country Parks are located near population centres for leisure and recreation opportunities and are not necessarily of nature conservation importance (JNCC 2010a). National Parks are in place for the purpose of promoting public enjoyment while conserving and enhancing these environments. In Scotland, National Parks additionally serve the purpose of promoting the sustainable use of natural resources, and sustainable social and economic development of communities. National Nature Reserves are managed for conservation and provide opportunities for scientific study, while Local Nature Reserves (LNRs) are managed for nature conservation, but are also meant to encourage contact with nature and offer opportunities for research and education. The multitude of designations making up the network of protected areas promotes participation in the natural environment while restricting access to sensitive sites of high conservation value. Additionally, National Trails (England and Wales) and Long Distance Routes (Scotland) link gaps between existing footpaths, bridleways and minor roads to increase the accessibility of landscapes for walking, cycling and horse riding activities (Natural England 2011d; VisitScotland 2011). In England and Wales, there are 2,500 miles (4,000 km) of National Trail (Natural England 2011d).

Since 1945, there has been a growing number of protection schemes to conserve socially valued landscapes (Section 16.2.3). Back in 2000, the government published the Rural White Paper (DETR 2000) which aimed, among other things, to ensure that everyone has the opportunity to enjoy an attractive and accessible countryside. It specifically aimed to increase the number of people from under-represented groups able to access the natural environment, culminating in the Outdoors for All Action Plan (Defra 2008g). Public consultation about the action plan highlighted the need to make policies and services relating to the outdoor recreation sector more coherent.

A Walking and Cycling Action Plan for Wales 2009-2013 (WAG 2008a) intends to change behaviour to encourage more people, young and old, to walk and cycle more often (**Figure 27.47**). Policy objectives to achieve this aim integrate with other strategies of the Welsh Assembly Government including: the Wales Transport Strategy—to promote sustainable travel options; the Wales Climate Change Strategy—highlighting the contribution made through sustainable travel; the Physical Activity Action Plan; and One Wales—which commits to supporting greater participation in walking and cycling. Monitoring of the action plan is performed by the Transport Statistics Branch of the Statistical Directorate, which has found that, although targets have not yet been reached, there has been a significant increase since 2004-05 in the percentage of adults cycling for recreation (Statistics for Wales 2010a). The new Local Transport White Paper—Creating Growth, Cutting Carbon—aims to make travelling on foot, by bike or



Figure 27.47 A group cycling through the countryside for recreational purposes. Image © mega, 2011. Used under license of Shutterstock.com.

on public transport more attractive in England by offering choices that deliver a shift in behaviour towards more sustainable transport (Department for Transport 2011). In Scotland, a range of government policies seek to encourage more people to enjoy the outdoors (SNH 2007). Policy priorities for work until 2011 can be divided into five major categories: paths, access rights, participation, rangers and places (SNH 2010d).

A draft of the UK Marine Policy Statement was published by the Department for Environment, Food and Rural Affairs and the Devolved Administrations for consultation in 2010 (HM Government 2010c). The Marine Policy Statement, which will apply to all UK waters, will provide the framework for making decisions that affect the Marine environment, and for preparing Marine Plans (Section 27.7.3.2; Section 27.7.3.3). It includes consideration of marine tourism and recreation, and stresses the importance of both economic and environmental factors. Consultation responses are currently being analysed, and the UK Government and Devolved Administrations aim to adopt the Marine Policy Statement in 2011 (Defra 2010m). A Coastal Tourism Strategy exists in Wales to sustainably develop the tourism potential of the coastline (VisitWales 2008). It involves cooperation between relevant divisions and departments of the Welsh Assembly Government, and external partners including local authorities, the Countryside Council for Wales, the Environment Agency, the National Trust and the RSPB. Through the Wales Coastal Access Improvement Programme there is a proposal to create an all-Wales coastal path by 2012, and the Environment Agency Wales is aiming for a substantial increase in all water-related recreation, especially recreational fishing (Chapter 20). The Scottish Coastal Forum published A Strategy for Scotland's Coast

and Inshore Waters (Scottish Coastal Forum 2004), which consists of a national strategy for the sustainable use of Scotland's coast, and a vision for the next 25 years. It outlines the need to promote sustainable tourism and responsible recreational use by raising awareness, and identifies the need to find suitable locations for the development of specific activities and the enhancement of visitor experiences. In the UK, there remains a need to limit the acidification of water which leads to widespread ecological damage and consequently reduces opportunities for recreational water use (Section 14.9).

Recent policy has emphasised re-wilding and the planting of native woodland, and grazing and burning regimes have been changed to allow woodland cover to increase (Section 27.5.3.3, Chapter 22). The number of livestock on the Scottish hills has fallen dramatically since 1999, due, in part, to CAP reform which decoupled livestock numbers from payments to farmers (SAC Rural Policy Centre 2008). Alteration of the number of grazing upland livestock impacts landscape character, influencing the aesthetic appeal of this environment and the opportunities for recreational activities such as game shooting (Sections 19.2, 19.4.1).

Planning policy also has an important enabling role to play in the recreation and tourism sector. In England, Planning Policy Guidance 21: Tourism (PPG21) was replaced in 2006 with the Good Practice Guide on Planning for Tourism (DCLG 2006a) which brought together guidance about a number of policies relevant to tourism including Town Centres Planning (PPG6), Countryside and Rural Economy Planning (PPG13), Transport Planning (PPG13), and Green Belt Planning (PPG2) (DCLG 2006b). The guide outlines the vital role that the planning system plays in facilitating the development and improvement of tourism

in England. For example, Green Belt Policy (PPG2; ODPM 2006) safeguards the countryside by protecting open land from urban sprawl and directly relates to other mechanisms, including landscape, countryside and nature conservation, sustainable transport, open space, green networks, and access, which all have important implications for recreation and tourism. In Scotland, the Scottish Planning Policy (SPP; Scottish Government 2010c) identifies the tourism industry as one of Scotland's largest business sectors, and covers policy which impacts tourism such as: rural development, coastal planning, historic environment, landscape and natural heritage, renewable energy, and transport. Planning policy for open space, sport and outdoor recreation (PPS8; The Planning Service 2004) facilitates appropriate recreational activities in the countryside of Northern Ireland through policy to: safeguard open spaces, ensure access to these spaces and to sporting facilities by all sections of society, and ensure provision of new spaces and facilities.

Much has been said up to this point about the responses adopted by government, but NGOs and charities also have an important role as actors in the recreation and tourism sector. These organisations have a long history of involvement with the public to encourage collaboration and responsible participation in the natural environment. Many of the organisations devoted to conserving habitats and species in the UK also campaign for increased participation in outdoor activities in the natural environment. One example is the National Trust: with more than 3.7 million members, it actively encourages people to visit and enjoy the natural environment through its website and publications (National Trust 2010). Other organisations are devoted entirely to recreation in the natural environment (**Box 27.38**). The Ramblers Association, Britain's largest walking charity, has evolved over the last 75 years into a vocal advocate of outdoor recreation. It is made up of 125,000 members across Britain, "working to safeguard the footpaths, the countryside and other places we go walking, and to encourage more people to take up walking" (Ramblers 2010).

The role of businesses within the tourism sector is significant as there are currently 146,000 businesses in the hospitality, leisure, travel and tourism industry in GB, employing 1,887,700 people (7% of all UK jobs) and accounting for 4.5% of the UK's total economic output (People 1st 2010). One example of a response by businesses to reduce impacts on the environment is the Green Tourism Business Scheme: a certification scheme for energy and water efficiency, waste management and biodiversity (The Green Tourism Business Scheme 2011). The tourism sector includes 14 industries: visitor attractions, holiday parks, events, restaurants, contract food service, membership clubs, pubs, bars and nightclubs, self-catering accommodation, gambling, tourist services, travel services, hotels, hostels, and hospitality services (People 1st 2010). Businesses in this sector continue to recover from the recession, and it is possible that they will play an even more important role in responding to the challenges of ecologically sustainable tourism in the future.

27.8.3.4 Changing social attitudes (enabling)

It is important to understand the individual behaviours and aggregated social categories which influence decision-

Box 27.38 Sustrans and the delivery of smarter travel choices. Source: Sustrans (2010a,b,c).

Sustrans is a leading UK charity that influences changes in travel behaviour and shapes policy to make smarter travel choices possible. The charity employs more than 400 full- and part-time staff, and has over 3,000 volunteers working across the UK.

In 1995, Sustrans began work on the National Cycle Network which now extends 12,600 miles and comes within one mile of 57% of the UK's population. Sustrans has been monitoring progress since 2000 and, in 2009, it found that:

- the network was used by 1.5 million cyclists and 1.6 million pedestrians;
- nearly one quarter of all journeys made on the network (95 million) were commuting trips;
- 79% of trips were made by foot or bike alone, emitting zero carbon;
- 42% of users got at least 30 minutes of physical activity at least five days a week;
- 10% of trips were made by people over the age of 65, 17% of users described themselves as black or minority ethnic, and women users increased by 8%.

It is the only national transport network in the UK "with no obligations by government to support it, develop it or maintain it, either at a local or national level" (Sustrans 2010b, p.6). Public transport information was distributed to 40,000 households, resulting in a reduction of car use between 460–875 miles per household per year. In monetary terms, the health benefits from the network equate to £288 million from cycling trips and £96 million from walking trips, and potential carbon savings are worth an additional £32 million.

"The Network is a catalyst proving that when you create the right environment for people of all ages and abilities to walk and cycle, people will use it, and will often choose to leave their car behind" (Sustrans 2010b, p.6).

making about the environment (Section 16.1.3). As declared in Chapter 16, "one notable characteristic of the UK is the depth and breadth of our cultural engagement with nature and wildlife which continues to flourish despite the blandishment of contemporary consumer culture.". The trend of decreasing opportunities for aesthetic experiences with socially valued landscapes during the post-war period led to the creation of parks, AONBs, Landscape Character Assessments, and coastal and marine protection.

Evidence for increased enthusiasm about the environment is demonstrated by the popularity of nature television programmes, growing membership of societies involved with landscape and nature interests, and the high numbers of people utilising Urban parks, greenspaces and allotment gardens (**Box 27.39**; Section 27.9.3.6) on a regular basis. The media plays an important role in influencing people's interest in recreational pursuits. The BBC's Springwatch and Autumnwatch are examples of popular television programmes which encourage wildlife-watching and direct engagement with the natural environment. The extent of local community participation through informal residents' networks and associations is also substantial.

Public Attitudes and Behaviours Towards the Environment is a survey that was conducted by the Department for Environment, Food and Rural Affairs (Defra 2009a). It found that 80% of respondents worry about changes to the countryside in the UK and loss of native animals and plants, while 67% actively encourage wildlife in their garden. Interestingly, the number of respondents who said that they used public gardens, parks, commons and other greenspaces at least once a week decreased slightly between 2007 and 2009 from 54% to 48%, respectively; however, local greenspaces are evidently of considerable importance

Box 27.39 Allotment gardening as a recreational activity.

Allotment gardening is one of the only recreational activities to have specific legislation. Benefits from this activity include low-cost physical exercise, community involvement and direct access to fresh produce (Scottish Parliamentary Corporate Body 2000; **Figure 27.48**). Allotment gardens can also provide regulating services and support biodiversity.

The legislative basis for allotment gardening in Scotland is the Allotment (Scotland) Act 1982, as amended by the Land Settlement (Scotland) Act 1919 and the Allotment (Scotland) Acts of 1922 and 1950. The Allotments Act (Northern Ireland) 1932 remains in place in Northern Ireland, while in England and Wales, the Small Holdings and Allotments Act 1908 was followed by Allotments Acts 1922, 1925 and 1950.

The resurgence of interest in allotments has sparked policy development in this area. As part of the National Food and Drink Policy, the Scottish Government has committed to providing more support for 'grow your own' initiatives (Scottish Government 2010f). According to the same source there are approximately 3,000 people on allotment waiting lists in Scotland. Growing in the Community: a good practice guide for the management of allotments (Local Government Association 2006) provides guidance for allotment officers and societies and Planning Policy Guidance 17 (ODPM 2002) "encourages local authorities to undertake robust assessments of the need for different forms of open space" (Wiltshire 2010). The same reference estimates that 76,300 names were on allotment waiting lists in England in 2009.

In the UK, local authorities are typically responsible for providing a sufficient number of allotment plots to meet demand in their area (Campaign for More Allotments 2010). Wiltshire (2010) recommends that management of current allotment sites could be improved through: re-definition of non-cultivation, adjustment of plot sizes to accommodate more gardeners, fair and efficient management of waiting lists, and support to devolved management associations to adopt good practices.

Numerous funds and societies exist to support allotment gardening. The National Society of Allotment & Leisure Gardeners is the recognised national body for the allotment movement in the UK (National Society of Allotment & Leisure Gardeners Limited 2010). The Society offers information and advice concerning allotment leases, rental agreements and consultations with local authorities and government offices. The Allotments Regeneration Initiative (ARI 2010) is a project that was launched in 2002 to support and develop allotment regeneration and support the creation of new allotment sites in the UK. It is funded by the Big Lottery Fund, Department for Communities and Local Government, and the Fund for the Environment and Urban Life.



Figure 27.48 An allotment garden filled with flowers and vegetables. Image © joingate, 2011. Used under license of Shutterstock.com.

in the UK. The English public recently demonstrated their concern for the future of the Public Forest Estate during consultations about the proposed change of management of lands controlled by the Forestry Commission (Defra 2011b). The Public Opinion of Forestry Survey showed that an increasing proportion of respondents said that they had visited woodland between 2005 and 2009 for walks, picnics or other recreation; Scotland was an exception to this rule, showing a large decrease in woodland visits during the same period (Forestry Commission 2010a). Visits to the seaside make up 5% of all leisure visits in the UK (4% in England, 9% in Scotland and 12% in Wales) (Natural England 2003), and an increasing proportion of trips away from home involve wildlife-watching or nature study (Chapter 12).

Key trends since 2004 include an increase in the number of shorter duration visits made closer to home, a greater proportion of visits taken on foot, and a decrease in visits taken by car (Section 16.2.1). Nonetheless, car travel is still a prominent means of travel for recreation. In England, the car was the main form of transport for 59% of trips, and was used for 78% of trips to National Parks (typically, longer distance trips) (Research International Ltd. 2006). A more recent survey found that 31% of visits to the natural environment in England were made by car or van (Natural England 2010d). While the mobility of the urban population has increased, in the future, infrastructural access to the countryside may be less important as improvements in information and communication technology increase and

restrictions on car use come into force (Foresight 2010). Some people have begun to adopt "new approaches to lifestyle based on a creative (re)connection with the land and environment in a positive, productive way." (Chapter 16). This may indicate a greater connection to local ecosystems.

The link between health and proximity to natural environments as a catalyst for healthy behaviour continues to be strengthened as the body of empirical evidence grows (Chapter 22). The average time spent walking or cycling for travel purposes in the UK decreased between 1995 and 2007 (National Statistics 2010). We are living more sedentary lives than we used to; overall, energy expenditure has dropped by 800kcal/day between 1945 and 1995 (Section 16.3.3.1). There has also been a trend towards a substantial loss of direct contact with nature in deprived areas in the UK. For these reasons, increased attention is being given to the physical and mental health benefits of being outdoors and being in contact with nature. There is considerable participation in outdoor sports, the most popular of which are swimming, cycling and golf (Section 16.3.2). The Scottish uplands are highly regarded as a landscape for many recreational activities including: hiking, biking, climbing, skiing, camping, nature-watching, fishing and hunting (Section 19.4.1). The future of game hunting is highly dependent on social attitudes towards these activities (Chapter 16). If negative attitudes were to develop, it would be difficult to justify large public spending for game management.

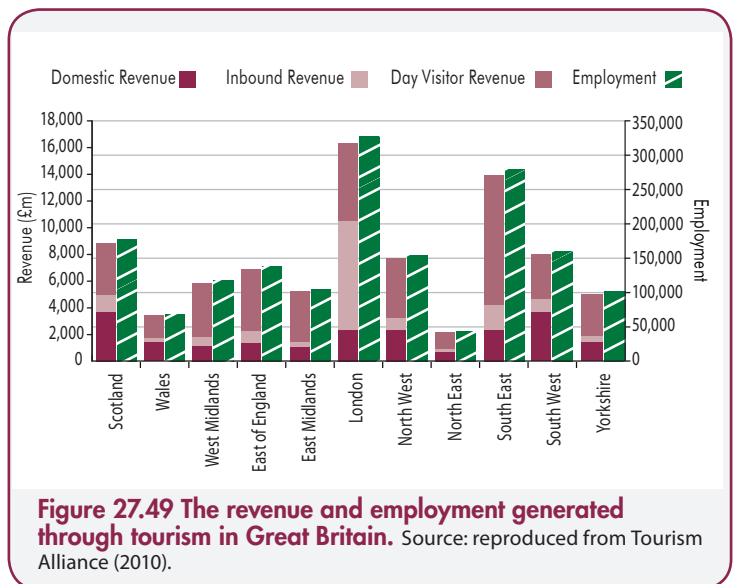
27.8.3.5 Markets and incentives (instrumental)

“Most tourism in the UK is domestic. British residents take well over 1 bn overnight trips and day visits each year (an average of 17 per person). This travel results in the circulation of over £67 bn around the UK economy, with much of that expenditure being redistributed from large towns and cities to rural and seaside communities” (Tourism Alliance 2010a).

The devastating outbreak of Foot and Mouth Disease in 2001 “showed how the economic benefits of the countryside were more dependent on tourism and recreation than had been previously realized.” (Chapter 16). The recreation and tourism sector is an important source of income, employment and economic activity, especially in rural areas (**Figure 27.49**). Although only three in ten visits to the natural environment in England were shown to involve expenditure (Natural England 2010d), large sums are spent on specialist recreation activities such as game shooting, angling, birdwatching, sailing, kayaking, etc. In Scotland, for example, all forms of wildlife-watching tourism are estimated to generate 7,446 jobs and £156 million in income (Chapter 12). A survey of marine and coastal recreation in Scotland found that the greatest proportion of spending was close to home versus on the web or close to the coast (LUC 2006). In England, leisure visits to the countryside account for £9.4 billion being spent in the countryside, £1.4 billion spent in seaside coast, £400 million spent in National Parks, and £200 million spent in open access land (CRC 2010).

Although incentive schemes are not as commonly utilised as instruments in this sector as they are in others, examples do exist, and indirect impacts from other payment schemes also affect recreation and tourism. As mentioned previously, the CAP single payment schemes impact tourism by altering livestock density and landscape character. Specialist grant schemes to support conservation activities, which have increased 1,000% from 1992 to the mid-2000s, encourage protection of habitats and species that attract visitors and improve the aesthetic, spiritual and inspirational values of outdoor recreation and tourism (Section 3.1). One example of a grant scheme designed specifically to incentivise tourism-based enhancements to LNRs is the Wildspace! scheme (**Box 27.40**) Access to Nature, funded by Natural England and the Big Lottery Fund’s Changing Spaces Programme, is also a popular, £28.75 million grant scheme that financially supports projects encouraging people from all backgrounds to understand, access and enjoy the natural environment (Natural England 2010a). It aims to have benefited 1.7 million people from urban, rural and coastal communities by 2014. Another grant scheme is Splash—the water recreation challenge fund for Wales (EA 2010f). In this scheme, the Welsh Assembly Government offers up to 100% grants to projects which improve public access to lakes, waterways, reservoirs and coastal areas to promote recreational and educational activities.

Certification schemes acting to improve standards can also add value to recreation and tourism services. One example is the WiSe (Wildlife Safe) Scheme which aims to promote responsible marine wildlife-watching through training, accreditation and awareness-raising (WiSe Scheme 2011). The development of marine wildlife-based tourism



can generate income for coastal communities, and act as alternative sources of income for fishers and private and commercial boat owners (Dobson 2008).

27.8.3.6 Voluntary actions and technology (instrumental)

There are a large number of voluntary codes of practice and conduct that exist to promote responsible recreation in the natural environment. Countryside codes are non-statutory mechanisms which provide guidance for responsible recreation and tourism in the countryside. The Countryside Code in England and Wales helps members of the public “respect, protect, and enjoy the countryside” (Natural England 2010f). The Code also provides guidance to land managers about how to encourage visitors to act responsibly, and to know their rights. The Scottish Outdoor Access Code provides detailed guidance about the responsibilities of those exercising their access rights (Scottish Outdoor Access Code 2010). This code, which has been approved by Ministers and the Scottish Parliament, is based on three key principles: respect the interests of other people, care for the environment, and take responsibility for your own actions. The Countryside Code in Northern Ireland provides advice on how to enjoy visits to the countryside while helping to protect it (NIDirect Government Services 2010). These Codes act as an important practical means to create public awareness about the access rights contained in the Land Reform (Scotland) Act 2003, the Countryside and Rights of Way Act 2000 and the Access to the Countryside (Northern Ireland) Order 1983.

The Accessible Natural Greenspace Standard (ANGSt) is a tool produced by Natural England to assess levels of accessible natural greenspace, and to plan for better provision (Natural England 2010e). It was initially developed in the early 1990s, and was subsequently reviewed in 2008. The underlying principles of the standard are: to improve access to greenspaces, to improve naturalness of green spaces, and to improve connectivity with greenspaces. Specifically (Natural England 2010e):

“ANGSt recommends that everyone, wherever they live, should have an accessible natural greenspace:

Box 27.40. The Wildspace! grant scheme. Source: Natural England (2006a); Natural England (2006b).

With funding from the Big Lottery Fund, English Nature (now Natural England) launched the Wildspace! initiative in England back in 2001. By mid-2006, 169 grants totalling £7 million had been distributed to Wildlife Trusts, charitable groups and local authorities to support work on Local Nature Reserves (LNRs), with a particular focus on disadvantaged areas lacking access to natural open space (Table 27.20).

In terms of the social benefits perceived to be gained from LNR designation, 60% of surveyed grantees identified “greater awareness and understanding; opportunities for education, learning, training and developing skills, and increased interest” as the most important (Figure 27.50). In addition, 94% of grantee respondents agreed that projects had made LNRs safe, accessible and enjoyable places to visit.

The evaluation concluded that the Wildspace! scheme was a success not only at reaching its targets, but also in realising wider social and environmental gains. A valuable recommendation for future schemes was to extend the life of revenue support targeting ‘hard-to-reach’ communities because these areas were more time consuming to engage due to low levels of initial interest and awareness. The evaluation also recommended that reporting requirements be reduced to harbour trust, and that a tapering of the period of revenue grants could allow local authorities to find necessary additional funding to sustain posts.



Figure 27.50 The Wildspace! grant scheme provided opportunities for environmental education and learning in Local Nature Reserves. Photo © Natural England (2006a).

Table 27.20 The aims, targets and outcomes of the Wildspace! grant scheme. Source: information from Natural England (2006a).

Aims	Targets	Outcomes
To increase the number of Local Nature Reserves (LNRs) in England.	Create 200 new LNRs over the lifetime of the scheme.	As a result of the grant, 230 new LNRs were designated.
To realise the potential of LNRs for wildlife and the community by enhancing the quality of experience for users.	To give grants towards the ‘visitor friendly’ enhancement of two LNRs per region that can be used as examples of best practice from which others will learn.	Two sites in each of the nine English regions were enhanced as exemplars of ‘visitor friendly’ LNRs.
To enable the employment of Community Liaison Officers to facilitate community participation in the management and development of LNRs.	To give grants towards the employment of 46 Community Liaison Officers throughout the life of the scheme.	Grants were awarded for the employment of 89 Community Liaison Officers, almost twice the number first envisaged. Of these, 63 were employed by local authorities and 26 by a mixture of conservation groups and other organisations.
To promote the use of LNRs for environmental education.	To give grants towards the development of two LNRs per region as centres of excellence for environmental education from which others will learn.	Two sites in each of the nine Regions were developed as centres of excellence for environmental education.

- Of at least 2 hectares in size, no more than 300 metres (5 minutes walk) from home;
- At least one accessible 20 hectares site within two kilometres of home;
- One accessible 100 hectare site within five kilometres of home; and
- One accessible 500 hectare site within ten kilometres of home; plus
- A minimum of one hectare of statutory Local Nature Reserves per thousand population.”

Since the review, the standard also aims to identify appropriate delivery of tools and partners, and to “collect information on the role of accessible natural greenspace in improving quality of life and reducing negative impacts of climate change” (*ibid.*, p.19). Natural England has also developed Visitor Service Standards to encourage excellence in terms of both recreation and nature conservation at three levels: NNRs, Country Parks and LNRs. Greenspace quality standards apply criteria that ensure these spaces reach their full potential. In 2009, Natural England also launched the Country Parks Accreditation Scheme which

identifies and officially recognises sites delivering the core facilities and services expected of a Country Park (Natural England 2011a).

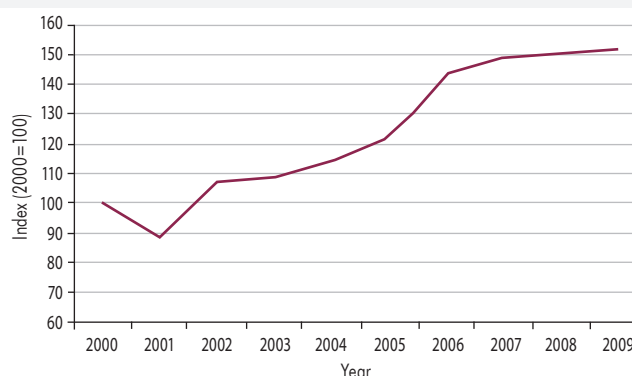
The Green Flag Awards scheme has become the benchmark of excellence for recreational green areas in the UK (Keep Britain Tidy 2010; Section 27.9.3.4). The scheme, which was initiated in 1996, judges applicants against eight criteria: a welcoming place; healthy, safe and secure; clean and well-maintained; sustainability; conservation and heritage; community involvement; marketing; and management. The scheme was piloted in parts of Scotland in 2007, after which, it was evaluated by Greenspace Scotland (Gibb 2008). It was found that working towards the Green Flag criteria helped green areas to make improvements at site level and in management approaches, in interdepartmental working, and in raising awareness. Additionally, it was determined that the award had the potential to influence greenspace planning and investment. Following this evaluation, the Green Flag Awards scheme was extended to the rest of Scotland.

The Best of Both Worlds is a management approach designed with the aim of improving and increasing

opportunities for outdoor sports and recreation in ways that respect and safeguard natural and cultural heritage (BoBW n.d.). The approach promotes the use of tools like codes of good management practice, management agreements or consents, and permit arrangement systems. There exist a number of documented case studies of how the Best of Both Worlds' principles have successfully resolved conflicts and led to collaboration between conservationists and recreationalists with regards to the use of a variety of habitats for a number of different activities taking place on land, in the water and in the air (*ibid.*).

There is evidence to support an increase in the number of people engaging with the natural environment through volunteering (**Figure 27.51**). This trend is "important for the protection, management and enhancement of habitats and ecosystems, for the delivery of policies, and it is likely to improve the volunteers' sense of well-being" (CRC 2010, p.172). In 2009, BTCV worked with more than 620,000 volunteers to improve the environment (BTCV 2010), and it aims to actively support a total of 1.5 million people to take part in environmental action by 2013 (BTCV 2009). The National Trust currently has more than 52,000 volunteers (National Trust 2011) and The Wildlife Trusts have over 35,000 volunteers (The Wildlife Trusts 2011).

Footpaths are used in the recreation and tourism sector to minimise the impact visitors have on the natural environment (**Box 27.41**). A more recent technological



* Where possible organisations have used records of actual volunteer hours, or where this is unavailable, volunteer numbers along with an estimate of hours per volunteer.

† The decline in volunteer hours seen in 2001 was a real effect caused by the Foot and Mouth outbreak that year.

‡ Defra estimates have been used in the index calculation for Woodland Trust (2000 and 2001), Butterfly Conservation (2000 to 2002), and the Wildlife Trusts (2000 to 2004).

¶ As data provided by the Royal Society for the Protection of Birds (RSPB) were for financial years as opposed to calendar years, 2008–2009 data were allocated to 2008 and Defra estimates were made for 2009.

Figure 27.51 Index of conservation volunteering in the UK from 2000 to 2008[†]. Source: data from Bat Conservation Trust, British Trust for Conservation Volunteers, British Trust for Ornithology, Butterfly Conservation[‡], Natural England, Plantlife, Royal Society for the Protection of Birds[¶], The Wildlife Trust[‡], Woodland Trust[‡], Defra (2010k).

Box 27.41 Use of the Pennine Way footpath to minimise recreational disturbance of the golden plover (*Pluvialis apricaria*). Source: Finney *et al.* (2005).

Legislation and policy has drastically increased access to the countryside for recreational purposes. In turn, this has fuelled concern for the conservation of wildlife that faces increased human disturbance. Human presence can illicit defensive behaviour in animals and can increase the risk of predation. This is especially true for ground-nesting birds such as the golden plover (**Figure 27.52**)—a priority species for conservation.

A study by Finney *et al.* (2005) assessed the effect of recreational disturbance on the reproductive performance and breeding distribution of the golden plover along the Pennine Way long-distance

footpath in the Peak District National Park. A fence was erected along the edge of the road, and a 4-km section of the path was paved with flagstones in 1993–1994 (**Figure 27.53a**). This significantly affected the behaviour of hikers, reducing the proportion of people who strayed from the path from 30% to just 4% after the resurfacing of the path.

Before the path was resurfaced, golden plovers were found to be 54% less likely to occupy areas within 200 m of the path on weekends during the chick-rearing period due to recreational disturbance. After the Pennine Way was resurfaced, golden plovers were only 24% less likely to occupy areas within 50 m of the path during weekends, and during the week they were not found to avoid areas near the footpath at all, despite the number of visitors doubling after the path was improved. In other words, 96% of walkers stayed on the path after it was resurfaced, allowing the birds to exploit habitat closer to the footpath.

Under the Countryside and Rights of Way Act, people have the right to freely access mapped open access areas; this could have adverse impacts on breeding populations of golden plover, and other upland waders. The results from this study demonstrate how simple technology, such as flagstone footpaths (**Figure 27.53b**) and fencing, can significantly minimise the negative impacts of recreation by altering visitor behaviour.



Figure 27.52 Golden plover (*Pluvialis apricaria*). Image © Leksele, 2011. Used under license of Shutterstock.com.

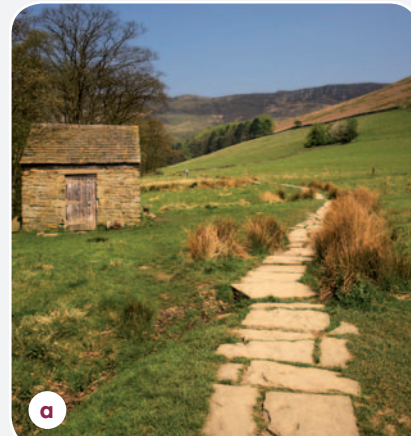


Figure 27.53 a) The Pennine Way long-distance footpath; b) Type of footpath at Arthur's Seat, Edinburgh.

Source: a) image © David Hughes, 2011. Used under license of Shutterstock.com; b) photo courtesy of Lindsey Elliott.

development is the use of pervasive computing to support mass engagement environmental campaigns. Pervasive, or ubiquitous, computing describes the integration of information processing capabilities into everyday objects. The UK Participate project, which began in 2006, brings together industry and academic actors to “collectively explore how the convergence of mobile, online and broadcast media can enable a broad cross-section of the public to contribute to, as well as access, environmental information—on the move, in public places, at school and at home” (Paxton 2008). The schools strand of the project involves the BBC, ScienceScope, BT, the University of Nottingham and the University of Bath to determine how primary and secondary schools in the UK can be supported to collect environmental data and to share their outcomes via the internet (Participate 2011). Social networking sites and new media technologies provide novel opportunities to engage the public with nature.

A final example is the potential use of market segmentation technology to identify the specific needs, requirements and preferences of various groups to enable efforts to focus on making the natural environment more interesting, accessible and relevant. A research project entitled Understanding What People Want from the Natural Environment using Customer Segmentation is currently being run by the Department for Environment, Food and Rural Affairs, Natural England, the Forestry Commission, the Environment Agency and British Waterways to develop a segmentation model.

27.8.4 Recreation and Tourism Summary

Table 27.21 summarises the key insights from this review of responses in the context of recreation and tourism, highlighting those that have been well-established, but also identifying a set of responses that are either in early implementation or are proposed. It is important to learn from these early pilots across all sectors to scale-up the adoption of an integrated ecosystem approach to the management of the UK’s diverse habitats, which is one key policy direction that this review recommends.

27.9 Urban Planning, Transport and Energy

27.9.1 Urban Planning, Transport and Energy and Ecosystem Services and Human Well-being

Urban ecosystems deliver essential services which have an important, yet undervalued, impact on human well-being. Towns and cities are dependent on ecosystems beyond their boundaries for food, products and other goods and services, but also benefit from a range of local services such as air

Table 27.21 Recreation and Tourism Summary.

	Established responses	Early implementation, pilots	Proposed, under development
Knowledge	<ul style="list-style-type: none"> Numerous established surveys such as UK Countryside Survey, Countryside Quality Counts and The Scottish Recreation Survey 	<ul style="list-style-type: none"> Monitor of Engagement with the Natural Environment The Welsh Outdoor Recreation Survey A Review of Marine and Coastal Recreation in Scotland Research about environmental inequality & transport disadvantage 	<ul style="list-style-type: none"> Green exercise, physical and mental benefits of outdoor recreation Research about public attitudes and values relation to recreation
Legislation	<ul style="list-style-type: none"> National Parks and Access to the Countryside Acts Countryside and Rights of Way Act Land Reform (Scotland) Act 2003 Access to the Countryside (Northern Ireland) Order 	<ul style="list-style-type: none"> Marine and Coastal Access Act Marine (Scotland) Act 	
Policies, institutions and governance	<ul style="list-style-type: none"> Countryside Recreation Network Tourism Alliance The Countryside Access and Activities Network in Northern Ireland Institution of Protected Areas Outdoors for All Action Plan A Strategy for Scotland’s Coast and Inshore Waters 	<ul style="list-style-type: none"> A Walking and Cycling Action Plan For Wales 2009–2013 Transport Strategies Climate Change Strategies Coastal Tourism Strategy Good Practice Guide on Planning for Tourism Sustrans National Cycle Network 	<ul style="list-style-type: none"> UK Marine Policy Statement
Changing social attitudes	<ul style="list-style-type: none"> Nature television programming (e.g. BBC’s Springwatch) Public Attitudes and Behaviours Towards the Environment Public Opinion of Forestry Survey 	<ul style="list-style-type: none"> The Allotments Regeneration Initiative 	
Markets and incentives	<ul style="list-style-type: none"> Wildspace! Grant Scheme 	<ul style="list-style-type: none"> Wildlife Safe (WiSe) Scheme Splash – water recreation challenge fund for Wales 	
Voluntary actions and Technology	<ul style="list-style-type: none"> Countryside Codes Green Flag Awards scheme British Trust for Conservation Volunteers Pennine Way footpath 	<ul style="list-style-type: none"> Accessible Natural Greenspace Standard (ANGSt) – reviewed Country Parks Accreditation Scheme The Best of Both Worlds (BoBW) management approach 	<ul style="list-style-type: none"> Market segmentation technology

filtration, micro-climate regulation, noise reduction, flood regulation, and recreational, cultural and health-related benefits. Perhaps most importantly, greenspace (parks, playing fields, gardens, allotments, etc.) has been found to be beneficial for mental and physical health (Chapter 10; Section 27.5.3.4; **Figure 27.54**). The potential to increase the provision of Urban ecosystem services is substantial—largely because, in the past, the spatial planning system did not reflect their value appropriately, compared to other factors, when making planning decisions.

To date, most supporting and regulating services in Urban habitats have been constrained, with little realisation of the consequences. Urban soils, for example, regulate flooding by storing and slowing water down, but development and infrastructure have compacted and sealed them, thus increasing flood risk. Vegetation in cities and towns can contribute to climate change adaptation and mitigation by regulating temperatures and absorbing carbon dioxide. Urban environments support biodiversity and can be understood and managed as a distinct and valuable habitat type (**Box 27.5**, Section 27.2.3.4; Section 27.7.3.4). The impacts and demands created by urban living need to be analysed in relation to the potential impacts of that number of people if they were not concentrated in an urban area (Newman 2006). Urban areas have considerable ecological footprints, however, drawing on vast quantities of resources and energy from outside their limits—hence, cities have become a major driver of environmental change (Rees 2001). So urban areas both mitigate and generate the demographic pressures that human numbers and urban lifestyles impose on the environments from which they import ecosystem services.

According to the Department for Transport (TfL 2008), demand for air travel continues to grow rapidly and car use remains high. While the number of passengers travelling by bus has risen over the last decade in some regions, such as London, and rail travel has increased by 70% since the 1980s, walking and cycling has declined significantly (Section 27.8.3.4). These transport trends affect ecosystems and people's relationship with nature. Firstly, while transportation networks allow people to access the countryside and seaside for recreation and tourism,

conversion of land to accommodate the expansion of transport infrastructure effects biodiversity and fragments habitats, and can adversely impact the aesthetic and cultural values of landscapes (Section 27.8). Secondly, transport is a significant source of air pollution and greenhouse gas emissions, which indirectly affect ecosystems in the UK, the latter through climate change. Lastly, the travel choices people make effect the level of interaction people have with nature with implications for health and well-being.

Energy underpins our society and economy. It heats our homes, powers our transport systems, produces the food we eat, and is used to make every product we buy. It is essential for our quality of life. The majority of our energy is derived from the burning of fossil fuels. In the 1970s, the UK became increasingly dependent on imports of fossil fuels, with domestic production accounting for less than half of the total primary energy consumption (Foresight 2010). Since the 1970s, energy demand has been met by imports, the construction of nuclear power stations, and the exploitation of North Sea gas and oil reserves to fuel gas and oil power stations. More recently, policy is shifting towards supporting a wider portfolio of energy sources, including renewable energy.

The impact of fossil fuel energy production on the global climate is well-established (IPCC 2007). Climate change is expected to become a major driver of change for UK ecosystems, and their ability to provide services, this century (Chapter 25). Reducing demand for energy, and switching to alternative low carbon sources of energy, will be required to mitigate climate change. Decarbonising the UK economy would contribute to the protection of ecosystems both globally and domestically, and help avoid irreversible change that would undermine essential ecosystem services that we depend on for our well-being. In this section, however, we focus on responses to the immediate impacts of the energy sector on ecosystem services and human well-being through, for example, habitat loss, visual intrusion, and air and water pollution.

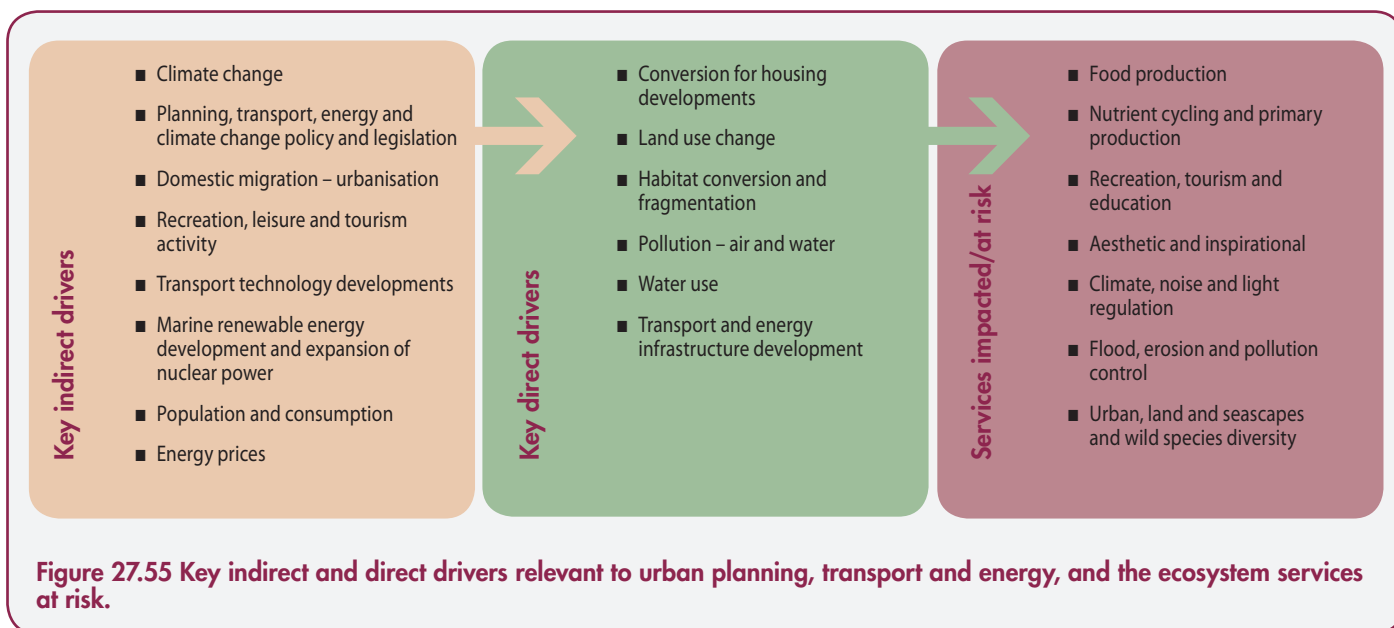
In the past, fossil fuel combustion has had major impacts on health through emissions of sulphur dioxide and particulate matter. The introduction of legislation and technologies have reduced air pollutants from power stations and transportation, although exhaust fumes from vehicles still have substantial health impacts (RCEP 2007). Although the development of renewable energies is likely to play a vital role in climate change mitigation, it will have a predominantly localised impact on the environment. The planned expansion of renewable energy production (including biofuel crops, off- and onshore windfarms, and tidal and hydropower) is likely to have local implications for ecosystems in the UK in the near future. Nevertheless, given the importance of decarbonising energy supplies in the longer-term, it will be necessary to consider and minimise the impacts on ecosystem services of renewables and all the low carbon energy options.



Figure 27.54 Parks are important for good mental and physical health. Photo: Holyrood Park, Edinburgh, courtesy of Lindsey Elliott.

27.9.2 Challenges to Urban Planning, Transport and Energy Development

Figure 27.55 summarises the major urban planning, transport and energy-related direct and indirect drivers



and their impact on ecosystem services. The challenges discussed here are in relation to maximising the potential of Urban ecosystems to provide services, rather than global environmental sustainability, including the decarbonisation of cities.

Bolund and Hunhammar (1999) argue that consideration of ecosystem services needs to be integral to land use planning given the potential of Urban ecosystems to improve quality of life. Monitoring of Urban ecosystems is weak, preventing the quantification of ecosystem goods and services. Without such information it will be difficult for the true potential of these habitats to be recognised in decision-making processes (Chapter 10). One reason for this lacuna is that cultural services, which are arguably one of the most important types of Urban ecosystem service, are intangible and are linked to human perceptions, cultural values, norms and behaviours that resist quantification (Price 2008).

The lack of value placed on greenspace in planning processes and inadequate funding for maintenance has, until the 2000s, progressively decreased the amount and quality of greenspace in towns and cities. For example, around 10,000 playing fields were lost in the UK between 1979 and 1997 (DCMS 2009). In recent years, local authorities and community groups have rejuvenated many greenspaces across the country. Ensuring these improvements are maintained and continued in the coming years will be challenging for budget-constrained authorities. Local authorities are also under increasing pressure to increase the UK's housing stock. At the same time, there is a growing recognition of the importance of Urban ecosystems for human well-being. Planners are likely to be required to design cities that can cater for both of these objectives.

It is widely accepted that current transport trends cannot be maintained without harming the natural environment and human well-being. The further expansion of transport infrastructure will cause the additional loss and fragmentation of habitats and culturally valued landscapes, while increases in road and air traffic will exacerbate light, noise and air pollution levels. It is well-established that air pollution causes significant impacts to the natural

environment, not least through acidification. Air pollution reduces the life expectancy of every person in the UK by an average of six months, with equivalent health costs of up to £19 billion a year (Defra 2011a). Furthermore, noise pollution can have deleterious effects on health, work productivity and happiness. Pockets of tranquillity, such as parks, are likely to increase in value in this context (**Box 27.42**, Section 27.9.3.2), while sustainable solutions to transport, both through demand management and encouraging modal shift, would reduce air and noise pollution.

The concept of urban heat islands, where an urban area is warmer than its surrounding rural areas, is well-established. Preparing cities for the expected increases in temperature, and the duration, frequency and maxima of heatwaves associated with climate change, is a priority for urban planners. Urban ecosystems can play a significant role in climate change adaptation in cities and towns. Securing these opportunities, as well as those for climate change

Box 27.42 Quiet Areas. Source: POST (2009).

The Environmental Noise Directive requires Member States to identify and aim to preserve 'Quiet Areas'. Quiet Areas are understood to be important for well-being in urban areas, reducing annoyance and stress. A recent survey by Environmental Protection UK found that 91% of people think that it is important to protect Quiet Areas from an increase in noise.

In the first round of Noise Action Plans, the Environmental Noise Directive requires Member States to identify Quiet Areas in large urban areas. Eventually, it is expected that Quiet Areas in open country will also be designated. Scotland began with parks and national heritage sites and then selected candidate sites based on a set of criteria including land type, noise level and area. Wales asked local authorities to identify quiet open spaces that are of importance to the local community. Their list includes parks, playing fields, allotments and cemeteries, reflecting the fact that many different types of open space may be valued for their quietness. England and Northern Ireland intend to adopt an approach similar to Wales. The consequences of designating an urban site as a Quiet Area, and how this fits in with the other government policies, such as the aim to deliver greener public spaces, are not yet clear.

mitigation, against a background of increasing competition for land will be challenging.

The challenge for the energy sector is finding ways to produce more energy from low carbon sources without undermining the flows of ecosystem services. According to the Department of Energy and Climate Change, a quarter of the UK's electricity generation will need to be replaced in the next decade as many nuclear and coal-fired power stations are decommissioned. Furthermore, the EU Renewable Energy Directive requires the UK to source 15% of its energy from renewables by 2020 (Foresight 2010); Section 27.9.3.2). Switching to renewable energy is an essential component of the UK's efforts in tackling climate change. However, many renewable energy projects do have impacts on the environment and may be publicly opposed. The construction of windfarms and transmission lines to convey energy from remote, windy areas has been met with stout resistance from local residents due to the visual intrusion and noise produced from turbines (Devine Wright 2005); Section 27.9.3.4). For example, the upgrading of a key transmission line for renewables in Scotland attracted 18,000 objections in the Beaully-Denny planning inquiry (BBC 2010).

27.9.3 Response Options for Urban Planning, Transport, and Energy

27.9.3.1 Knowledge (foundational)

In the past, research has predominantly focused on understanding the impact of urban areas on distant ecosystems that are essential for global sustainability. Research is now emerging from several disciplines on the importance of local ecosystems for the quality of life of urban dwellers. To date, this has focused on valuing the economic (benefits and savings), social-ecological (e.g. resilience), psychological (well-being), cultural (e.g. inspiration) and health benefits provided by Urban ecosystems.

Many urban local authorities have mapped their network of public greenspaces as part of developing Greenspace Strategies (**Box 27.43**), and have an understanding of the benefits they provide (CABE 2010a). Scottish Heritage has used maps of greenspace based on aerial photographs to plan habitat networks and recreation areas (Section 10.5.3). Mapping tools may also be useful for understanding the links between ecosystem character, ecosystem connectivity and ecosystem services that people benefit from within a cityscape (Andersson 2006).

Currently, no comprehensive, national information source on the quality, quantity and use of Urban greenspaces exists in the UK, although a recent study by CABE (2010b), Urban Green Nation, collected available data and research, and identified data gaps. Chapter 10 also found that data was dispersed across many organisations, with no central collection or analysis. Without a consistent framework for data collection on greenspaces, comparison between urban areas and Urban subhabitat types will not be possible (Section 10.6). A key message from the Urban Green Nation report was that the collection and management of baseline data on Urban greenspaces would enable a strategic overview, coordinate the provision of ecosystem services, and allow the evaluation of the effects of measures. For more information on research

Box 27.43 Greenspace maps in Scotland. Source: greenspace scotland (2009).

In 2005, the Glasgow and Clyde Valley Structure Plan Committee commissioned work to map the distribution and typology of all open spaces in the area. The work was intended to develop an information resource which would be owned and maintained by the eight Glasgow and Clyde Valley local authorities. An Ordnance Survey Master Map and aerial photography was used to map open space types across each local authority area; these maps were then verified by staff with knowledge of the area or by sample site visits. The data is held on a Geographic Information System (GIS) which can be accessed and updated by local authority staff.

The methodology was subsequently applied by a number of other central Scotland local authorities including Falkirk and Edinburgh. The success of the datasets as the basis for auditing greenspace led to Greenspace Scotland applying for Scottish Government support to roll-out mapping to other parts of Scotland in 2006-07. There are now consistent distribution and typology maps for greenspace in 25 of the 32 Scottish local authority areas. These 'greenspace maps' provide a baseline for mapping data on quality and fitness for purpose of spaces, and also to compare greenspace provision with population data relating to age, gender, levels of social deprivation and health statistics.

gaps and monitoring, data collection and mapping related to Urban ecosystems refer to Section 10.6.

Undertaking Urban ecosystem assessments, as a first step to inform decisions about GI and enable trade-offs to be identified, could facilitate the delivery of multiple ecosystem services. Economic analytical tools for valuing Urban ecosystem services need further development, but are useful in demonstrating to decision-makers the benefits of and costs saved by GI (Section 10.5.3).

Chapter 10 reports that data, research and decision-making tools are needed to improve the evidence base on regulatory services (e.g. climate, noise, light, flood regulation) provided in urban settings and to support their integration into planning policy. Further research is also required on the role of biodiversity in urban areas and its relationship with human well-being (Section 10.6.4). Response options (presented here and in Chapter 10) could be improved and better transformed into actions through greater collaboration between research organisations and implementation bodies (Section 10.6.5).

Our understanding of the impacts of climate change on urban areas, including rises in temperature, has improved. Considerable investment has been made recently in research on options for adapting to these potential climate changes, including the Sustainable Cities: Options for Responding to Climate Change Impacts and Outcomes and the Development of a Local Urban Climate Model and its Application to the Intelligent Development of Cities projects (**Table 27.22**). The Sustainable Urban Environment programme is a £38 million Engineering and Physical Sciences Research Council initiative involving 30 UK Universities that is exploring various aspects of sustainability in an urban context including waste and water management, transport planning and spatial planning.

Research gaps related to the impacts of transportation on ecosystems include: understanding the effects of noise, lighting and air pollution on wildlife and tranquil areas; establishing the effectiveness of environmental mitigation techniques (e.g. tree barriers) used in transport development; the contribution of transport to habitat fragmentation and implications for

Table 27.22 UK research programmes: new approaches to urban design and development.

Research programme	Aim
Sustainable Urban Environment (SUE)	To investigate different ways of improving sustainability in the urban environment.
Sustainable Cities: Options for Responding to Climate Change Impacts and Outcomes (SCORCHIO)	To develop tools for the analysis of adaptation options in urban areas, with a particular emphasis on heat and human comfort in the built environment.
The Development of a Local Urban Climate Model and its Application to the Intelligent Design of Cities (LUCID)	To calculate local climates in the urban environment and the impact on the internal built environment, energy use and the consequences for health.
Urban River Corridors and Sustainable Living Agendas	To produce innovations, tools and knowledge to help guide the regeneration of urban river corridors.

resilience to climate change; and the cumulative impact on ecosystems from transport infrastructure.

Our understanding of climate change, energy consumption and the impacts they have on ecosystems has significantly improved over the last few decades. The UK Energy Research Council was established in 2004 to conduct research on sustainable future energy systems. It focuses on five major themes including: technology and policy assessment, energy and environment, energy supply, energy demand, and energy systems. Another source of information within the sector is the Living with Environmental Change partnership between government departments and agencies, Devolved Administrations, local government and research councils (LWEC 2011). Living with Environmental Change supports long-term science and policy-driven research activities related to energy including: the Marine Renewable Energy activity to predict the environmental impacts of large offshore wind, wave, and tidal energy devices; and the Biofuels Executive Research Board which, among other things, monitors and manages research into biofuels.

A number of collaborative research centres in the UK have contributed to our understanding of energy and climate change issues such as the Tyndall Centre for Climate Change Research, the Centre for Climate Change Economics and Policy (est. 2008), the Centre for Social and Economic Research on the Global Environment (est. 1991), and the Centre for Business Relationships, Accountability, Sustainability and Society (est. 2001). The Energy Generation and Supply Knowledge Transfer Network links industrial, academic and government organisations in the areas of: offshore wind; wave and tidal; carbon abatement technologies; fuel cells and hydrogen technologies; maximising oil and gas resources; and future and emerging energy generation and supply opportunities (Technology Strategy Board 2011).

There remains a need to broaden the evidence base for several energy technologies, and to increase our understanding of the impacts of climate change and energy use on ecosystem service delivery. For example, evidence of the environmental impacts of marine renewable energy installations remains limited (Inger *et al.* 2009). To allow for the full range of biodiversity impacts to be assessed, additional multi- and interdisciplinary research will be needed (*ibid.*). The UK Strategic Environmental Assessment

(SEA) on marine wind, oil and gas licensing and carbon sequestration revealed several knowledge gaps (Dolman & Simmonds 2010). In response, the Joint Nature Conservation Committee identified a number of steps to address these gaps: “(1) gap analysis of environmental information; (2) comprehensive Environmental Impact Assessment guidance (including criteria for site selection); (3) targeted survey work (large scale and collaborative approach); (4) a preliminary round of development based on a precautionary threshold coupled with adoption of an iterative approach to consenting; (5) structured and funded monitoring (all stages of pre-development planning, construction and operation) and (6) commitment to full, well-resourced SEA for licensing rounds” (*ibid.*, p.1024).

27.9.3.2 Legislation (enabling)

The system of planning laws in the UK has undergone a number of major reforms in recent years, and remains in a state of flux as the government plans a further series of amendments. Until recently, it operated along a hierarchical structure comprising national level Planning Policy Statements, Regional Strategies and Local Development Frameworks. The legislation laying the basis for this framework is the Town and Country Planning Act 1990, but this has been amended several times, and a number of elements of the current system are set out by the Planning and Compulsory Purchase Act 2004. Recent and proposed changes to the planning system include the discontinuation of the Regional Strategy tier and associated targets for housing development, and a review of planning policy with the intention to consolidate Planning Policy Statements, circulars and guidance documents into a single National Planning Policy Framework.

The new framework is still in preparation, with little detail of its content available at the time of writing. A Ministerial Statement in December 2010 cited the reason for the reform of the planning system in England as “the current suite of planning policy statements and guidance notes is too centralist in its approach...”, and that the new framework will ensure “the majority of planning decisions are made at the local level” (Clark 2010). These changes are aligned with the Decentralisation and Localism Bill 2011, discussed below.

Until the new national framework is in force, planning policy will continue to be stipulated in Planning Policy Statements (PPS). Some selected PPSs are considered below. Regional Strategies were (until their abolition) set on a 15 to 20-year timescale, and set out the spatial strategy proposed for the region showing the scale and, broadly, the location for developments including housing, transport, retail and GI. Local Development Frameworks are sets of documents dealing with the detail of planning at local level, but prepared with regard to national planning policy, and also conforming to the regional strategy.

The Planning and Compulsory Purchase Act 2004 required the authorities preparing local and regional plans to have regard to sustainable development. In addition, that act required a sustainability appraisal of the strategies and policies in the regional and local plans (ss 5(4) and 19(5)). The sustainability appraisal incorporates the requirements of the Strategic Environmental Assessment Directive.

A number of national policy documents contain provisions for the incorporation of environmental protection into the planning system. Among them is PPS9 on Biodiversity and Geological Conservation, which states in its key principles that planning decisions should aim to prevent harm to biodiversity (Section 27.2.3.2). Planning decisions should favour less biodiversity-damaging alternatives, plus provide mitigation and compensation measures where damage is unavoidable. Planning Policy Statement 9 also incorporates duties in relation to consideration of protected sites designated at international, EU and national level. According to Natural England (2009e), planning policy has generally protected the UK's designated areas adequately. Planning Policy Statement 1 deals with the delivery of sustainable development, stating that this is the core principle underpinning planning. Planning Policy Guidance (PPG) 2 describes the designation of green belt land and sets out a presumption against inappropriate development in the green belt. Planning Policy Statement 7 on Sustainable Development in Rural Areas requires priority to be given to brownfield over green-field land for development, and for strict control of development in the open countryside. It is important to bear in mind that the sustainable development objectives of planning policy are constantly being weighed against economic development pressures, and economic development goals also feature heavily in the national planning policy documents. A specific principle of PPS7, for example, is the maintenance of high levels of economic growth and employment in rural areas.

The EU has put in place a common set of rules for the consideration of the environmental impacts of development. There are two impact assessment regimes. Each lays down procedures for the systematic consideration of possible environmental impacts before planning decisions are made. One set of rules (the Environmental Impact Assessment Directive) operates at the level of individual projects, while the other (the Strategic Environmental Assessment Directive) governs the consideration of impacts flowing from government development programmes. There is broad consensus that the Environmental Impact Assessment regime has had positive effects and succeeds in many cases in building environmental considerations into planning processes (EC 2009a). This has beneficial effects for environmental protection, but also for the better design, and public acceptance, of developments (*ibid.*). A particularly helpful aspect of both Environmental Impact Assessments and Strategic Environmental Assessments is that they employ wide-ranging concepts of environmental effect. This means that impact assessments can, and should, cover the effects of a project or plan on almost any aspect of the environment.

However, the framework contains a number of weaknesses. In short, the requirements are procedural only, i.e. the law does not actually specify that projects with significant adverse effects on the environment must not be carried out, just that there must be an assessment to identify and describe those effects. In practice, there are many cases where a policy decision is made to authorise a project, plan or programme despite dangers shown by an impact assessment. Other problems (especially with the project-level system) have their roots in the fact that the developer,

with a vested interest in seeing the project authorised, is generally the party determining what information is contained in an environmental assessment and where that information comes from. This means there is potential for major problems with quality of data contained in environmental reports and the independence of conclusions drawn. Environmental statements should be clear, accurate, comprehensive and objective—but the current law does not contain mechanisms to ensure this is the case (EC 2009a).

A separate set of planning rules for large infrastructure developments of national significance is contained in the Planning Act 2008. This established a system of National Policy Statements (NPSs) for setting out government policy on Nationally Significant Infrastructure Projects including in the sectors of energy, transport (ports, national roads and rail networks), water and waste management. National Policy Statements include matters such as the amount, type and size of such development which is appropriate nationally, and the criteria to be applied in deciding whether a location is suitable for it. It may even identify specific locations as particularly suitable.

The Planning Act also set up a new body, the Infrastructure Planning Commission, to take decisions on the planning of NPSs. The draft Decentralisation and Localism Bill (being debated in Parliament at the time of writing) abolishes the Infrastructure Planning Commission on the grounds that it is unelected and unaccountable. Instead, the bill returns to a position where the Secretary of State takes the final decision on major infrastructure projects of national importance.

The overall theme of the Decentralisation and Localism Bill is to return power for planning decisions to local authorities and communities. The move to planning decisions being decided locally will be supported through the new National Planning Policy Framework that “will be used as a mechanism for delivering Government objectives only where it is relevant, proportionate and effective to do so” (DCLG 2010b). The regional tier of the planning hierarchy, whereby Regional Strategies were developed by unelected regional bodies, will be removed. In particular, this is intended to free local planning authorities from housing targets imposed at regional and national level. As well as improving the ability of the planning system to reflect local needs and sentiments, this measure is designed to remove ‘red tape’ and reduce costs. Environmental groups have pointed out that a certain level of regional planning and coordination will need to be maintained in order to avoid parochialism or competition for economic growth between different areas (CPRE 2010; FoE 2010). The new bill includes a duty for local planning authorities to liaise and cooperate with each other in this context.

The EU Directive on Environmental Noise (Directive 2002/49/EC) was enacted in 2002. It requires governments to draw up strategic noise maps for major roads, railways, airports and large urban areas, using harmonised noise indicators. Action plans must then be developed to reduce noise where necessary. In addition, where environmental noise quality is shown to be good, this must be maintained and designated as Quiet Areas (**Box 27.42**). The directive does not contain any specific noise limit values. The process of identifying and dealing with noise issues through

mapping and action plans is intended to complement other EU legislation dealing with noise emissions from specific sources (Defra 2010p).

The requirements of EU Directives such as the Renewable Energy Directive (2009/28/EC) to increase renewable energy in order to decrease carbon emissions may conflict with those safeguarding areas of biodiversity importance (Chapter 17). In addition, conflicts may arise over locations for renewable energy developments, such as tidal and wind power, and rules for biodiversity and water quality protection under the Habitats and Birds Directives, MSFD and WFD. For example, the environmental regulation of water quality and water usage as a result of the WFD, the MSFD and the Habitats Directive limits the nature and location of future operating thermal plants.

Climate change presents one of the greatest long-term risks to ecosystem service delivery, and the energy sector is embarking on massive changes to decarbonise energy production, driven by legislation such as the EU carbon emissions trading scheme and the Renewables Obligation [Order 2009] for electricity suppliers. The Renewables Obligation Order 2009 (as amended) in England, Wales and Northern Ireland, and the Renewables Obligation (Scotland) Order 2009 (as amended), require electricity providers to supply, during a given period, a specified number of renewable obligation certificates which guarantee a renewable source. Eligible renewable sources include biomass and waste of which less than 90% is derived from fossil fuels. Similarly, the Renewable Transport Fuel Obligations Order 2007 (as amended) stipulates that 4.17% (during the period commencing 2011, and 5.26% after the 2012 period) of the transport fuel provided by a supplier must come from renewable sources, thereby regulating an increase in the proportion of renewable transport fuel.

There are a large number of statutory measures in place to minimise climate impacts. The Climate Change Act 2008 and the Climate Change (Scotland) Act 2009 set carbon targets and budgets, and cover the carbon trading scheme and adaptation to climate change. The Climate Change and Sustainable Energy Act 2006 sets targets for micro-generation of energy, provisions for energy efficiency, and building regulations. The Energy Act 2010 covers financial assistance schemes for carbon capture and storage, and for decarbonisation. The purpose of the Green Energy (Definition and Promotion) Act 2009 is to promote “the generation of electricity or heat from renewable or low-carbon sources by the use of any equipment”.

The energy sector is also subject to several further pieces of European legislation: the Large Combustion Plant Directive, the National Emissions Ceilings Directive and Integrated Pollution Prevention and Control Directive. Sulphur dioxide and nitrous oxide emissions have reduced by 92% and 47%, respectively, between 1980 and 2009, which can, in part, be attributed to legislation governing thermal energy plants (Passant *et al.* 2011). Many ecosystems are consequently recovering from acidification (Ormerod & Durance 2009). Also, the environmental regulation of water usage and water quality is progressively tightening as a result of the WFD, MSFD and Habitats Directive, with implications for the energy sector.

279.3.3 Policies, institutions and governance (enabling)

The planning system aims to implement sustainable development, whereby economic, social and environmental objectives are met together. Government planning policy (PPS1: Delivering Sustainable Development) demands that planning authorities make land available to meet expected ‘needs’ for housing, industrial development, the extraction of raw materials, retail and commercial development, and leisure and recreation. However, careful assessment of the difference between ‘demands’ and ‘needs’ is required. Meeting demand for growth is already problematic in many regions of the UK, and increasing supply indefinitely is unlikely to be possible within the capacity of the environment, particularly in areas of especially high demand such as the south-east of England. Increasing the sustainability of homes has the potential to minimise damage to the environment; but avoiding unacceptable loss or modification of ecosystems will be challenging. Demand for housing is rising, partly due to family break-up and more people living alone and for longer, and the UK Government is concerned about the affordability of homes for young people and families. House prices have doubled in real terms in the last decade, and the average house now costs more than eight times the average salary (DCLG 2007). In addition to increasing the housing stock, there may be potential to better control demand and find alternative long-term solutions that do not exceed environmental capacity.

Environmental capacity (or limits) is one of five key components of the UK’s Sustainable Development Strategy (HM Government 2005). In the planning context, it refers to the ability of ecosystems to sustain development without irreversible damage or decline in services or benefits derived from them. Yet there is still inadequate guidance on how practitioners can operationalise the concept at the regional and local scales in spatial plans (Smith & Pearson 2008). Trials and studies have been undertaken to address this shortcoming in the South East, East, and North West regions of England (**Box 27.44**).

Ecosystem services approach to development. The adoption of an ecosystem service approach in the design of new developments could yield significant benefits to occupants and the wider community. The incorporation of GI into development plans with explicit objectives to supply a range of services (e.g. recreation, flood attenuation, micro-climate regulation) could significantly increase the value of developments for society beyond direct social and economic benefits. Several PPSs already implicitly protect ecosystem services: PPS 9: Biodiversity and Geological Conservation, emphasises the importance of protecting and enhancing the quality of the natural environment; while PPS 24: Noise recommends the use of natural noise barriers.

Natural England’s (2009e) Policy Position on Spatial Planning acknowledges that the adoption of the sustainable development agenda in planning policy has increased the environmental performance of developments. However, it finds that the planning system does not sufficiently capitalise on the multifunctional opportunities that GI in developments could offer (see below, this section). Enhancement of the environment, including habitat creation and landscape restoration, could

Box 27.44 Environmental limits and spatial planning in East England. Source: Smith & Pearson (2008).

Practitioners need to know what the concept of environmental limits embodied in the UK's Sustainable Development Strategy means in practice. In developing the East of England's Regional Spatial Strategy there was concern expressed during a public consultation that proposed growth could exceed environment capacity. Land Use Consultants was commissioned to develop a method that could assist spatial planners in taking account of environmental limits, since it was deemed that the concept wasn't explicit or based on sound science.

Land Use Consultants developed a five-step methodology which they applied to Haven Gateway, a 'growth point' for development in the East of England Region. They found that a lack of data and scientific tools prevented a sound assessment of the likely changes that would result from developments. Ecosystem services were integral to the methodology, but due to data constraints, they had to revert to state of the environment data for the case study. **Figure 27.56** shows a GIS output from the pilot that illustrates surface water resources relative to the environmental limit for Haven Gateway.

Land Use Consultants concluded that national guidance is required about how the 'living within environmental limits' agenda and the 'ecosystems approach' can be embedded in the planning system.

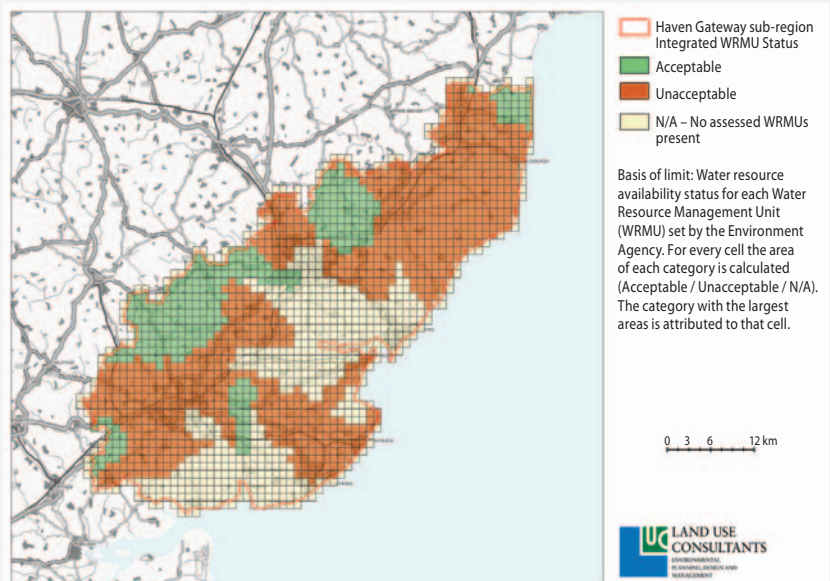


Figure 27.56 Surface water resource relative to environmental limit. Source: Smith & Pearson (2008) Data from Environment Agency. Reproduced from Ordnance Survey information with the permission of The Controller of Her Majesty's Stationery Office, Crown Copyright, Land Use Consultants, Licence Number 100019265.

provide benefits for ecosystem functioning and people. Moreover, by considering the landscape and ecosystem setting of the development location, existing landscape distinctiveness could be enhanced and the connectivity of onsite GI with that offsite could be improved (*ibid.*).

Designing developments to create opportunities for people to access and enjoy the natural environment could bring substantial health and well-being benefits for occupants. Rather than adding landscape features as a 'finishing touch', environmental assets could be at the core of development design from the outset; currently, priority is instead given to grey infrastructure in land use planning at the cost of valuable ecosystem services (Landscape Institute 2009). How new buildings are designed will also determine the ease and ability of occupants to behave sustainably. Natural England (2009e) recommends that spatial plans should aim for net improvements in environmental quality and increased environmental capacity, rather than merely minimising damage. The services provided by the natural environment could be multiplied and enhanced substantially if they were planned for and integrated into planning policies from the beginning (Landscape Institute 2009).

Policy support for multifunctional Green Infrastructure. Green Infrastructure refers to parks, green spaces, public squares, trees, allotments, woodlands and waterways and how they are spatially connected as networks of public spaces that benefit local communities. Green Infrastructure can provide green routes for safe travel by foot and bicycle, filter polluted air, attenuate floodwaters, reduce the urban heat island effect through cooling and shading, supply local food and biofuel, and provide habitats and corridors for wildlife to move around urban areas. Green Infrastructure, such as parks and woodland, can also be designated as quiet and dark areas where noise and light levels are limited (**Box 27.43**). It is well-established that

these features improve perceptions of an area, can provide stimulus to local economies, and can bring health benefits (CABE 2010a). Chapter 10 discusses the potential benefits of GI in more detail.

Green Infrastructure is increasingly recognised in planning policy as an important response to creating sustainable communities. The role of GI in addressing climate change adaptation is cited in a supplement to PPS1 (2007). Natural England (2009d) recommends that local authorities should develop GI strategies to ensure its integration into development processes from the outset.

Localism and greenspace management. The government's move towards devolving power to local authorities, set out in the Decentralisation and Localism Bill, is likely to change the way greenspace is owned and managed. Local actors will be expected to play a larger role in managing community open spaces. Some local authorities are considering whether to transfer ownership of public open spaces to communities as a way of reducing costs. Many community groups are already active in influencing the way their greenspaces are managed and contribute volunteer time to their upkeep and improvement. The idea of getting these groups more involved in the management of these spaces is growing in popularity. Underused or neglected space can be managed by groups or leased or licensed by a local authority to restore them for the benefit of their local community. Transfer of ownership is rising: a survey of local authorities in 2009 found that about 1,000 transfers were being made at that time in England (CABE 2010a).

The Community-led Spaces Report by CABE (2010a) states that the benefits of community group ownership of greenspaces include: the maintenance of funds by the group irrespective of budget cuts by local government; savings in terms of staffing costs as volunteers donate their time; and better management because people living close

to a greenspace care most about it and know the specific needs and priorities. Community groups are also thought to respond to opportunities more rapidly, such as converting land to food production, and can build trust between local authorities and communities. The establishment of trusts to manage open spaces has proven successful in cases where sufficient resources and skills are available (**Box 27.45**). Building the skills and capacity of volunteers and providing sufficient funding support will be essential if greater responsibility for the management of greenspaces is to be transferred to communities. However, the risks of relying excessively on local volunteers need to be recognised, particularly lack of expertise, diseconomies of operating

in relatively small-scale units, and competing pressures on people's time and finances. There are also risks associated with the capacity of local authorities to support and liaise with community groups.

Minimising the negative impacts of transport on ecosystems. In the past, the UK government's transport policy typically backed the expansion of transport infrastructure to support economic growth and reduce congestion. In terms of congestion, at least, this rationale was flawed. Evidence suggests that the expansion of road capacity, for example, is eroded over time as new and longer journeys fill the extra space. The London Orbit Multi-Modal Study (2001) found that the M25 could be widened indefinitely and still fail to stop congestion unless demand control measures were implemented, such as road pricing. Expansion of transport infrastructure, and road and air traffic, impacts ecosystems through conversion and fragmentation of habitats, light, noise and air pollution, and loss of valued landscapes and tranquillity (Natural England 2009f).

More recently, the government has sought to reduce emissions from the transport sector and to encourage a modal shift from private cars, road and airfreight to more sustainable forms of travel and transportation such as walking, bicycle, rail, bus/coach and boat (Section 27.8.3.3). Progress towards this objective has been slow; car use remains high and air travel continue to increase (DfT 2009). Expanding the capacity for public transport within and between urban areas could reduce congestion and have limited overall direct effects on ecosystems. Not only would a substantial modal shift reduce the transport sector's contribution to climate change, but it would also (**Figure 27.57**) minimise the space required for transport infrastructure and avoid the associated environmental impacts. The logic is clear, but the challenges for its attainment great.

Box 27.45 Community management of historic Urban park woodland. Source: CABE (2010a); WWCT (2010).

Warley Woods, a 40-ha Urban park in Swethwick (West Midlands), was a neglected public space run by Birmingham City Council until the late 1990s when local residents took charge of management. Warley Woods Community Trust was established in 1997 and has since raised and invested over £2 million in park improvements.

In 2004, the Trust acquired a 99-year sub-lease for the woodland after a lengthy legal process. The Trust conserves the woodland, promotes and offers educational opportunities, and provides recreational facilities for the local community. Paths and railings have been installed, and a woodland management plan implemented. The Trust employs nine staff and has 800 members, many of whom volunteer. The Heritage Lottery Fund awarded the initial funding of £757,000, and income to pay for running costs is generated from various sources, including a golf course, Sandwell Council and fundraising activities.

The Trust put their relative success down to a number of reasons such as having volunteers with relevant professional skills (e.g. finance, legal and environmental skills), having a clear vision of what they wanted to achieve, and dogged determination.



Figure 27.57 The amount of space required to transport the same number of people by car, bus or bicycle. Source: a poster in the Press Office, city of Münster, Germany.

In 2011, the government published the Local Transport White Paper (DfT 2011). It focuses on improving the quality of existing public transport primarily at the local level with limited expansion of infrastructure (notably a high speed rail network). A Local Sustainable Transport Fund of £560 million will be available for local authorities to develop local transport initiatives.

The government also intends to support the development of the electric car market in the UK.

Current transport planning policy attempts to minimise damage to ecosystems, particularly if there is potential to impact protected areas such as SSSIs, AONBs, National Parks and SACs. Even with protection, these areas can still be impacted by increasing noise, air and light pollution from increasing traffic, and major transport projects are still regularly proposed in AONBs and National Parks. Green infrastructure, such as tree barriers, can be useful instruments for reducing noise impacts (Section 27.5.3.6). A report by The Royal Commission on Environmental Pollution (RCEP 2009) found that sufficient evidence exists to “generate concern regarding the adverse ecological consequences of artificial lighting schemes”; but further research is required on this subject. The report also noted that, between 1993 and 2000, the UK became more intensely lit at night, and outdoor lighting continues to grow at around 3% every year. Although there is currently inconclusive evidence at an ecosystem level of the impact of light pollution, including on protected areas, there is sufficient information to warrant concern and to prompt actions to reduce light pollution.

In the future, there is potential for transport policies to deliver net environmental gains. Ecosystem services can be better valued in transport decision-making processes, and transport choices that are less harmful to ecosystems have the potential to be made more attractive. By integrating transport and spatial planning, towns and cities could be designed to minimise the need to use a car (Stantchev & Whiteing 2010). Making environmentally sustainable modes of transport more convenient, affordable and more enjoyable than travelling by car is likely to be important in encouraging a modal shift. The Land Use Futures report (2010) warned that the “failure to integrate transport into land use strategy over the next two decades will have serious consequences for congestion, pollution and managing climate change, and will lead to mismatches between the location of housing development and the availability of jobs.”

Energy policy. According to the Foresight Land Use Futures report (Foresight 2010), the future energy of the UK is likely to be obtained from a mix of nuclear, renewables, coal-fired powered stations with carbon capture and storage, and conventional fossil fuels such as gas. How much each of these will contribute is still under debate and may vary between the four countries of the UK. It will depend on a range of factors including the incentives provided by government, fuel prices, regulations and technological developments. Electricity demand could double, according to the government’s 2050 Energy Pathways report (HM Government 2010a), meaning that the decarbonisation of electricity generation will be a major priority.

In 2009, the UK Government published the UK Low Carbon Transition Plan (HM Government 2009a) which sets

out the policies needed to achieve the targets set by the 2008 Climate Change Act to reduce emissions by at least 34% below 1990 levels by 2020, and by 80% by 2050. The plan aims to reduce emissions through energy efficiency gains, the increased use of renewable energy and the EU Emissions Trading System. The Climate Change (Scotland) Act sets the ambitious target of reducing emissions by 42% below 1990 levels by 2020.

Renewable energy is further promoted by the UK Renewable Energy Strategy (HM Government 2009b), and through devolved policy. The strategy sets the legally binding target of 15% of energy coming from renewable sources by 2020. In order to achieve this overall target, it is proposed that 30% of electricity, 12% of heat and 10% of transport energy are generated from renewables. Legislation including the Renewables Obligation 2009 (amended 2010), the Renewables Transport Fuel Obligation (Amendment) Order 2009 and the new Renewables Heat Incentive will further encourage the development of the renewables sector. The UK Biomass Strategy (DTI *et al.* 2007) evaluates the contribution biomass can make as a sustainable resource. It predicts that 35,000 ha of perennial energy crops will be needed by 2020 to meet targets, plus an additional 740,000 ha for transport biofuel. Land conversion at this scale will conflict with food production, protection of water resources, biodiversity and other services unless it is appropriately planned and managed (Section 7.2.2.1).

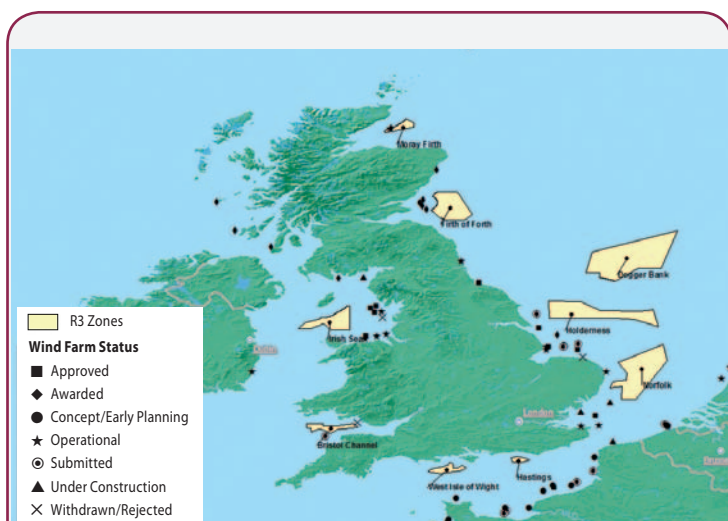
The Scottish Government has backed renewables through the Renewables Action Plan 2009 (as updated in 2010, 2011; Scottish Government 2009c), with a pledge to generate 20% of its energy and 50% of its electricity from renewable energy sources by 2020; it is already on course to exceed its 2011 interim target for 31% of electricity to come from renewable sources (Scottish Government 2010a). Other relevant Scottish policies include: the Energy Efficiency Action Plan (Scottish Government 2010c), the Renewable Heat Action Plan (Scottish Government 2009d), the Low Carbon Scotland Public Engagement Strategy (Scottish Government 2010d), and the Roadmap for Carbon Capture Storage (Scottish Government 2010b).

The Climate Change Strategy for Wales (WAG 2010c), The Energy Policy Statement (WAG 2010a), the Renewable Energy Route Map for Wales (WAG 2008c) and the Bioenergy Action Plan for Wales (WAG 2010b) form the a framework for renewable electricity generation and energy efficiency in the Welsh context. In Northern Ireland, the Strategic Energy Framework (DETI 2010) outlines aims for a more secure and sustainable energy system.

The Department of Energy and Climate Change has opened a consultation on the reform of the electricity market with the aim of creating a new market framework that favours the development of low carbon energy, including nuclear power. This is the most important assessment of the electricity market since it was privatised, and an appropriate reform will accelerate the transition to a low carbon electricity mix. The modelling used in the Energy 2050 study estimates that the UK can maintain its energy supplies while still complying with its international environmental obligations for low carbon energy and without causing catastrophic change (UKERC 2010).

The backing of wind energy will have substantial implications for ecosystem services. Windfarms are located in exposed areas to ensure sufficient average wind speeds that maximise energy generation—these places are often coastal, upland and offshore locations which frequently contain environmentally sensitive habitats that could be threatened by inappropriate wind energy projects. WWF-UK *et al.* (2001) recommend that if a windfarm development is likely to have adverse effects on a site of regional or local nature conservation importance, it should only be permitted if there are strong reasons for the project that outweigh the need to safeguard nature conservation. There are some examples emerging, however, where both nature conservation and renewable energy can benefit, such as at Black Law windfarm in Scotland (**Box 27.46**). Due to local resistance towards the noise and visual impacts of turbines, windfarms are often subject to planning delays and the industry worries that lengthy planning processes and guidelines could hamper the achievement of onshore renewable energy targets (POST 2009). Although there are many complaints about noise from wind developments in the UK, issues can often be resolved by limiting turbine rotation speed (*ibid.*).

potential to generate energy from the Marine environment. Plans are afoot for substantial development of marine renewable energy infrastructure to harness this energy. In February 2009, the Crown Estate announced ten sites for the development of offshore windfarms within Scottish territorial waters. These sites are spread out on the east and west coasts, and will contribute to delivering an additional 25 gigawatts from offshore wind. Prior & McMath (2008) postulate that the expansion of marine windfarms and marine energy generators will be the most large-scale engineering intervention in the UK's coastal waters in the coming decades. **Figure 27.59** maps the locations of marine windfarms planned in the UK. The Marine Energy Action Plan (HM Government 2010b) sets out the vision for the marine energy sector upto 2030, and covers wave, tidal range and tidal stream energy across the UK. It incorporates a full sector engagement approach, encouraging collaboration between government and industry for the development of the sector. The plan recommends delivery of the full Strategic Environmental Assessment for Wave and Tidal Energy involving engagement of all relevant stakeholders. The Scottish Government has also proposed Strategic Environment Assessments for marine wind energy.



Box 27.46 Win-win for renewable energy and conservation at Black Law windfarm. Source: RSPB Scotland (2010).



environmental groups, the fishing sector and energy companies (Inger *et al.* 2009). Clearly, evidencing potential environmental benefits, and integrating stakeholders into the design, construction, and installation phases, could minimise conflicts.

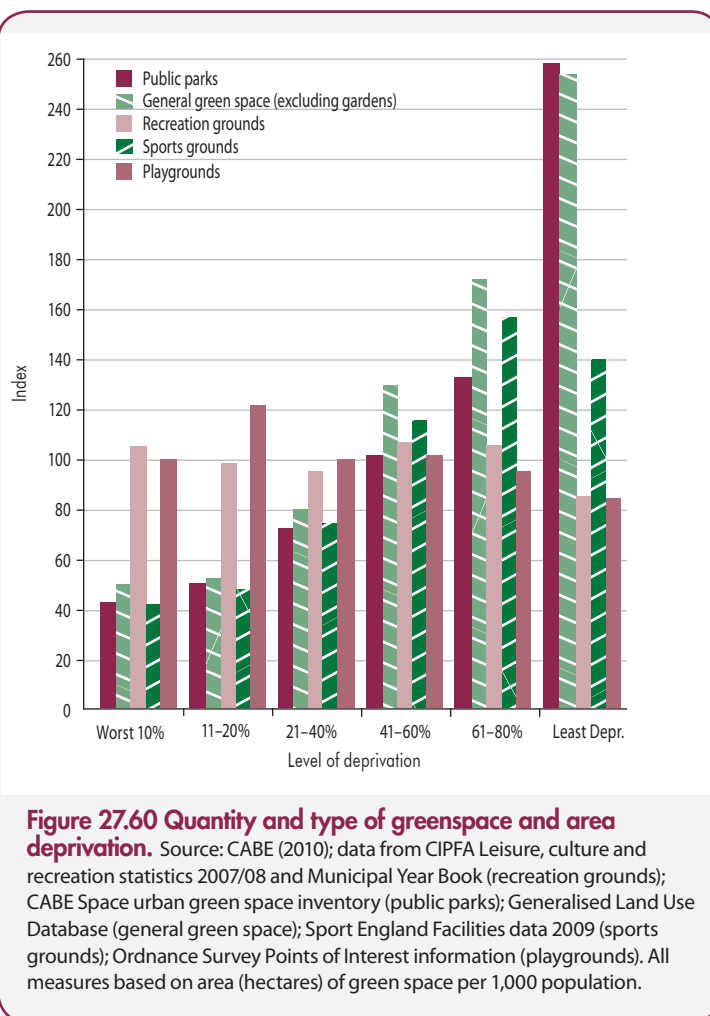
27.9.3.4 Changing social attitudes (enabling)

Interaction with nature is believed to be essential for nurturing an understanding of the value of ecosystems and an interest in protecting them (Nisbet *et al.* 2009). Urban dwellers are often less connected with nature than those living in rural areas because there are less opportunities within cities to spend time in natural environments and there may be negative associations with some Urban wildlife (Johnson & Catley 2009). Since over 90% of the UK's population live in urban areas (GreenLINK 2010), designing places where people work and live to maximise exposure to meaningful interactions with the natural world could support widespread change to more sustainable behavioural patterns (Miller 2005 in Andersson 2006). Providing opportunities for volunteers to manage Urban greenspaces can foster a greater awareness of the wider environment (GreenLINK 2010), and more contact with nature can also have benefits for physiological and physical health (Chapter 10).

Since the 1990s, the trend of a decline in quality of greenspace has been stopped, and even reversed, in many cases. This has resulted in people using and valuing greenspace more (CABE 2010b). The benefits of using greenspace have not reached everyone though, with variable quality and quantity of greenspace in different regions of the UK. A study by CABE (2010) found deprivation and affluence to be the most significant determinants of greenspace provision and quality (**Figure 27.60**). People from certain socioeconomic and cultural backgrounds do not have equal access to greenspace—this has implications for health, their relationship with nature, and the potential for behavioural change (Section 27.8.3.1).

The CABE report also found that by improving the quality of greenspace (for example, by providing more facilities and improving safety) more people will actively use it, including for exercise. If parks and greenspaces are well-managed, research has shown that communities use their local spaces more, have better relationships with their local councils and take pride in the area where they live and the quality of life of individuals is enhanced (CABE 2010b). Concern about personal safety is the most common reason for people not using parks, and constraints on personal time (perceived and real) make the proximity of greenspace to homes and workplaces another important determinant. Once-avoided greenspace can be rejuvenated, however, into popular amenities for communities through good design, management and maintenance (CABE 2005). The Green Flag Award allows greenspaces to be compared with the national standard and encourages authorities managing the parks and greenspaces to improve performance and gain national recognition (Section 27.8.3.6; **Figure 27.61**). Likewise, successful community-managed greenspace can be recognised by the Green Pennant Award.

Public and organisational behaviour change will be necessary in order for sustainable travel to become widely



adopted, thus reducing emissions and the pressure from the transport sector on the natural environment. Perhaps the greatest 'value-action gap' is on transport behaviour: even those with strong 'green' values are unwilling to give up, or accept restrictions on, private car use and aviation. More 'social invention' action research could find new approaches and frameworks that effectively reduce travel distances and encourage modal shift to 'green' modes (e.g. car share clubs and city-wide bike hire schemes such as Velib in Paris and London's 'Boris bikes'; **Figure 27.62**).

In fact, a fundamental cultural shift in the way the public view travel is required. 'Smart' travel measures, such as travel plans and personalised journey planning, can encourage walking, cycling and public transport use, but these also need to be complemented with hard measures, such as cycle routes and priority bus lanes, to make sustainable travel choices more attractive (Natural England 2009f). Forming a network of greenways by closing some residential streets to cars and establishing trees, cycle and walking paths, and recreational facilities is one option for improving the appeal and safety of walking and cycling in urban areas (Chapter 10, Box 10.2).

To embed the value of the natural environment in the planning system, the UK Man and Biosphere Committee's Urban Forum (UK MAB Urban Forum 2010) recommend providing adequate training on ecological considerations in the education of planners. Such knowledge will be essential for the development of robust GI plans.

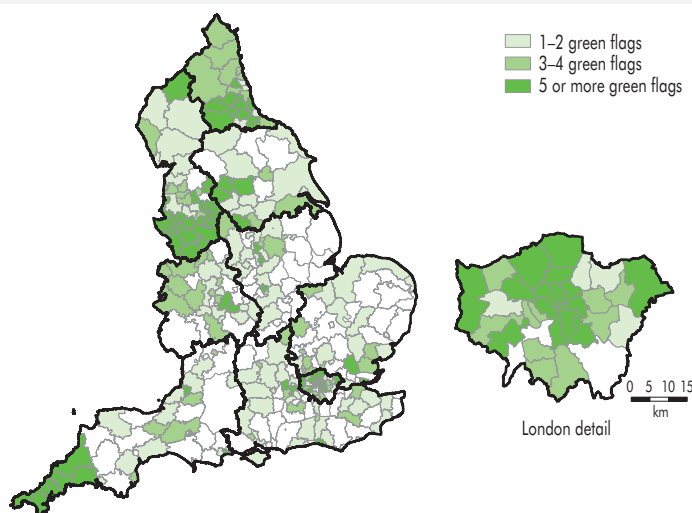


Figure 27.61 Number of Green Flags awarded to each local authority in England. Source: CAGE 2010b.



Figure 27.62. Research is needed on innovative approaches—such as the London bicycle hire scheme—to encourage a shift in travel behaviour towards ‘green’ modes. Photo by Seth Anderson available under a Creative Commons Attribution-Share Alike license.

The process of researching and understanding public perceptions and acceptance of renewable energy development is of great importance. The development of different forms of renewable energy is supported by central government, and the public have a generally favourable attitude towards renewables overall, but there is strong resistance to specific developments, coined ‘not in my back yard’ sentiments, or ‘NIMBYism’ (Devine Wright 2005; Owens & Driffill 2008, p.4413). Upreti (2004) found that, in England and Wales, public opposition is one of the major obstacles in the promotion of biomass energy. Much research has been conducted on public attitudes towards windfarm development. Public oppositions to such developments include: visual impacts, noise, perceived unreliability, high cost, dangerous impacts on birds and wildlife, perceived inefficiency (vs. coal-fired power stations), suspicion on motives of development, and annoyance towards idle turbines (Devine Wright, 2005). Even when people recognise the necessity to promote renewable energy, they would prefer it does not take place in their locality. In this respect, public participation in the delivery of renewable energy is of great importance.

Studies have shown that local involvement positively influences public perceptions of windfarms. A study by Warren & McFadyen (2010) in south-west Scotland found that “a change in development model towards community ownership [as opposed to developer-owned] could have a positive effect on public attitudes towards windfarm development in Scotland” (p.204). In order to address the complexities involved in behaviour change towards climate change, the Scottish Government has developed the Climate Change Behaviours Research Programme (CCBRP; Scottish Executive 2006a). Between 2010 and 2012, the programme aims to better understand mechanisms for stimulating, facilitating and supporting behaviour change to feed into policy development.

The approach commonly taken to transform social attitudes in energy and environmental fields is awareness raising and education, but the provision of information often has little impact on behaviour, especially when counter

to social norms or prices (Owens & Driffill 2008). Attitudes are additionally influenced by social, political and cultural factors. Many examples demonstrate that domestic energy consumption campaigns have failed to lead to the take-up of energy efficiency measures. Owens & Driffill (2008) highlight the need for more interactive and deliberative communications between a broad spectrum of actors. Contextual constraints also limit capacity for effective action; for example, physical infrastructure, spatial separation of activities and availability of public services may limit people’s ability to minimise driving in order to mitigate climate impacts (*ibid.*).

The Energy Saving Trust is one example of a non-profit organisation acting in the energy sector to provide a range of resources for citizens, businesses and the public sector to minimise energy wastage and inform green behaviour (EST 2011a). Their Green Communities programme aims to support, facilitate and promote community-based energy projects through the provision of advice and expert support. Collaborative networks also exist in this field.

27.9.3.5 Markets and incentives (instrumental)

To encourage a shift to more sustainable transport modes, pricing can be an important driver of behavioural change. Currently, the external costs of transportation are not reflected in the cost of travel by car. Fiscal instruments, such as road pricing, fuel tax and vehicle excise duty, can reduce traffic growth and make more sustainable forms of transport more financially attractive. These policies, however, often need to be complemented with other measures, such as behavioural change, technology and regulations, to be successful (Natural England 2009f). A review of evidence by the Land Use Futures study (2010) found that “rationing road use in cities by pricing is economically and environmentally sound, but may accelerate the rate of decentralisation of economic activities to fringe locations (‘Edge Cities’).” The Central London Congestion Charge, introduced in 2003, successfully reduced congestion by 20–30% in the zone (**Figure 27.63**). Congestion has increased again in London recently due to high levels of road works and more road allocated to cycling and buses, not due

to increased traffic (Albalade & Bel 2008; TfL 2008). Transport for London estimated that the scheme was responsible for up to one-half of the bus patronage increases seen over the period 2002 to 2003 in London. Attempts to replicate the London system in other towns and cities have been met with resistance from the public. In Manchester, congestion charging was rejected—almost 80% voted against the introduction of the scheme—and the government removed financial support for congestion charging when it discontinued the Transport Innovation Fund in March 2010. The downsizing of the London congestion zone in 2011 also demonstrates the lack of public and, therefore, political acceptability of such schemes. This is despite there being no discernable impacts on the economy of London (TfL 2008).

The government is reviewing market arrangements for electricity supply to determine how to deliver major new investments in low carbon electricity generation. This is likely to result in market and incentive arrangements to drive low carbon electricity, in addition to existing instruments such as the EU Carbon Emissions Trading Scheme and the Renewables Obligation for electricity suppliers. Grants exist for home energy saving, domestic renewable projects, commercial renewables, and for infrastructure for alternative fuels. The Low Carbon Building Programme is now closed to new applications due to cost saving measures; however, the Feed-in Tariff (FIT) for electricity-generating technologies was introduced as a government incentive (in GB) in April 2010 (EST 2011b). The aim of FITs is to incentivise small-scale renewable energy generation from, for example, solar photovoltaics and wind turbines, by energy suppliers making regular, minimum payments to individuals, communities and businesses for the electricity they supply to the national grid. The new Renewable Heat Incentive (RHI) financial support scheme is due to be put in place in 2011 following consultations on the proposal (DECC 2010). This scheme proposes to support a range of technologies including: “air, water and ground-source heat pumps (and other geothermal energy), solar thermal, biomass boilers, renewable combined heat power, use of biogas and bioloquids and the injection of biomethane into the natural

gas grid” (*ibid.*, p.3). The Energy Crops Scheme in England provides establishment grants for short rotation coppice (of willow, poplar, ash, alder, hazel, silver birch, sycamore, sweet chestnut and lime), and *Miscanthus* (a tall woody grass) (Natural England 2009c); (Section 27.5.3.5).

27.9.3.6 Technologies and practices (instrumental)

Multifunctional Green Infrastructure. Green Infrastructure is acknowledged as one of the most promising ways to enhance ecosystem service provision in urban areas. Rural GI will be covered in less detail here since many of the responses are discussed under other sectors including Biodiversity (Section 27.2.), Water (Section 27.3.), and Forestry (Section 27.5.).

Green Infrastructure is a planned network of greenspaces and other environmental assets (**Box 27.47**). The intention of GI is to provide multiple ecosystem services that have benefits for the quality of life of local communities. The development of GI involves a process of planning, design, implementation and management of a network of greenspaces, habitats and places which, if managed together, exceed the sum of the individual parts (Landscape Institute 2009).

The human well-being benefits of greenspaces are substantial. There is strong evidence that greenspace provides health benefits, and increases informal and physically active recreational opportunities. Coombes *et al.* (2010) found that people living closest to formal greenspace are more likely to meet recommended levels of physical activity; reducing the sedentary population by just 1% would save an estimated £1.44 billion per year in costs to the economy (Natural England 2009e). Ensuring people don't have to travel far to use greenspaces and that they are of a high quality has a significant influence on user levels and equal access (Section 27.9.3.4). Green Infrastructure can also provide for Quiet Areas (**Box 27.43**). A growing body of literature indicates that access to greenspace reduces long-term noise annoyances (Gidlöf-Gunnarsson & Ohrstrom 2007).



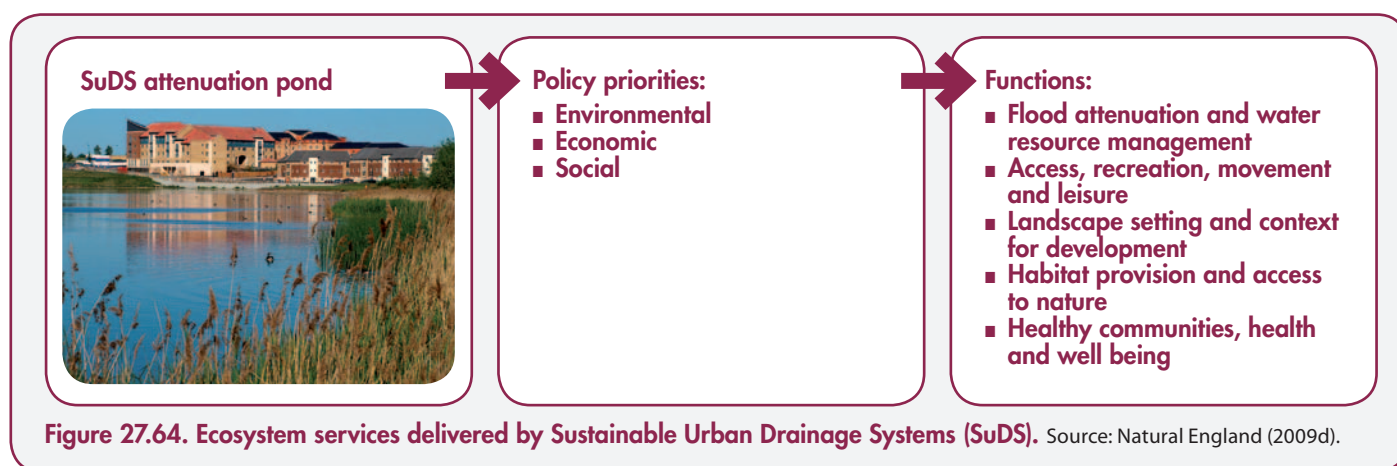
Figure 27.63 The Central London Congestion Charge reduced congestion by 20–30%. Photo by audreym available under a Creative Commons Attribution-NonCommercial-ShareAlike license.

Box 27.47 Green Infrastructure definition and typology (Table 27.23). Source: Natural England (2009d).

Green Infrastructure is defined in PPS 12 as:
“a network of multi-functional green space, both new and existing, both rural and urban, which supports the natural and ecological processes and is integral to the health and quality of life of sustainable communities”

Table 27.23 Green Infrastructure typology. Source: Natural England (2009d).

Parks and gardens	Urban parks, Country and Regional Parks, formal gardens
Amenity greenspace	Informal recreation spaces, housing greenspaces, domestic gardens, village greens, urban commons, other incidental space, green roofs
Natural and semi-natural urban greenspaces	Woodland and scrub, grassland (e.g. downland and meadow), heath or moor, wetlands, open and running water, wastelands and disturbed ground), bare rock habitats (e.g. cliffs and quarries)
Green corridors	Rivers and canals including their banks, road and rail corridors, cycling routes, pedestrian paths, and rights of way
Others	Allotments, community gardens, city farms, cemeteries and churchyards



Water management and urban drainage. Increased flooding in towns and cities has prompted interest in the role that town planning can play in reducing flood risk. The replacement of hard impermeable surfaces with semi-permeable surfaces (such as honeycomb structures) can reduce surface runoff by retaining water (Shaw *et al.* 2007). Water features, such as ponds and lakes, can have a substantial cooling effect, as well as providing recreational and aesthetic benefits and habitats for wildlife. As rivers have become cleaner, they have become a focus of urban regeneration; since cleaner rivers support wildlife, and are aesthetically pleasing, they bring improvements in well-being and are a source of economic benefits (EA 2002). Sustainable Urban Drainage Systems (SuDS) fulfil a range of functions including the attenuation of surface water runoff and the enhancement of biodiversity and recreation opportunities (**Figure 27.64**). They include rainwater re-use, soakaways, permeable surfaces, ponds and wetlands. The runoff of pollutants into watercourses can be reduced by slowing down the flow of rainwater so that it passes through soils where pollutants are retained and broken down. Reedbeds are also extremely effective at removing contaminants from water. SuDS have also been used in transport infrastructure schemes to minimise impacts on water quality (**Box 27.48**).

Allotments and community gardens (Chapter 10, Box 10.4, Section 27.8.3.4, **Figure 27.65**). During WWII, urban food production played a significant role in meeting the nutritional needs of the urban population, but today, cities are fed by an enormous inflow of food and other goods that have impacted ecosystems, both within the UK and globally, during their production. Food production may once again be returning to the Urban landscape, however, with a rise in the number of city dwellers working allotments and gardens



Figure 27.65 Allotments in Bristol, England. Photo courtesy of William Bolton/Ecojam.org.

(Chapter 10; **Box 27.40**). There has also been a proliferation of community food projects. The Landshare scheme aims to bring together people who have land to share with those who need land for cultivating food. Since its launch in 2009, it has grown into a community of more than 55,000 growers, sharers and helpers (Landshare 2011).

By creating more space for allotments, community gardens and orchards to meet rising demand, spatial planning can increase access to healthy food, provide educational opportunities, contribute to food security, and reconnect communities with their local environment and source of food (Landscape Institute 2009) (Section 27.8.3.4). Practices to reduce the extent and levels of soil contamination in urban areas would support the expansion of food production in cities.

Energy—practices and technologies. New technologies are expected to make a significant contribution to decarbonising energy supply, including carbon capture and

Box 27.48 Using Sustainable Drainage Systems to minimise the impact of a bypass—A5 Newtownstewart, Northern Ireland. Source: NIEA (2009).

The construction of the 2.6 km single carriageway trunk road near Newtownstewart in Northern Ireland, and two bridges over the River Strule, posed a risk to the scenic and environmentally sensitive Strule Valley. The river is important for recreational fishing and a fish farm is located downstream of the bypass. A number of measures were implemented to mitigate the environmental impacts of the project and those from traffic following construction. To protect the quality of the river water, Sustainable Drainage Systems were incorporated into the project's design.

The road was constructed without kerbs, and an open, stone filter, with a perforated pipe at its base, was installed along both sides of the road. Surface water flows from these drains to five detention basins that are planted with reeds to purify contaminants. Water from the basins is discharged to the river via penstocks, which can be closed in the event of a hazardous spillage.

storage of fossil fuel emissions, and the electrification of transport and heating. Geothermal technology is one area of research and development in the UK. The UK Government has committed £6 million to explore the potential of deep geothermal power generation in the country (HM Government 2009a). A field trial of heat pumps by the Energy Saving Trust (EST 2010) revealed that well-installed heat pumps can lead to domestic carbon savings in the UK, and that the simplest systems perform with higher efficiencies.

With respect to energy crops, empirical models using GIS can be used to produce yield maps for energy-generation potential, taking into account environmental and socioeconomic factors (Lovett *et al.* 2009). The use of this technology will optimise trade-offs between land uses at regional and local scales. Lovett *et al.* (2009) conclude that increased planting of biofuels crops on 350,000 ha (as proposed in Section 27.9.3.3) would utilise 4–28% of lower grade land and would not necessarily impact on UK food security. The use of hay as a biomass fuel from Semi-natural Grasslands could create synergies between bioenergy production and conservation (Section 17.4.2.2).

Dolman & Simmonds (2010) identified a number of steps to minimise the negative consequences of the marine renewable energy industry in Scotland including appropriate criteria for site selection, marine and spatial planning, Strategic Environmental Assessments, providing best practice guidance to developers, real-time monitoring, and measures to mitigate potential impacts.

27.9.4 Urban Planning, Transport and Energy Summary

Table 27.24 summarises the key insights from this review of responses in the context of urban planning, transport and energy, highlighting those that have been well-established, but also identifying a set of responses that are either in early implementation or are proposed. It is important to learn from these early pilots across all sectors to scale-up the adoption of an integrated ecosystem approach to the management of the UK's diverse habitats, which is one key policy direction that this review recommends.

27.10 Adopting an Ecosystems Approach: Integrated Responses

The MA (2005) defined integrated responses as those that “intentionally and actively address ecosystem services and human wellbeing simultaneously”. So far, this chapter has reviewed responses that have been tried within a selection of sectors which have a major influence on ecosystems and the services they provide. Such a sectoral approach represents

Table 27.24 Urban Planning, Transport and Energy Summary.

	Established responses	Early implementation, pilots	Proposed, under development
Knowledge	<ul style="list-style-type: none"> ■ Mapping of public green space ■ Collaborative interdisciplinary research centres and programmes ■ Strategic Environmental Assessments 	<ul style="list-style-type: none"> ■ Research on adaptation to climate change in urban areas 	<ul style="list-style-type: none"> ■ National database on green spaces ■ Urban ecosystem assessments, including valuation studies ■ Research on regulatory services and biodiversity in urban areas; cumulative impact of transport on ecosystems; energy technologies and their impacts on ecosystems
Legislation	<ul style="list-style-type: none"> ■ Town & Country Planning Act 1990, Planning and Compulsory Purchase Act 2004 ■ Environment impact assessment Directives ■ Environmental Noise Directive ■ Energy related EU legislation, e.g. Combustion Plant Directive 	<ul style="list-style-type: none"> ■ Designation of ‘Quiet Areas’ ■ Climate change and energy legislation, e.g. Climate Change Act 2008 ■ Renewable Energy Directive (2009) 	<ul style="list-style-type: none"> ■ National Planning Policy Framework ■ Decentralisation and Localism Bill (2011)
Policies, institutions and governance	<ul style="list-style-type: none"> ■ Planning Policy Statements ■ Regional Strategies (discontinued), Local Development Frameworks ■ UK Sustainable Development Strategy 	<ul style="list-style-type: none"> ■ Operationalising the concept of environmental limits in spatial plans ■ Management and ownership of green space by local communities ■ Improving sustainable modes of transport ■ Low Carbon Transition Plan ■ Renewable energy developments designed to also benefit biodiversity 	<ul style="list-style-type: none"> ■ Ecosystem services approach and Green Infrastructure in development planning ■ Integrate transport and spatial planning to minimise car use and improve public transport ■ Local Transport White Paper
Changing social attitudes	<ul style="list-style-type: none"> ■ Awareness raising and education ■ Energy Saving Trust 	<ul style="list-style-type: none"> ■ Volunteer opportunities to manage urban greenspace ■ Improve appeal of sustainable travel modes to change attitudes towards travel 	<ul style="list-style-type: none"> ■ Changing attitudes to travel and public transport ■ Training of planners to consider ecosystem services ■ Public participation in the delivery and ownership of renewable energy to reduce local opposition
Markets and incentives	<ul style="list-style-type: none"> ■ EU Emissions Trading System ■ Road pricing, congestion charging 	<ul style="list-style-type: none"> ■ Feed-in-tariffs (energy) 	<ul style="list-style-type: none"> ■ Reform of electricity market to favour low-carbon energy
Technologies and practices	<ul style="list-style-type: none"> ■ Water management and sustainable urban drainage systems (SuDS) ■ Measures to minimise impacts of energy installations and energy crops 	<ul style="list-style-type: none"> ■ Multi-functional Green Infrastructure ■ New renewable energy technologies, carbon capture and storage ■ New renewable energy technologies, carbon capture and storage ■ Measures to minimise impacts of energy installations and energy crops 	

how the impacts of human activities in the UK have been historically managed. Sector-by-sector approaches normally result in fragmented responses that do not adequately recognise the realities of the interconnections among natural and social systems. This has resulted in failures to achieve broader sustainable development goals. As the previous UK NEA chapters have demonstrated, it has also prevented the full potential and value of the goods and services provided by the UK's natural environment to be utilised.

Protecting the environment does not need to come at the expense of the economy and competitiveness. A growing body of evidence outlined in this chapter suggests that investment in nature can produce benefits that far outweigh costs. In the current economic climate, short-term political priorities of job creation and economic growth and stability are not necessarily incompatible with long-term imperatives of social, economic and environmental sustainability. Sustainable economic growth depends on healthy ecosystems delivering essential goods and services, whereas growth that undermines the UK's ecosystems also risks jeopardising the nations' future prosperity. This section will discuss approaches to integrated responses in a cross-sectoral context and options for collaboration between actors.

27.10.1 Knowledge (Foundational)

Our worldview has shifted from regarding human and natural systems as separate entities to an appreciation that the two are fundamentally interwoven. Humans impact ecosystems and environmental conditions, while ecosystems and the physical environment sustain and constrain human well-being and development. Both ecosystems and societies are complex and evolving through dynamic interactions at various scales, from local to global. Such linked natural and social systems are coined as socioecological systems. Our growing knowledge of the UK's socioecological systems provides a foundation upon which integrated responses can be formulated.

The MA (2005) provided a foundational review of our knowledge of ecosystems and the consequences of ecosystem change for human well-being. In addition to research since its publication, there is a need to better understand the relationships between different ecosystem services (provisioning, regulating and cultural) and the underpinning biophysical processes (supporting services). In the UK, data from the Countryside Survey and national datasets have been used in a Countryside Survey Integrated Assessment (Smart *et al.* 2010) to report on the ecosystem services provided by the countryside and how they respond to different pressures. The UK NEA takes the ecosystem research agenda forward further and identifies where more research is required to support improved decision-making. Essentially, we need to know how natural processes support the delivery of ecosystem services and how they might be best managed to deliver multiple ecosystem services, while respecting environmental limits.

The Scottish Government is encouraging an ecosystem approach, reflected in the Rural Affairs and Environment Strategic Research Programmes 2011–16, with ecosystem services as the first of eight research themes (Scottish

Government 2010h). The theme is structured to incorporate economics and natural and social sciences to encourage interdisciplinary research among research institutions.

Living with Environmental Change is a partnership of UK Government departments and agencies, Devolved Administrations, local government and research councils which provides a coordinated platform for funding multidisciplinary research in the context of environmental change (<http://www.lwec.org.uk>). The partnership has six identified challenges around which its programmes are structured: a) climate challenge; b) ecosystem challenge; c) resources challenge; d) health challenge; e) infrastructure challenge; and f) social challenge. Living with Environmental Change has a strategic role in coordinating activities for environmental evidence-gathering in the UK. Living with Environmental Change partners also engage in the co-design, co-delivery and coproduction of accredited activities, which involve long-term science and policy-driven research (including research programmes, monitoring, centres and networks) to address the six challenges.

One promising approach to assess the effects of policy changes on biodiversity is interdisciplinary modelling, although the use of this approach is still not widespread (Acs *et al.* 2009). Integrated ecological-economic modelling can be used to simultaneously address biodiversity conservation and economic viability for land managers. In order to be successful, in-depth knowledge of both disciplines is required, in addition to the identification of the problem and a common understanding among economists and ecologists of scales and modelling (Wätzold *et al.* 2006). One example of an integrated model applied in the Peak District National Park explored the effects of policy changes on biodiversity (bird species richness) and farm incomes (Acs *et al.* 2009). The results of the study showed that impacts of policy reform (such as changing from headage payments to single farm payments) differ across farm types and depend on policy design (for example, agri-environment options), suggesting that “policy initiatives which are uniform across farm types and bird species will not always produce results which are helpful for biodiversity conservation” (*ibid.*, p.11).

Historically, only ecosystem services that are bought and sold in markets at a price, such as food and timber, have been managed to maximise their provision. By recognising the value of ecosystem services not valued by markets, such as flood and climate regulation, we are better able to account for them in decision-making. A growing number of studies have made the link between various ecosystem services and attributes of human well-being, including economic (benefits and savings), socioecological (e.g. resilience), psychological (well-being), cultural (e.g. inspiration) and health benefits.

The valuation of ecosystem services has received continued interest from policy communities in the UK and abroad. In addition to this assessment, the United Nations Environment Programme's The Economics of Ecosystems and Biodiversity programme was established to understand the economics of biodiversity in the same way that the Stern Review drew attention to the economics of climate change. The Natural Capital project in the USA has developed a network of institutions working on valuing ecosystem services, and the Natural Environment Research Council

has recently established a Valuation Network to build research capacity in the valuation of ecosystem services in the UK. The Economic and Social Research Council, the Biotechnology and Biological Sciences Research Council and the Natural Environment Research Council jointly supported the Rural Economy and Land Use (RELU) programme which suggested considerable policy benefits from the adoption of an ecosystems approach (**Box 27.49**).

Behavioural change responses are increasingly seen as an essential long-term strategy for addressing environmental issues by encouraging pro-environmental behaviour among the public and organisations. Interdisciplinary research is rising to the challenge of providing the much-needed science-base upon which to develop behavioural change responses. A review by Upham *et al.* (2009) found that literature on public attitudes to environmental change was extremely variable in quantity. Most studies focus on UK attitudes to climate change and energy infrastructure rather than landscapes, species change and ecosystems. Dobson (2010) identified a number of research needs to better understand how to encourage environmental citizenship including: how many people are environmental citizens and how they influence others in their lives; evaluate the effectiveness of campaigns such as 10:10; and understand whether the wider public have values associated with environmental behaviour that are currently latent. The Department of Energy and Climate Change's Low Carbon Communities Challenge is likely to generate interesting findings from testing packages of responses to reduce energy use through community engagement.

27.10.2 Legislation (Enabling)

In Europe and the UK, environmental legislation really began to develop during the 1970s, in most cases, with single issue instruments addressing particular environmental media or pollution from a specific source. It developed on an *ad hoc* basis including in response to public sentiment on particular issues, or to environmental disasters. At EU-level (which is the source of large amount of environmental law affecting the UK), much focus was on water and waste. Early water legislation addressed quality objectives for drinking water, bathing waters, fish and shellfish waters, and was followed in later years by specific directives focusing on nitrate pollution and urban wastewater treatment. An early Waste Framework Directive (1975) addressed a number of specific waste issues such as hazardous waste disposal, landfill, packaging waste and waste shipment. Generally, an 'end-of-pipe' approach responded to environmental issues by introducing measures ex-post to deal with waste and pollution consequences rather than addressing source/systemic issues.

The drawbacks of this fragmented approach were recognised by the time of the Fourth EU Environmental Action Programme (1987–1991). Legislation began to move towards a more sectoral approach, attempting to analyse the overall environmental impact of economic sectors such as agriculture, manufacturing and transport. In the late 1990s, the pattern was towards consolidation and framework legislation, such as the Ambient Air Quality Directive, the WFD and the Directive on Integrated Pollution Prevention and Control. These attempted to put together long-term and coordinated work programmes for particular sectors.

Box 27.49 The Rural Economy and Land Use (RELU) Programme: benefits to policy making from adopting the ecosystem approach. Source: RELU (2010b).

A review of the outcomes from several projects run by the Rural Economy and Land Use (RELU) programme (2010b) identified a number of benefits that the full adoption of an ecosystem approach could have for policy making:

- Identify and quantify the range of services provided by land and water under different management options, drawing on evaluations of diverse datasets for any one area.
- Understand the synergies and trade-offs between the different types of benefits and costs associated with different options for land and water management.
- Reconcile competing objectives with policy measures which reward land managers for providing environmental public goods that are not rewarded by markets for food, fibre and energy.
- Appreciate how benefits and costs are distributed among different public and private interests, facilitate dialogue among them, and show what can and cannot be achieved through collaborative working.
- Design and promote new forms of land and water management that can deliver intended outcomes more cost-effectively.
- Design targeted policies that reward land and water managers for providing a wider range of beneficial services, within a single framework.
- Support the 'joining up' of hitherto fragmented policy objectives and funding mechanisms.
- Adapt policies to future challenges (political, economic, social, technological, legal and environmental), incorporating new knowledge as it becomes available.

More profound than a consolidation exercise is the recent movement towards incorporation of ecosystem principles. The WFD and the MSFD are both examples of EU legislation that provide frameworks within which there are opportunities to embed an ecosystem approach similar to that outlined in the Department for Environment, Food and Rural Affairs' Action Plan. These laws require management by ecologically delineated units, with monitoring and assessment against a range of ecological indicators. Both contain provisions for economic analysis of water or marine water use, with the WFD, in particular, requiring prices for water provisioning and treatment to reflect environmental costs. In national legislation, the Marine and Coastal Access Act applies holistic marine spatial and conservation planning in line with ecosystem principles. Neither, however, systematically recognise the economic value of ecosystem services, or provide a procedure to understand and manage trade-offs and synergies.

In EU law, an integration principle is specifically delineated in Article 11 of the Treaty on the Functioning of the European Union. According to this, environmental protection requirements must be integrated into the definition and implementation of the Union's policies and activities, i.e. across its activities in all sectors. In practice, although progress has been made in incorporating environmental parameters, for example in CAP or via requirements for Environmental Impact Assessments in various sectors, integration is still to be achieved. Systematic recognition of the economic value of environmental services might be the first step towards genuine legislative integration.

27.10.3 Policies, Institutions and Governance (Enabling)

Internationally, the ecosystem approach has gained currency as a powerful framework for the assessment, planning and management of the natural environment and resources.

The Department for Environment, Food and Rural Affairs has embraced the ecosystem approach as an important contribution to ‘securing a healthy natural environment’ through a more strategic and integrated process (Defra 2007d). The new marine planning regime is an example of how the Department for Environment, Food and Rural Affairs, together with the Devolved Administrations, are embedding an ecosystem approach in marine planning, as discussed in Section 27.7.3. There has been substantial piloting of the ecosystem approach in managing flooding and water quality (Section 27.3), whereby the accumulative impacts and responses are considered across catchments. Research has also been undertaken in three regions to understand how the concept of environmental limits can be integrated into decision-making (**Box 27.44**). The updated plan stressed the fundamental importance of stakeholder participation in decision-making for delivering an ecosystems approach, especially ensuring that appropriate stakeholders are engaged.

The Department for Environment, Food and Rural Affairs has embedded the ecosystem approach in several key policies and legislation. ‘Ecosystem services’ is one of three priority challenges for evidence gathering in the Evidence Investment Strategy. The Department for Environment, Food and Rural Affairs’ Future Water sets out a vision for water in 2030, and acknowledges the need to adopt a whole systems approach to managing water. The Appraisal of Flood and Coastal Erosion Risk Management states that opportunities to improve the capacity of the environment to provide services should be identified and the benefits valued. The Marine and Coastal Access Act (2009) also sets out an integrated approach to the management of marine activities with the ecosystem approach, at least in principle, if not yet in practice.

Multifunctional land use has been placed at the heart of how we can deliver ecosystem services and will be an essential contributor to climate change mitigation and adaptation. **Box 27.50** gives an example of how, by thinking outside a single land-use perspective, areas previously seen as unproductive can have significant value. There are numerous examples like this for upland areas but multipurpose land use in lowland areas is presently relatively rare. Currently, the two primary mechanisms for influencing land use are the planning system for developed areas and agri-environment and forestry schemes (LUC & GHK Consulting 2009).

Neither the UK in its entirety nor England, Wales and Northern Ireland as individual countries have a land use strategy. The Scottish Government has taken a lead in this area, and its first Land Use Strategy was laid in Parliament on 17 March 2011 (**Box 27.51**). The advantage of developing a land use strategy is that it can give a more integrated and consistent approach to managing land use, rather than piecemeal or incremental change; it can also identify opportunities for multifunctional land use (Foresight 2010) that can produce synergies for ecosystem service provision. The formulation of a strategy needs to be framed by political decisions, such as the scale at which decisions are made, and the environmental capacity of land.

Integration of science and policy across sectors can ensure the transition between urban, rural, freshwater

and marine habitats is more carefully managed. There is increasing interest in landscape-scale planning rather than planning by sector (Natural Capital Initiative 2009). To achieve more integrated management of land, water and sea there would need to be better connections across sectors, government departments, local authorities, the devolved countries and the rest of Europe. The Department for Environment, Food and Rural Affairs is already working more with other departments by encouraging the adoption of the ecosystem approach where appropriate. A range of government departments, including the Department for Communities and Local Government, the Department for Transport, Her Majesty’s Treasury, the Department for International Development, and the Department for Energy and Climate Change, are considering how taking better account of the value of ecosystem services can enhance the delivery of their own policy objectives in specific policy areas or through appraisal mechanisms.

Working with the Department of Communities and Local Government will be critical for using the planning system to protect and enhance rural and Urban ecosystems (Section 27.9). The Marine Management Organisation has

Box 27.50 Land use for conservation and aquifer protection. Source: extracted from LUC (2008).

“The chalk aquifers of the South East provide 70% of the water needs of the South East—the most populous region in England. In the face of climate change these aquifers are becoming increasingly threatened by ground water pollution and falling water levels with rising water abstraction and reduced recharge. They require nurturing and appropriate management to ensure that their enormous economic value is retained for future generations. Here there are clear synergies with other conservation objectives. The conservation of aquifers requires careful management of the land surface that overlies them, with low fertiliser levels and improved water infiltration, best provided by low input and extensively managed grasslands—objectives that are shared with the conservation and restoration of chalk grassland, one of the main habitats of international importance associated with the downlands.”

Box 27.51 Scotland’s Land Use Strategy: land use to provide ecosystem services. Source: Scottish Government (2010a; 2011b).

The Scottish Government has, for the first time, set out a high level strategy for sustainable land use across the country. It aims to guide and support those involved in land use management decisions by providing a long-term vision and objectives that will enable an integrated approach to land use in Scotland. The Land Use Strategy focuses on common goals for different land users, and provides a set of principles for sustainable land use to inform policy making by government and across the public sector.

The Scottish Government is developing an action plan to take forward the proposals that are included in the Land Use Strategy. It has also produced an information note on applying an ecosystems approach to land use. The ecosystems approach is summarised in the form of three key principles: i) the consideration of natural systems by using knowledge of interactions in nature and how ecosystems function; ii) taking account of the services that ecosystems provide, especially those that underpin social and economic well-being; and iii) involving people, especially those who benefit from ecosystem services and those who manage them.

been formed to be responsible for the integration of sectors (including fisheries, marine energy and seabed cable-laying) into the UK's new marine planning regime. The ecosystem approach may also require that links between ecosystem services and public health be formalised in policy and delivery through institutional cooperation. Cooperation and co-management between local authorities is essential for managing the environment at appropriate scales to deliver ecosystem services. For example, managing water at the catchment-scale and managing GI cannot be confined to administrative districts since natural units do not align with them (RELU 2010b). This also extends to natural units that cross the borders of the UK's nations. The WFD, for example, has required cross-border working among countries in the UK to develop RBMPs. The Solway-Tweed River Basin District, for example, crosses south-east Scotland and north-east England, requiring that the Scottish Environment Protection Agency and the Environment Agency (and appropriate stakeholders from each side of the border) work together to develop and implement the RBMP. Additionally, for the Marine and Coastal Access Act and Marine (Scotland) Act to improve fisheries management, cross-border cooperation between the Marine Management Organisation and Marine Scotland will be fundamental.

There is also scope for the UK to learn from other countries and their experiences of integrated policy making. The different ways that European countries are implementing the WFD and MSFD will provide many valuable lessons. Australasia and North America, although in different contexts, have many positive examples of approaches to nature resource management that could have resonance here as well. Watson (2004) argues that inter-organisational collaboration, rather than coordination, is essential for addressing land and water management problems under increasing complexity and uncertainty. Coordination may overcome problems of administrative fragmentation, but collaboration provides an open-ended, iterative approach to river basin management. Taking lessons from experiences in the Fraser Basin in British Columbia, Canada, key institutional conditions and arrangement for successful collaboration to take place in river basin management include: a common vision of the desired future conditions in the river basin among stakeholders; adaptive capacity to cope with changes in knowledge and circumstances; resources to fund the collaborative process and implement decisions; independence from government control, but with government involvement; fair representation of the various interests of groups; outputs to ensure the process is action orientated and not just a forum for debate; and outcomes to demonstrate that collaborative efforts have a positive impact on the sustainability of river basins.

27.10.4 Changing Social Attitudes (Enabling)

Historically, policy makers have tried to change the behaviour of individuals and organisations through legislation, fiscal measures, or market-based measures such as carbon trading (Dobson 2010). Engagement and communications can also be used to change behaviour, and have had mixed success in the UK. Communications involve a one-way

transmission of information and messages, whereas other approaches to behavioural change involve dialogue and the participation of the public in activities and decision-making. By positively changing attitudes towards environmental issues, pro-environmental policies and decisions are more likely to be accepted by the public (Waylen & Fischer 2010). Current government approaches are mainly one-way communications through mass media, such as the Act on CO₂ campaign. There have been concerns about the cost-effectiveness of communication campaigns and whether they are able to exert any long-term influence on behavioural change (POST 2010).

The Department for Environment, Food and Rural Affairs' pro-environmental behaviour framework (Defra 2008e) seeks to protect and improve the environment by primarily encouraging more sustainable consumption patterns, particularly in reference to reducing carbon emissions. The framework broadly follows a social marketing methodology, a technique adapted from commercial marketing practices. Social marketing breaks down whole systems into groups of people and organisations based on commonalities of behaviour, motivations and/or activities, and targets messages and marketing at them accordingly. This acknowledges that a campaign must take account of how messages are received and interpreted by a target audience, and what the target audiences' motivators and barriers to change are likely to be (Anable *et al.* 2006). Best practice in social marketing on environmental issues includes using influential people within communities to deliver messages, using positive messages rather than arousing fear and guilt that can cause people to 'switch off', and using non-environmental messages that fulfil other motivations such as saving money and health benefits (POST 2010). Consistency of messages is also important, as messages from different government departments can sometimes be contradictory. For example, people are being encouraged to eat more fish for health reasons yet overconsumption of fish could further threaten depleted fish stocks.

Rather than communicate messages to the public and organisations, engagement involves a two-way communication among individuals, groups and a change-maker. To change behaviours and attitudes, it is important to understand the factors that shape behaviour, including knowledge (of environmental issues), psychological factors (beliefs, values, attitudes), social norms (what people perceive as 'normal'), habits (routines), structural conditions (institutions, society, technology), and socio-demographic patterns. Research has shown a number of techniques for encouraging behavioural change such as making the impacts of behaviour visible (e.g. Smart Meters for electricity use), making the behavioural change aspirational, and providing information that enables action (e.g. the Department for Transport's 'Smarter Choices' personalised travel plans). Working with a whole group or community can be effective since people feel part of a collective movement (POST 2010; **Box 27.52**).

Because the factors which shape behaviour are so complex, a 'whole system approach' may be required to encourage behavioural change. Policy makers increasingly acknowledge the need for a multi-instrument approach

(Darnton 2006) where innovative policies, practical measures and consistent messages are targeted across sectors, within and among organisations, and at every level of society (Lucas *et al.* 2008). Joined-up working within and between government departments would be important in a whole system approach. Alongside social marketing and engagement, other incentives to change behaviour may be needed such as financial incentives (e.g. to take up electric cars) or regulations to encourage wider uptake once there is support from a significant proportion of the population to make it politically feasible. Other measures such as eco-labelling can make it easier for people to change their behaviour.

Many members of the public have become disconnected from the natural environment. By not being in touch with nature, people are less inclined to understand our reliance on ecosystem services and that it is within our self-interest to protect and enhance them (Natural Capital Initiative 2009). In Section 27.9.3.4, we report on the importance of urban dwellers having contact with greenspace to provide opportunities for further engagement in environmental activity. Spending time in nature also has significant mental and physical health benefits. Ensuring all sections of society have access to greenspace would have benefits for well-being and may encourage pro-environmental behaviour. Making use of the natural environment as a teaching resource can help to produce environmentally active citizens.

The formal education system offers substantial potential to change the behaviour of an entire generation. Not only

could this bring benefits in the future, but the ‘nag factor’ from children has been found to be very influential on the behaviour of parents as well. Environmental education has been present in the UK since the 1970s, and since the 1990s, the UK Government has included sustainable development in the national curriculum. Education for sustainable development encompasses many different aspects of sustainability such as environmental education, development education, and global citizenship. Each of the Devolved Administrations has its own approach to sustainable development education. In England, education has largely been through government-led education (e.g. formal, further and higher education). In Northern Ireland and Scotland, there are bodies and policies specifically for education for sustainable development, whereas the Welsh Assembly Government has placed it at the heart of their frameworks and activities, and have a strong global citizenship element in their curriculum. Northern Ireland has made guidance on good practice on education for sustainable development a component of initial teaching training (Dobson 2007). Increasing awareness and knowledge among teachers in all subjects of the value of nature to human well-being and of environmental issues, in general, would increase their capacity and passion to convey information to children and develop citizenship qualities.

The Eco-schools programme has perhaps had the most success in engaging schools and children in environmental and sustainability activities. Eco-schools is an international award programme that guides schools to improve their sustainability. In Scotland and Wales, 80% and 90% of schools have taken up the scheme, respectively, whereas, in England, 55% have taken up the scheme and Northern Ireland has almost half its schools registered as Eco-schools. The programme uses a flag system (eco-school, bronze, silver and gold) to reward schools for progress in several areas, such as waste, energy, transport and global perspective. By embedding principles of sustainability at school, the programme not only reduces the impact of the school, but also engages pupils about sustainability (**Box 27.52**).

Consumption choices influence market forces, which, in turn, affect land management, the exploitation of natural resources and pollution. Ultimately, what and how much people consume impacts ecosystems and their ability to provide services. Choices made on price alone, for example, would favour intensive food production with low costs. The factors noted above that shape behaviour, however, result in consumer choices that favour production techniques that have a lower impact on ecosystems. Eco-labelling and certification schemes enable consumers to know and trust how products are produced. Organic food certification (see Section 27.4.3.6) and the MSC’s label for fish (Section 27.7) are prime examples. In addition to the behavioural change responses above, the media has an enormous role to play in encouraging pro-environmental behaviour. The widespread switch from single-use plastic bags to reusable bags (**Box 27.54**) demonstrates how a mix of community action, media coverage and supermarket power can lead to a large proportion of the population changing their habits.

Box 27.52 Collective change: Ecoteam’s group-based approach. Source: POST (2010).

‘Ecoteams’ is an initiative run by the environmental charity Global Action Plan since 1990. Groups of between six and eight people attend regular meetings over five months, guided by a trained facilitator. The participants share information, discuss actions and monitor their progress on criteria such as energy use.

The scheme is claimed to cut emissions by 17% and a high proportion of participants appear to maintain their change in behaviour. Global Action Plan state that the reason for the programme’s success is that the information comes from peers who they trust; individuals are motivated by support from the group and by comparing their progress, and actions focus on small changes that fit existing lifestyles. However, the risk of schemes like this is that they tend to attract those who are already engaged and don’t reach a mainstream audience.

Box 27.53 Eco-schools success story: Pembroke Dock Community School, Wales.

Pembroke Dock Community School, located in rural Pembrokeshire, Wales, has won the international Green Flag three times—the highest award within the Eco-schools programme.

The school has 70 members on its Eco-schools committee who coordinate activities and maintain momentum. The pupils are engaged in the work through focus groups which meet weekly to work on key activities, such as an Eco-newsletter and school-wide projects. An ideas box is available for any pupil to suggest ideas and thoughts. The children have been involved in activities ranging from daily recycling, watering plants and providing bird seed for birds, to one-off events such as the production of a school musical on pollution and its effects. The school has also embedded outdoor learning as part of their school curriculum; children visit a local organic farm, and have regular excursions.

Box 27.54 Changing shopping habits: the case of plastic bags. Source: Ritch (2009); Brennan *et al.* (2009); Chase & Hampole (2010).

The impacts of plastic disposable bags rose to prominence in the media between 2007 and 2009, and led to the widespread adoption of reusable bags across the UK. This change in behaviour resulted from a number of sources.

At a community level, Rebecca Hoskings, a wildlife documentary film producer for the BBC, started a campaign to eliminate plastic bags from her local community of Modbury, Devon. By engaging local businesses and people in the movement, she succeeded in her mission in 2007. Following substantial media coverage, many other communities replicated Modbury's campaign with varying degrees of success.

At the same time, the issue of disposable bags rose up the political agenda. Seven of the UK's biggest supermarkets signed an agreement with the government to reduce the number of plastic bags they hand out by 50% by May 2009 (against 2006 levels). Marks and Spencer led the way in this effort by imposing a surcharge on plastic bags, after a successful trial in Northern Ireland where plastic bag use was reduced by 66%. Tesco has provided incentives to customers to reuse bags by awarding 'Green ClubCard points', which, between their introduction in August 2006 and 2009, resulted in 2 billion fewer bags being distributed. While these efforts, and those by other supermarkets, have made a substantial contribution to reducing plastic bag use, supermarkets have been criticised for not going further than their voluntary agreement and for not building on their success to bring about further pro-environmental behaviour. Reusable bags have become popular in the UK, but there are concerns that they are not reused enough—if they are only used a few times, their lifecycle impacts may be greater than disposable plastic bags.

While the UK has taken a voluntary approach to reducing plastic bags, other countries in Europe (Italy, Denmark and Ireland) have imposed levies to create disincentives for their use. In Ireland, a 15 cent levy reportedly reduced plastic bag consumption by 92%. Plastic bags as visible litter have consequently declined from 5% to 0.3%. The levy is paid into an Environment Fund, which accumulated €12.7 million in 2003 to support waste management and other environmental initiatives.

27.10.5 Markets and Incentives (Instrumental)

Market- and incentive-based instruments have been some of the most powerful drivers of ecosystem change over the past three decades. Fiscal incentives and disincentives can create positive outcomes very shortly after a charge is introduced (for example, congestion charging in Central London, Section 27.9). Given the immediacy and perceived importance of many environmental problems (such as climate change), they can be useful tools for bringing about timely behavioural change. On the downside, since people are responding to the financial incentive rather than underlying ethical principles, they may return to their previous behaviour once the incentive is removed (Dobson 2010). Furthermore, the New Economics Foundation (New Economics Foundation 2005) argue that in instances where people are naturally motivated to 'do the right thing' and feel bad if they don't, a punishment, such as a fine, can have a counter-productive effect by cleansing the conscience of the guilty party in return for accepting a punishment. This legitimises, rather than deters, the behaviour. However, incentive-based approaches, which can change behaviour quickly, can be combined with measures to change social attitudes that take longer to establish, but are more likely to prove sustainable and durable.

European and government subsidies for the agriculture, energy and fisheries sectors have expanded and intensified production at the cost of the provision of services not valued by markets. The narrow objective approach of these subsidies failed to acknowledge the consequences for the attainment of wider policy goals, such as sustainable development. The reform of subsidies that have caused unintended consequences is likely to be one of the most cost-effective means of delivering multifunctional land, water and sea use. Reform of the CAP is discussed in detail in Section 27.4.3.2, and reform of the CFP in Section 27.6.3.2.

Conventionally, the taxation system is sparingly used as an instrument to change behaviour, focusing predominantly on raising revenue in the most efficient (Natural England 2009g) and politically acceptable way possible. If taxes are

used to dissuade damaging or undesirable behaviour and activities, they can be a powerful driver of positive change. Not only can they reduce social costs, but they can also raise revenue for the government. The introduction of an environmental tax can be market 'correcting' in that the costs to the environment are better represented in the price of a product or service. Several environmental taxes have been introduced in the UK including the Aggregates Levy, Landfill Tax (**Box 27.55**) and Climate Change Levy. There is some evidence that these taxes have been served their purpose well, both for the environment and the exchequer. The public and political acceptability of taxation and other disincentives, however, can be problematic. Some taxes, such as fuel duty and Landfill Tax, are more likely to transcend different governments due to their importance as revenue sources. Others can be removed or decreased resulting in the behaviour of the target audience returning to pre-tax patterns if their underlying social attitudes and values have not changed (Dobson 2010).

The potential to use environmental taxes more widely is substantial, for example, by shifting taxation from 'goods' like labour to 'bads' like pollution. It is argued that such a shift to 'green taxes' would have benefits for the natural environment and the services derived from it, and also have economic advantages by making employment more attractive through reduced taxes, thereby yielding a double dividend. This may have the potential to increase UK employment and economic growth during a period of economic recovery (Green Fiscal Commission 2009; Natural England 2009g).

Environmental markets attempt to use market forces that have already been effective in driving innovation to initiate positive change that protects or enhances the environment. Markets have already been established internationally to encourage more efficient resource use and incentivise the provision of ecosystem services. In Europe, the EU Emissions Trading Scheme uses a cap and trade approach favoured by business and governments (CEMEX 2007). The effectiveness of the scheme is contested, but it is widely agreed that a persistently low price per tonne of carbon has reduced the impetus for investment and innovation to cut emissions.

Box 27.55 The impact of Landfill Tax.

The Landfill Tax was introduced in 1996 with the aim of reducing the amount of waste going to landfill and creating an incentive to find more sustainable means of waste management such as recycling. At first, a standard rate of £7 per tonne of waste was charged; this has since risen incrementally to £48 per tonne in 2010/11 (Defra 2010j). This tax has been the government's primary mechanism for meeting its obligations under the European Landfill Directive (99/31/EC). The tax is designed to be 'revenue neutral', meaning that all funds raised are distributed through the Landfill Communities Fund back into programmes that improve waste management, encourage recycling and promote the development of new waste technologies. The fund has supported 34,000 projects across the UK since 1996 (Entrust 2010). The Landfill Tax may, however, be an incentive for increased fly-tipping in the UK, with the result of associated increases in enforcement and clean-up costs (Webb *et al.* 2006).

Local authorities have to pay Landfill Tax on every tonne of household waste sent, hence there is a strong incentive to increase recycling rates and reduce waste. Today, almost 40% of household waste is recycled in England (3.3 times the amount recycled in 2000/01), but the tonnage of total household waste sent to landfill has only decreased to 94.4% of 2000/01 levels (Defra 2010l).

Overseas, markets have been established for water abstraction (e.g. Australia) and for individual transferable quotas for fishing in Norway and New Zealand (Natural England 2009g). Biodiversity offsetting is gaining popularity, but there are significant risks associated with its use (Section 27.2). Government intervention is normally needed to create the institutional arrangements and incentives necessary to establish markets.

Payment for Ecosystem Services (PES) is an innovative approach to accounting for the value of ecosystem services in decision-making. It involves paying land managers and others to undertake measures to protect and enhance the quantity and quality of ecosystem services (Defra 2010n). By putting a price on ecosystem services that are not conventionally valued by markets, it alters the economic incentives that motivate the actions taken by land managers, and corrects existing market failures. The payment under PES is paid directly by the beneficiary of the ecosystem service, and the transaction is voluntary.

The Environmental Stewardship scheme is a variation of a PES scheme. It makes payments to farmers who volunteer to take measures that can enhance ecosystem service delivery, such as leaving field boundaries uncultivated to create habitat for biodiversity, intercept agrochemical runoff from fields and store carbon. However, the scheme makes payments based on income foregone from participating, rather than the value of the benefits provided. The Rural Economy and Land Use Programme (RELU 2010b) proposes making payments for environmental public goods from farmland which reflect the true cost of providing them, rather than the opportunity costs of farming the land. Payments for ecosystem services have also been paid indirectly through, for example, the value added to food via organic certification schemes and eco-labelling.

New examples of PES are rapidly emerging. The Westcountry Rivers Trust's WATER project aims to establish a market-based catchment restoration scheme. The National Forest in England uses a novel approach where land managers design schemes to supply specific ecosystem services, quoting

a cost and time period of commitment, and then competitively implement them (RELU 2010b). Natural England has launched three upland pilots to explore whether packages of ecosystem services can be turned into business opportunities using the PES concept (Box 27.56).

27.10.6 Technologies and Practices (Instrumental)

Technological responses have been the prevailing reactions to many environmental issues. Technologies have tended to be deployed as a response to single issues with some success. Wastewater treatment plants, for example, have significantly improved water quality across the UK (Section 27.3). However, in many cases, decisions to use technology have failed to consider the broader implications for other locations and ecosystem services. For example, Coastal planning (Section 27.7) describes how sea defences and coastal protection have served their purpose locally, but have exacerbated erosion and flooding downdrift. Furthermore, they have reduced intertidal habitat for wildlife, which also stores carbon and detoxifies water.

Technologies will continue to play an important role in addressing many of the problems identified in this assessment. Such technological responses are discussed under each of the sectors in this chapter. However, in future, decisions to use technologies need to better account for unintended consequences throughout their lifecycle on whole systems. Opportunities to achieve multiple benefits simultaneously should be exploited (Foresight 2010); for instance, offshore windfarms may create Marine habitat through the creation of 'artificial reefs', thus enhancing recruitment in commercial fisheries.

Ecological innovations are likely to play an increasing role given recent evidence of their performance in providing multiple benefits and cost-effectiveness. For example, green roofs insulate buildings, making them more energy efficient; regulate temperature and humidity; attenuate surface runoff rates; and reduce air and noise pollution (Chapter 10, Box 10.9). Many of the case-studies of multifunctional innovations already discussed in this chapter, such as managed realignment schemes and GI, have been proven to deliver benefits significantly outweighing costs and with relatively short payback periods. To realise the full value of services that could be provided by the UK's natural environment, public investment will be required in protecting, maintaining and enhancing the UK's ecosystems.

27.10.7 Voluntary Actions (Instrumental)

In the past, decision-making processes have followed a linear path of 'propose-announce-decide', whereby a problem was diagnosed, response options were recommended by experts, the public was consulted, a political decision was made, and then implementation was enacted (RELU 2010b). A participatory approach is core to the goals of an ecosystems approach. The reasons for involving stakeholders in decision-making include: that they have the right to participate in decisions that impact them; engagement builds trust and legitimacy in decision-making; and that decisions and their outcomes become more informed (Fish *et al.* 2011). Moving from the 'propose-announce-decide' pathway to an

Box 27.56 Natural England's pilot schemes for payments for ecosystem services. Source: Natural England (2009b, 2009g).

In November 2009, Natural England launched pilot projects in three upland areas in the South West, Cumbria and Yorkshire to explore how a broader range of ecosystem services can be provided, including carbon storage, flood attenuation, water purification and supply, recreation, and biodiversity (**Figure 27.66**).

The projects are integrating ecosystems service concepts into their design from the beginning by undertaking an assessment of services currently provided in each area and the potential to deliver a wider range of other benefits. Valuation techniques will be used to attach an economic value to each service where possible. A range of options that can be taken by land managers will be scoped, and payments calculated for the improvement to the quality and quantity of ecosystem services that these options would produce.

The overall aim will be to implement integrated land management in the upland areas, with the beneficiaries and providers of the services working in partnership. Natural England hopes to demonstrate to the beneficiaries the value of the services they are receiving and encourage them to enter into a voluntary agreement with the landowners to supply them.

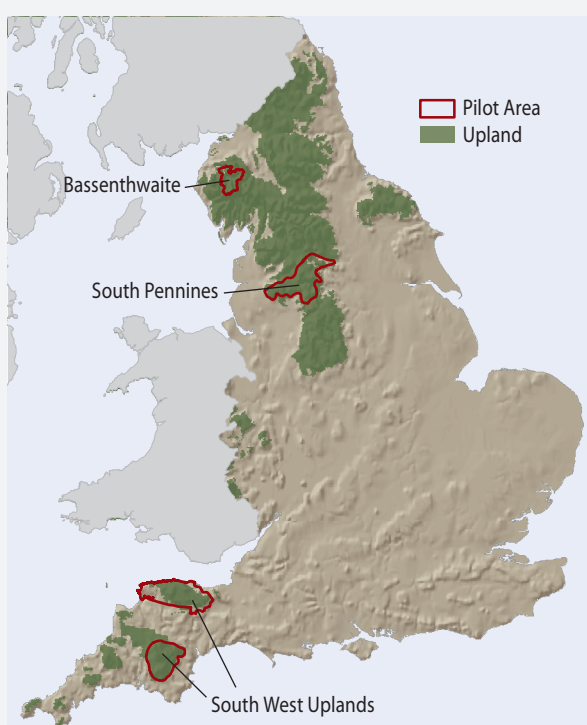


Figure 27.66 Three planned pilot schemes for payments for ecosystem services. © Natural England (2009b).

approach of 'engage-deliberate-decide' can better engage land managers, local communities and other stakeholders to effectively rise to future challenges. This latter approach has been adopted by the Environment Agency in the development of RBMPs in order to engage a diverse range of stakeholders who have an interest in, or are involved in activities that impact on, the water environment (e.g. spatial planning, highways, agriculture, forestry, sewage, research, water industry) (see Section 27.3). There is, however, significant scope to go further in devolving responsibilities for land and water management to local stakeholders.

A study of public participation in environmental decision-

making in the Great Lakes region of the USA and Canada concluded that public involvement had mostly positive outcomes, but that the legitimacy of those representing wider interests of the public is important for achieving successful results (Beierle & Konisky 1999). The USA has moved to more participatory governance of water in the last decade, representing a shift from top-down decision-making to bottom-up approaches. This change emerged due to frustrations with tackling multiple water management issues, which require detailed knowledge of local situations and the coordination of multiple agencies. The collaborative approach that they adopted involved face-to-face information exchange and problem-solving among stakeholders, with an emphasis on finding creative, win-win solutions to a variety of problems. Although the process takes time, it is likely to build mutual understanding and trust among the stakeholders, enhance collaborative efforts to tackle interrelated problems, and improve the support for implementation (Sabatier *et al.* 2005).

The balance between national, regional and local decision-making influences how land is managed to deliver ecosystem services, what priorities are set, and who is involved. Decentralisation approaches propose to transfer considerable powers from central government to local authorities and, ultimately, to local communities who are argued to have the most interest and knowledge of what is best for their local area. This could have significant implications for nature resource management in rural and urban areas.

Decentralisation would mean giving communities, voluntary organisations, trusts and cooperatives a greater role in enhancing the natural environment in their local area. The activation of volunteers, the formation of new types of community groups and environmental awareness raising campaigns could form part of such a package of measures (RELU 2010b; **Box 27.57**). Volunteers can bring knowledge to the management of natural resources that experts can't; anglers and fishery managers, for example, have first-hand knowledge of the water environment and care about it. Combining such local knowledge with scientific expertise will improve the performance of response options (Woods 2009). The Rural Coalition provided several recommendations for empowering local communities including embedding community-led planning, building local capacity for delivery (e.g. advice and training for local enablers), and Parish and Town Councils facilitating community-led plans (The Rural Coalition 2010). Pilots are needed to test new local approaches, building on initiatives such as Community Forests (Section 27.5).

Despite the benefits of a community-based approach, a balance needs to be struck with management at a local level and ensuring strategic management at appropriate scales for the ecosystem services involved in order to account for services that might be consumed some distance from their source. For example, management decisions made locally for water supply and flood risk could have potentially substantial cumulative effects at the catchment-scale. Mitigating and adapting to climate change is also likely to require a more integrated, strategic perspective. Broad principles and a common approach to decision-making processes at a national level are likely to be complemented by detailed implementation at regional or local levels (Foresight 2010). A more centralised

Box 27.57 Local participation in catchment management: Australia's Landcare policy. Source: Benson *et al.* (2010).

In Australia, participatory, community-led approaches to integrated land management have been characterised by the Landcare movement: a community-based initiative which supports voluntary and farming groups in tackling environmental issues, especially soil erosion and salinisation of land. Encouraged by its successes, Landcare members lobbied the federal government to roll-out the initiative nationally, which it did by announcing the Decade of Landcare policy; \$360 million was provided in grants to community groups to support their activities. The National Heritage Trust continued to provide funding after its establishment in 1996, and was also instrumental in establishing regional-scale governance across Australia for coordinating natural resource management at the local level. By 1998, there were 2,500 Landcare groups across Australia with a membership of 65,000.

A new scheme, Caring for Our Country, established in 2008, builds on this work by supporting the regional institutions and allowing them to bid for funding by submitting a business plan. Nearly \$171 million has been invested in regional natural resource management organisations on a competitive basis, and a further \$138 million allocated annually to support their environmental protection activities. The regional organisations must set out how they will engage stakeholders, including local communities and the Landcare groups, and how they will communicate information to the public.

Evidence from the earlier Landcare schemes suggests the Australian approach was successful in mobilising local actors in natural resource management and has demonstrated quantified improvements in the environment.

approach would involve greater direction from national government responsible for achieving the strategic and sustainable management of land (Foresight 2010).

27.10.8 Cross-sectoral Synergies and Integration

The review of responses in this section has focused on attempts to adopt a more integrated approach to ecosystem management. In previous sections, the discussion of sectorally specific responses also identified a number of interventions that are adopting a more integrated approach. These are reviewed here, to highlight the possibility for cross-sectoral synergies in responses which allow the delivery of multiple ecosystem services.

The Biodiversity section (Section 27.2) identified the role of green accounting as a mechanism for including values for natural capital and ecosystem services alongside an economic appraisal of national wealth. The UK NEA economics chapter (Chapter 22) provides further guidance on methods for valuing ecosystem services, and complements initiatives discussed here, such as the Natural Environment Research Council's Valuation Network. Other **knowledge-based responses** that offer possibilities for integration are the water cycle studies that attempt a more comprehensive assessment of the impacts of development on the water environment (Section 27.3). These overlap with similar approaches to integrated assessment such as the Countryside Survey Integrated Assessment.

In the context of **legislation**, the most significant opportunities for integration discussed in previous sections emerge from discussions around reforms to the CAP (see Section 27.4) and the CFP (see Section 27.6). In both cases, embedding ecosystem-based thinking in proposals for reform will allow for a more cross-sectoral approach to be adopted, which will deliver multifunctional and resilient

habitats, and recognise the importance of these activities in broader ecosystem management.

There are a number of areas of **policy-, institutional- and governance-based** responses discussed in a sectoral context that are beginning to reflect a more integrated approach. Adopting principles of Integrated Water Resource Management and strategic flood risk management allows for a more coordinated approach to manage water and land resources to secure ecosystem health and human well-being, and to minimise vulnerability (Section 27.3). The impact of forested land uses on water quality and quantity is an important consideration in both the Water and Forestry sectors. The recognition of a holistic approach to land use may require collaboration between farmers to achieve landscape-scale benefits that secure habitats for certain mobile species such as butterflies and birds (Section 27.4); this complements more integrated land use planning such as Scotland's Land Use Strategy. Multifunctional forested landscapes have scope to deliver potentially synergistic recreational, conservation and climate change mitigation outcomes, and are being promoted (Section 27.5). Within the Marine context, marine spatial planning and Integrated Coastal Zone Management can reflect integrated ecosystem-based thinking and deliver substantial benefits (Section 27.7). Spatial planning in an Urban context and the promotion of GI also provides potential benefits for ecosystem functioning and human well-being (Section 27.9).

The educational system offers opportunities to **change social attitudes**, especially of the young, such as in the case of Forest Schools (Section 27.5). There are additional benefits from outdoor learning opportunities including improved mental and physical health, and greater community engagement with local forests. Similarly, improving access to greenspace in Urban areas can provide health benefits and improve environmental awareness (Section 27.9). In a wider context, changing social attitudes to issues such as forest certification (Section 27.5), the certification of fish products (Section 27.6) and food sourcing (Section 27.4) are important reflections of the sustainable consumption agenda that has become more prominent in recent years.

Agri-environment schemes (Sections 27.2, 27.3, 27.4) are an important example of the ways in which **markets and incentives** can be harnessed to deliver an integrated approach to ecosystem management. Payments for Ecosystem Services can also reward landowners for the delivery of multiple ecosystem benefits (Section 27.3). Similarly, there is scope for rewarding marine managers and fishers for the delivery of conservation outcomes alongside the provision of sustainable fish for consumers through conservation credits schemes (Section 27.6). These innovative uses of price mechanisms complement existing systems of environmental taxation and congestion charging which seek to use the power of markets to promote pro-environmental behaviour.

The use of new **technologies and practices**, such as biodiversity offsetting, can be used to enhance ecosystem values in the wider countryside, and can encourage the involvement of private sector stakeholders in habitat creation (Section 27.2). Similarly, restoring natural rivers and Floodplains, including through the reintroduction of vegetation and forest cover, helps to slow water down,

reducing flood risk and improving water quality and security of supply (Sections 27.3; 27.5). Also, promoting sustainable catchment drainage and restoring and managing Wetlands in order to intercept pollutants provides improvements in water quality, as well as increased wild species diversity and the supply of materials, such as reeds for thatching (Section 27.3). In the coastal context, managed realignment schemes have been shown to significantly reduce the costs of hard sea defences, while also acting as a store of carbon and providing a useful habitat for wild species (Section 27.7). Within the farmed landscape, techniques such as Integrated Farm Management can benefit species abundance, as well as benefiting water quality, pest regulation and controlling soil erosion (Section 27.3). Soil conservation efforts that focus on peat soils provide synergies between biodiversity conservation and climate change mitigation agendas (Section 27.2). In the energy context, some renewable technologies offer win-win opportunities with conservation, such as large wave and tidal generation sites which may need to be closed zones for fishing, thereby acting as MPAs (Section 27.9).

Multi-stakeholder approaches to river basin management require an acceptance of collaborative possibilities between authorities, experts, interests groups and the public (Section 27.3). Similarly, farmers may need to learn to collaborate more closely in the delivery of landscape- or catchment-scale ecosystem services (Section 27.4). Each of these provides considerable opportunities for the integration of **voluntary actions** across different stakeholder groups, and complements the discussion of participatory approaches (such as Australia's Landcare movement; **Box 27.57**) in this section.

Table 27.25 summarises the key insights from this review of integrated approaches to ecosystem and habitat management, based both on the material presented in this

section and in earlier parts of this chapter. There is considerable evidence of cross-sectoral and synergistic approaches in a number of key areas, cutting across all types of responses. A number of these are still in relatively early stages of implementation; it is important to learn from these early pilots in order to scale-up the adoption of an integrated ecosystem approach to the management of the UK's diverse habitats, which is one key policy direction that this review recommends.

27.11 Summary and Conclusions

This chapter has reviewed a wide range of responses in the context of UK ecosystem and habitat management implemented by stakeholders at every level. The chapter has distinguished between responses that are *foundational*, typically involving the generation of knowledge and information; those that are *enabling*, which include legislation, policies, institutions and governance, and changing social attitudes; and those that are *instrumental*, which include the use of markets and incentives, technologies and practices, and voluntary actions. Actors at every level—national and local governments, business and industry, private land managers and fishers, civil society organisations and NGOs, research organisations, and citizens and communities—undertake these responses. This chapter has discussed the impacts of these responses on habitats and associated ecosystem services, and their ultimate effects on human well-being.

Table 27.25 Integrated Responses Summary.

	Established responses	Early implementation, pilots	Proposed, under development
Knowledge	<ul style="list-style-type: none"> ■ Countryside Survey Integrated Assessment ■ Rural Economy and Land Use programme ■ Living With Environmental Change programme 	<ul style="list-style-type: none"> ■ UK National Ecosystem Assessment ■ Scotland Rural Affairs and Environment Strategic Research Programmes 	<ul style="list-style-type: none"> ■ Green accounting ■ Water cycle studies ■ Natural Environment Research Council Valuation Network
Legislation	<ul style="list-style-type: none"> ■ EU Water Framework Directive ■ EU Marine Strategy Framework Directive ■ Common Agricultural Policy ■ Common Fisheries Policy ■ Marine and Coastal Access Act 		
Policies, institutions and governance		<ul style="list-style-type: none"> ■ Department for Environment, Food and Rural Affairs Ecosystem Approach ■ Scotland Land Use Strategy ■ Marine Management Organisation ■ River Basin Management Plans 	<ul style="list-style-type: none"> ■ Integrated Water Resource Management ■ Strategic flood risk management ■ Multifunctional forests ■ Integrated Coastal Zone Management ■ Urban spatial planning
Changing social attitudes	<ul style="list-style-type: none"> ■ Eco-schools programme ■ Eco-labelling and certification schemes 	<ul style="list-style-type: none"> ■ Forest schools ■ Urban greenspaces 	<ul style="list-style-type: none"> ■ Sustainable consumption
Markets and incentives	<ul style="list-style-type: none"> ■ Environmental taxes ■ Congestion charges ■ Agri-environment schemes 	<ul style="list-style-type: none"> ■ Payment for Ecosystem Services schemes 	<ul style="list-style-type: none"> ■ Fishing conservation credits schemes
Technologies and practices	<ul style="list-style-type: none"> ■ Restoring hydrological regimes ■ Wetland restoration ■ Managed realignment 	<ul style="list-style-type: none"> ■ Conservation of peat soils ■ Green Infrastructure ■ Urban agriculture and allotments 	<ul style="list-style-type: none"> ■ Biodiversity offsets ■ Integrated Farm Management ■ Renewable energy
Voluntary actions		<ul style="list-style-type: none"> ■ Participation in River Basin Management Plans 	<ul style="list-style-type: none"> ■ Collaboration of farmers at the landscape-scale

Evidence in this chapter shows that the sustainable management of ecosystems and their services typically involves a mix of approaches including regulations, policies, attitudes, incentives, technologies and voluntarism. The chapter emphasises the need to manage ecosystems through the adoption of holistic and integrated approaches, which recognise the impacts of actions across a range of sectors and provide opportunities for collaboration between actors at different levels. Broadly, over the period under review, the evidence suggests that approaches are moving away from relatively isolated sectoral responses towards more integrated strategies that are reflective of ecosystem thinking. Promoting multifunctionality requires the identification of synergies between different ecosystem services, but also needs to acknowledge that there may be difficult choices to be made where trade-offs exist. Responses that are initiated in one sector almost always have associated impacts in other sectors, and these impacts need to be understood and managed to promote human well-being.

This chapter has drawn on examples from the devolved UK context, but these are not intended to be an exhaustive catalogue of the entire spectrum of responses that have been implemented or discussed over the last 60 years. The material that has been presented here is illustrative, but not comprehensive. However, through an extensive review process and stakeholder engagement, the chapter does cover several of the most important initiatives that have had significant impacts on the management of habitats and landscapes within the UK, paying particular attention to differences at country level. In many ways, the UK offers an empirical context that provides excellent lessons from the experiences of the different Devolved Administrations since common principles are often implemented to reflect the particular circumstances within each country. Innovation at country level, and divergence between these approaches, provide a controlled experimental environment which fosters very useful learning opportunities.

This chapter has emphasised the importance of sensitivity to spatial and temporal scale. Institutional mechanisms that link across scales provide opportunities for stakeholder engagement and collaboration between actors. Strategic spatial planning of terrestrial, freshwater and marine habitats is important for the delivery of ecosystem services; while this is happening in some cases, it needs to be better reflected in future responses. In a temporal sense, recognising potential trade-offs between short-term goals and medium/long-term targets is important, and ecosystem management strategies need to reflect a dynamic perspective on the delivery of resilient and robust flows of services to enhance human well-being over time. This is particularly important in the face of considerable uncertainty about the drivers of ecosystem change in the medium-term, and the associated need for the adoption of more flexible and adaptive management frameworks that are implemented within self-reflexive learning environments. Knowledge frameworks need to support this adaptive approach, and lay and local knowledge needs to be adequately reflected in this broader learning environment, especially as it helps to secure the involvement of a wider range of stakeholders in ecosystem management.

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