The Natural Environment, Its Protection, and the Scottish Economy

For Scottish Environment Protection Agency

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Executive Summary

This paper outlines some of the economic concepts and evidence that inform the design of better environmental regulation. It firstly considers evidence that has quantified the importance of the natural environment in Scottish economic activity. It then discusses the consequences of regulating to protect the natural environment, including the problem of freeloaders and the role of better regulation principles in ensuring opportunities for long-term economic development. The paper also considers the concept of ecosystem services, which is used to link understanding of environmental processes to human wellbeing (i.e. economic, social and environmental benefits).

The key points from the paper (drawn from its various sections) are:

- The natural environment is an integral part of the performance of many of the main sectors in the Scottish economy (Section 1).
- The way some specific sectors rely heavily on natural resources for their inputs has been quantified and shown to be significant (Table 1).
- Sites that operate without licences (freeloaders) derive an unfair commercial advantage over legitimate operators and can cause significant harm to the environment, limiting other people's access to good quality environments. This can undermine the ability and willingness of legitimate operators to invest in environmental protection and improvement or utilise the natural environment as part of their economic activity (Section 2).
- The concept of ecosystem services has emerged over the last decade as a framework that combines ecological and economic concepts, and therefore helps understand the economy's impacts on, and reliance on, the quality of the natural environment (Section 3).
- The UK National Ecosystem Assessment (UKNEA) identified the substantial benefits that ecosystem services provide in Scotland, and billions of pounds of additional value that could be realised from the environment. Obtaining these values is dependent on improved future management of ecosystems (Section 3).
- Both the economic costs and benefits of environmental protection, in particular dynamic effects, can be difficult to predict and long-term costs may often be overestimated while the innovative benefits of regulation may be underestimated (Section 4).
- Environmental protection has social consequences, such as health impacts on communities and enabling regeneration in areas of low environmental quality (Section 4).
- The types of regulations that are adopted to deliver environmental protection can influence these social and economic impacts (Section 5).
- In the long term better regulation that leads to environmental protection can stimulate more efficient use of resources and innovation, leading to sustainable net economic gains (Section 4).

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1. The Natural Environment and the Scottish Economy

The important role of the natural environment[1] in the performance of many of the main sectors in the Scottish economy is widely recognised. The way some specific sectors rely heavily on natural resources for their inputs has been quantified, and shown to be significant. This section firstly considers how economic sectors rely on the natural environment. It then discusses these links for some of the important sectors in the Scottish economy. Finally, there is a summary of information from a study quantifying the value of Scotland's natural environment to different sectors in the Scottish economy.

Work by RPA and Cambridge Econometrics (2008) for Scottish Natural Heritage examined the potential wider benefits that may accrue due to the high quality of Scotland's natural environment. Several different types of benefits were considered, of which the following are relevant to the performance of individual economic sectors:

i. The relative value of Scotland's natural environment in attracting businesses and individuals to Scotland, and how this may change in the future: here the environment is seen as a marketing asset that can encourage businesses and individuals to invest in Scotland, promising a high quality of life as well as economic and recreational opportunities (SDI, 2012)[2].

ii. Areas of economic opportunity in relation to the natural environment and an assessment of the enablers and barriers to exploiting these opportunities, and how this may change in the future: there are numerous targets already in place to increase the productivity and performance of industry sectors with strong links to the environment (e.g. Whisky distilling). In addition, there are many strategies and policies focused on improving the sustainability of economic growth, such that those sectors not currently strongly associated with the environment may become increasingly linked in time (e.g. insurance).

iii. The importance of the natural environment hinterland for a city economy in Scotland: a city's hinterland provides green space and access to the countryside for recreation, as well as providing alternative attractions for visitors to the city. The city provides benefits as an economic hub, supporting the rural economy, while the hinterland provides a source of raw materials.

iv. The value of Scotland's natural environment for branding: the natural environment is valuable as a brand as it reflects positive, memorable qualities linked to attractiveness, uniqueness and sustainability. The use of the natural environment as part of the brand can benefit future economic development by becoming self-fulfilling in that it can influence decision making when developing policies and plans.

The way some of these benefits work is discussed here for some of the key sectors in the Scottish economy. A more in-depth quantitative sectoral analysis is located at the end of this section.

[1] This paper uses a definition of natural environment used by Scottish Natural Heritage as, *'the natural materials, processes, habitats and species, and topography that exist in Scotland'* (2008).

[2] SDI (2012), Top Seven Reasons to Invest in Scotland, http://www.sdi.co.uk/invest-in-scotland/top-seven-reasons.aspx

1.1 Sectoral overview

Public Water Supply and Households

Environmental protection leads to good quality water and good status of aquatic ecosystems. This improves the availability of water resources for human consumption:

- It can help reducing drinking water treatment costs.
- If the quality of polluted water bodies are restored, they become available for public supply, and this can reduce the need for more costly alternative water resources (e.g. through investment in terms of storage and pipes to bring these new resources to the demand) to respond to new water demands.
- It ensures that water resources that are not tapped today are of pristine quality, as (some of) these resources can be strategic resources for the future (in particular in a context of climate change and economic uncertainty).

Improvements in the quality of water in the environment can in turn reduce water bills to domestic and commercial water customers. Such reductions in costs are particularly valuable during a period of slow economic growth, and in relation to vulnerable social groups, for which utility bills account for a higher than average proportion of income.

Furthermore, good quality water and good status aquatic ecosystems can have a high aesthetic value (with associated economic benefits, e.g. house prices) and may also benefit recreation and tourism (see below).

Beverage (including Whisky)

Of particular interest will be the benefits arising from environmental protection for the beverage industry that relies on good quality water:

- Good quality water is a key input to the drinks industry, including breweries and Scotland's distilleries. Ensuring water quality is high has both a "cost-reduction" role (limiting the need for additional treatment prior to using raw water for beer production) and an image role (that indirectly can impact sales and market shares, in particular in a society in which sensitivity to nature and to good environment is progressively increasing, and in which the environment is increasingly used as part of marketing slogans); and
- Ensuring that "pristine water" remains recognized as a key characteristic of Scotland is directly relevant to the image of the Scottish whisky industry. Today, whisky is increasingly produced outside Scotland (Japan, France etc.). Although such production remains targeted to local markets, this might change in the coming years - it will be important that Scotland keeps its comparative advantage and maintains the image of a high-value product, including in new markets opening in Asia (China for example).

Agriculture

Environmental protection policy can incentivise farmers to make more limited use of chemical inputs in their farm practices or to adapt their entire farm strategy (including shifting to organic farming). This in turn can have positive impacts by:

- Reducing human health risks associated with residues of new molecules used in agriculture in food, and with production in a better quality environment (in terms of water quality, soil quality, air quality). This is particularly true for fruits and vegetables production that might be marketed locally (see below).
- Reducing health risk for farmers from exposure to chemicals when they make use of agro-chemical products.
- Reducing water pollution risks (see public water supply above).

In some cases, the need to comply with new environmental regulation can bring new social links between farmers and other parts of society, as illustrated by: a) the emergence of voluntary agreements between farmers and local communities for reducing pressures on the environment or delivering new ecosystem services that benefit these communities; b) the increasing importance of direct "short-distance" product sales (i.e. farmers markets) partly in response to the search for "more healthy food" (and produced in a better environment) that bridge the gap between producers and consumers. These markets can provide alternative revenues for farmers helping to maintain/stabilise their income in the face of volatile world food prices and uncertainty over future policy incentives (e.g. within the EU Common Agricultural Policy).

In France, for example, the city of Lons le Saunier has entered into voluntary agreements with farmers that combine both dimensions: Firstly, a shift to organic farming for all farmers located in the city's drinking water protection zones; and secondly a commitment by the municipality to purchase all bio agricultural products for supplying its self-managed restaurants and cantines. This commitment acts to compensate farmers for possible economic losses, ensures a stable income and reduces the farmers' risk associated with the shift to organic farming. Similar agreements of "community-supported agriculture" are increasingly found in other countries like Belgium, Germany, Switzerland

Food

Scotland produces a number of regionally-distinct foods. Ensuring a good environment can be key to specific local food labels (e.g. Scottish meat) whose image is linked to the quality of the environment in which the products are produced. This can be important for local consumers, but also for products exported to the rest of the UK, other European countries and further afield.

As described for Whisky above, the image of these products is often associated with the quality of the natural environment, which is an important part of their branding. Therefore, maintaining Scotland's environmental quality contributes to maintaining a positive brand for many Scottish food products.

Food quality has many attributes such as taste, texture, smell and appearance that are all affected by the quality of the surrounding environment (e.g. the absence of contaminated soils, air and water quality), and consumers worldwide are increasingly seeking higher quality food products, further increasing the value of a well-managed natural environment (Environment Australia, 1997). The quality of the natural environment can also influence levels of food production. For example, lower air quality can result in reduced crop production (e.g.

Defra, 2006)[3] and water quality can influence fish production (see below). Finally, water is often an important input into food processing and manufacturing activities. Therefore, protecting water resources from damage (depletion and/or pollution) helps maintain the availability of water resources for food production, and to reduce costs of treating water to a sufficient quality to be an input to food production processes. Increasingly however, the food processing industry treats raw (or publicly supplied) water as part of its processes to reduce (health) risks, representing a business cost as a result of lower water quality.

Fish

As discussed above, maintaining a good quality environment is a necessary condition for maintaining some types of food production. Fish production is a prime example. Controls on terrestrial pollution to rivers help maintain a good aquatic (including freshwaters, coastal and marine) environment, which is necessary for any capture fisheries and aquaculture businesses. UK National Ecosystem Assessment (UKNEA, 2011, pp 896)[4] identified pollution as a potential constraint on biological productivity in Scottish marine ecosystems.

In relation to capture fisheries, these controls are most relevant to inshore fisheries, shellfisheries and aquaculture. The exact value of fisheries in Scottish inshore waters is hard to determine, but can be estimated at around £70milion or more per year based on:

- The value of landings other than by towed nets and seines in the Northern North Sea, Scottish Continental Shelf, and Minches and Western Scotland, of £71.4m in 2007 (PSEG, 2010).
- The value of Scottish lobster, crab and scallop landings of £80m in 2003 (SEERAD, 2003).

According to the Scottish Salmon Producers' Organisation (2012), salmon is Scotland's largest food export and, in 2009 alone, Scotland's salmon farmers injected some £500 million into the economy (with the Highlands and Islands continuing to be the biggest beneficiary). According to the SSPO, there are 6,200 jobs that are reliant on the aquaculture industry in Scotland and SSPO member companies alone employ a total of over 2,100 people. The Scottish salmon industry is also a growing sector, with 86% of SSPO member companies planning to increase staff numbers over the next five years.

Good environmental quality can increase the opportunities for future aquaculture development. Locally, this can have an important socio-economic impact, allowing local commercial fisheries to remain operational, and for locally sourced fish to remain available in local markets. Pollution by hazardous chemicals can in some cases lead to "fishing bans" (for shorter or longer time periods) that can lead (if repeated) to the end of fishing in some areas.

Energy (including Hydropower)

Reducing the quantitative pressures on rivers through environmental protection can help restore river flows including during periods of water scarcity. In turn, this might help to keep

[3] Defra (2006), An Economic Analysis to Inform the Air Quality Strategy Review Consultation, London, UK, Department for Environment, Food and Rural Affairs, Commissioned Report No. 398

[4] UK National Ecosystem Assessment (2011), The UK National Ecosystem Assessment: Synthesis of the Key Findings. UNEP-WCMC, Cambridge, http://uknea.unep-wcmc.org/

water temperatures down during hot spells of weather. Sufficient quantities of water and lower water temperatures are important for energy generation:

- Water is used by thermal and nuclear energy plants, which produces a risk of emergency shut-downs during periods of high water scarcity and droughts. This is likely to become increasingly important in the future as a result of the continuing socio-economic development and/or the influence of climate change.
- Water flows are the source of energy for hydropower generation. A reasonably consistent flow of water from the natural environment is needed to maintain water levels behind dams from which water flows are drawn.

Waste Management

According to a recent report by the Scottish Government (2010)[5], Scotland produced almost 20 million tonnes of waste in 2008, with household waste accounting for 2.9 million tonnes, 8.6 million tonnes coming from the construction industry, and 7.9 million tonnes from the rest of the commercial and industrial sector.

Disposing of waste can have serious consequences for the environment. Landfill sites can generate greenhouse gases, most notably methane, which not only has a significant global warming potential, but is also highly explosive. Leachate produced as waste decomposes may cause pollution, particularly to groundwater bodies. Incinerating waste can also cause environmental problems – for example, plastics tend to produce toxic substances (such as dioxins) when they are burnt; gases from incineration may cause air pollution and contribute to acid rain, and ash from incinerators may contain heavy metals and other toxins that are harmful to human health and the environment.

There are many economic benefits associated with recycling. Firstly, it is often cheaper to make products using recycled materials than it is to use virgin materials. As more waste is recycled, costs associated with landfill and incineration can be reduced. Recycling also creates new business and job opportunities (e.g. in transporting, processing and selling recovered materials, and in manufacturing and distributing products made with recycled materials). It has been estimated that in 2008 there were 500 businesses and 8,335 people employed in the Scottish waste collection, treatment and disposal sector (FOE, 2010)[6]. Input-Output analysis of the Scottish economy shows that for every 100 jobs created in the recycling sector, 36 indirect jobs will be created in the supply chain and a further 27 induced jobs will be created as a result of employees in these businesses spending their wages in Scotland. Processing food waste at anaerobic digestion facilitates may also facilitate the harnessing of green energy and the production of high quality fertilisers (SEPA, 2011)[7]. Finally, recycling is a practical behavioural change that can enhance awareness of environmental issues, and thus contribute to changes in behaviour favourable to the environment in other fields.

[5] Scottish Government (2010), Scotland's zero waste plan, Edinburgh, http://scotland.gov.uk/Resource/Doc/314168/0099749.pdf

[6] Friends of the Earth (2010), Report: More jobs, less waste – Potential for job creation through higher rates of recycling in the UK and the EU, London, http://www.foe.co.uk/resource/reports/jobs_recycling.pdf

[7] SEPA (2008), The Natural Health Service, SEPA View (34), downloaded from www.sepa.org.uk/publications

Chemicals including Oil & Gas

The chemicals industry in Scotland has significant links to the oil industry, however it was not found to be one of the key sectors that directly need a high quality environment in order to operate, according to a 2008 study for SNH on the economic contribution of Scotland's natural environment (see below). The oil and gas sector may nonetheless have an interest in a high quality environment from a corporate responsibility perspective and environmental protection may also have significant regulatory implications for the sector.

Manufacturing

Protecting the quality of the environment helps ensure the provision of some important raw materials for manufacturing. Examples of raw materials from the Scottish environment used in Scottish manufacturing include water (as discussed above), forest products, including timber, paper and pulp, agricultural products (as discussed under food and drink), and ornamental goods derived from the natural environment (e.g. horn, stone).

For example, water is an indispensable medium for all stages of pulp and paper production and the pulp and paper industry has specific water quality demands. Biofouling, corrosion and scaling (all important problems in the pulp and paper industry) may be caused by using water of insufficient quality. In the textiles sector, water quality is important for the stability of production and quality of products. Most critical parameters are hardness, pH, and metal content (AquaFit4Use, 2010)[8]. Maintaining good quality water resources may therefore reduce treatment costs for the pulp and paper and textiles industries (as it would do for public water supply).

Data on the reliance on the natural environment by several manufacturing sectors in Scotland is presented in Table 1 below.

Tourism and recreation

The natural environment is an important part of several key activities that make up Scotland's tourism and recreation sector (e.g. golf, hill walking, nature watching). It is also part of the overall image of Scotland's leisure and tourism industry, which are associated with what the UKNEA refers to as the diverse and extensive cultural services from Scotland's ecosystems (UKNEA, 2011, pp 898).

Protection of the natural environment helps to maintain the sector in general and many activities more specifically. Total Scottish visitor spending attributable to nature-based tourism each year is about £1.4 billion, supporting about 39,000 FTE jobs (Bryden et al. 2010)[9] – although assessing how these economic values would change as a result of improvements or some degradation of to environment remains a challenge. Examples of activities in this sector that are highly dependent on environmental quality include (UKNEA, 2011):

- Coarse fishing: which is estimated to be worth £113m per yr in Scotland and supports 2,800 jobs (UKNEA, 2011, pp 952);

[8] AquaFit4Use (2010), Sustainable water use in chemical, paper, textile and food industries, (co-financed by the European Union's 7th Framework Programme)
http://www.aquafit4use.eu/userdata/file/Public%20results/AquaFit4Use%20-%20Water%20quality%20demands%20in%20paper-chemical-food-textile%20industry.pdf

- Expenditure on recreation in the Highlands and Islands In 2002–2003 area included: walkers and mountaineers - £246 million; water sports participants - £90 million; snow sports - £29 million; cyclists - £24 million; equestrianism - £15 million), and
- Tourism expenditure related solely to the east of Scotland bottlenose dolphin population was estimated to be at least £4 million, providing 202 FTE posts.

1.2 Quantifying the value of Scotland's natural environment to sectors in the Scottish economy

Not all the links between the natural environment and economic sectors discussed above can or have been measured. However, in addition to studies of ecosystem services in Scotland (Williams et al. 2003[10], and UKNEA 2011), other studies have attempted to quantify these links. In 2008, Scottish Natural Heritage identified a need to quantify the benefits that the natural environment provides to Scotland's economy, where 'natural environment' is defined as 'the natural materials, processes, habitats and species, and topography that exist in Scotland'[11]. 'Scotland' includes the coastal waters surrounding Scotland and not just terrestrial features. The study by Risk & Policy Analysts Ltd. and Cambridge Econometrics (2008) aimed to help ensure that the full value of the natural environment is recognised.

As part of the work carried out, the study: developed estimates of the then current value of economic input/output activity generated by the natural environment at an all-Scotland level as well as a regional distribution of these benefits; gauged the level of environment-related employment in Scotland, including indirect employment, and the relative importance of natural environment employment compared with other sectors; and made an assessment of the potential for the use of Scotland's natural environment to aid sustainable growth of the economy.

For each of the 128 industry sectors included in the 2003 Standard Industrial Classification (SIC) codes, an estimate was made of the extent to which each sector relies on and/or utilises the natural environment. In particular, consideration was given to reliance on a high quality environment, rather than exploitation of the environment. Twenty six industry sectors were identified as having significant links (where significant was defined as greater than 20% of activities being related to the environment). The sectors with the strongest link to the natural environment included food and drink production, water use, timber production and use, tourism and recreation.

The Scottish Input-Output table[12][13] was expanded to incorporate the environment through the addition of an extra row and column to the matrix to represent monetary flows of some

[9] Bryden et al. (2010), Assessing the economic impacts of nature based tourism in Scotland Scottish Natural Heritage Commissioned Report No. 398, http://www.snh.gov.uk/docs/B726802.pdf

[10] Williams et al. (2003), The Value of Scotland's Ecosystem Services and Natural Capital, *European Environment*, Vol.13 (2), pp. 67-78.

[11] RPA & Cambridge Econometrics (2008). The Economic Impact of Scotland's Natural Environment. Scottish Natural Heritage Commissioned Report No.304 (ROAME No. R07AA106), http://www.snh.org.uk/pdfs/publications/commissioned_reports/ReportNo304.pdf

[12] *An input-output table is a matrix that depicts the sectoral structure and inter-relationships of an economy. It does this by breaking down the commodity inputs to an industry's final output by the sectors from which these inputs*

conceptual environment 'product' to and from the economy's other sectors. The environment sector thus becomes both a supplier and purchaser of inputs in the expanded table.

The value of Scotland's environment, in terms of intermediate demand (industry to industry), can be calculated as the total of the environment column in the expanded Input-Output (IO) table. This figure captures the environment's relationship to the economy in terms of its purchases of inputs and can be interpreted as the direct 'value' of the environment – the direct fall in Scotland's output that would result from a negative environmental shock sufficient to set the sector's output to zero. The additional indirect and induced effects can also be measured, i.e. the wider economic effects of the shock. These will arise because the environment sector's demand will have been reduced by the shock. The non-environment sectors will, in turn, reduce their own demand and economic activity will fall. Allowing for the indirect effects in addition to the direct and accounting for the reduction in wages and the subsequent fall in household expenditure the fall in output is estimated to be £17.2 billion, or 11% of total output in Scotland.

A further consideration is that Scotland's Low Carbon and Environmental Goods and Services (LCEGS) sector is currently growing and Scotland is well-poised to exploit comparative advantages in environmental industries such as resource recovery and recycling, offshore wind and contaminated land remediation.[14] In addition to economic benefits, the businesses involved in the LCEGS sector benefit the natural environment as their activities may include seeking solutions for air, soil and water pollution; developing renewable fuels; environmental advisory; and waste management and recycling (BIS, 2012)[15].

The number of Scottish jobs (in the entire economy) supported by the environment was estimated to be 242,000 (around 11% of full time jobs). Like the estimated value of £17.2 billion, this employment figure captures the direct, indirect and induced effects on employment. Details of these results for different economic sectors are shown in Table 1 below (RPA and Cambridge Econometrics, 2008)[16].

originate for a given time period, typically a single year. Multiplier analysis allows examination of the economic effect of a 'shock' (a significant degradation of the environment) to a particular sector by estimating the value of the environment in terms of the economic activity 'lost' if there were a negative shock to the environment sufficient to set its demand to zero, effectively eliminating the sector from the economy.

[13] *Note: the GVA figures in the final column have been updated from the original study to reflect the latest available data from 2007 (published in October 2010).*

Note: *The Link to Environment figures were estimated by RPA & Cambridge Econometrics during multiplier analysis (modeling 'shocks' of environmental degradation) as the extent to which each sector relies on and/or utilises the natural environment. In particular, consideration was given to the need for sustainable use of the environment, which in practice means that activities do not degrade the quality of the environment, rather than exploitation of the environment. Thus, industry sectors such as mining and quarrying, which although they use the natural environment for their primary resource are assigned a dependence/link of 0%, since they do not rely on, or contribute to (in the short-term at least), a high quality environment.* (RPA & Cambridge Econometrics, 2008)

[14] Innovas Solutions Ltd. (2011), Scotland Low Carbon and Environmental Goods and Services Sector Study, http://www.scotland.gov.uk/Resource/Doc/344829/0114756.pdf

[15] Department of Business, Innovation and Skills (May 2012), Low Carbon Environmental Goods and Services, Report Update for 2010/11. http://www.bis.gov.uk/assets/biscore/business-sectors/docs/l/12-p143-low-carbon-environmental-goods-and-services-2010-11.pdf

[16] RPA & Cambridge Econometrics (2008). The Economic Impact of Scotland's Natural Environment. Scottish Natural Heritage Commissioned Report No.304 (ROAME No. R07AA106), http://www.snh.org.uk/pdfs/publications/commissioned_reports/ReportNo304.pdf

Table 1: Industry Sectors with the Greatest Links to the Environment – Based on 2003 Input-Output Tables and Expert Opinion (and agreed with SNH Steering Group)				
Sector	**Link to Environment**	**Justification**	**Employees**	**Expenditure/GVA**[17]
Activities Concerned with the Protection, Restoration and Enhancement of the Environment				
Sewage and refuse disposal, sanitation and similar activities	90%	90% of Scottish STWs compliant	22,062 or 1.0% of total for Scotland (2001, for electricity, gas and water supply)	£876.1 million (GVA at basic prices 2007)
Activities that make Sustainable Use of one or more Elements of the Environment as a Primary Resource				
Collection, purification and distribution of water	100%	100% (all water from natural sources)	6,000 (water, 90% full-time) or 0.3% of total for Scotland	£426.9 million (GVA at basic prices, 2007)
Fishing and service activities incidental to fishing	96%	96% of Scottish fish stocks sustainable (4% cod, which is over-fished)	6,705 or 0.31% of total for Scotland (2001, for fishing)	Total value of landings by Scottish vessels (2011) was £501 million; shellfish £164 million[18]
Agriculture, hunting and related service activities	80%	80% of audited farms are compliant with environmental pollution controls	3,000 or 0.2% of total for Scotland (2001)	£1,236.6 million (GVA at basic prices, 2007)
Forestry planting and related service activities	70%	70% certified under FSC	3,588 or 0.2% of total for Scotland (2005)	£66.2 million (GVA at basic prices, 2007)
Forestry logging and related service activities	70%	70% certified under FSC 50% of forestry sustainably managed (with Chain of Custody certificate, 2003)	352 or 0.02% of total for Scotland (2005)	£72 million (GVA at basic prices, 2007)
Fish farming and related service activities	68.4%	68.4% meeting environmental impact standards	6,705 or 0.31% of total for Scotland (2001, for fishing)	£141.6 million (GVA at basic prices, 2007)
Activities which are Dependent upon the Quality of the Environment, in Particular Tourism and Recreation and Supporting Industries				

[17] Note: *Original data updated with 2007 Gross Value Added figures from Input-Output tables (2010) at:* http://www.scotland.gov.uk/Topics/Statistics/Browse/Economy/Input-Output/IOAllFiles2007

[18] *This is the total catch figure provided separately to the Input-Output tables:* The Scottish Government (2012), Fishing income at record levels, http://www.scotland.gov.uk/News/Releases/2012/09/fishstats13092012

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Sector	**Link to Environment**	**Justification**	**Employees**	**Expenditure/GVA**[17]
Hotels and restaurants	30%	30% (60% of hotel nights booked by holiday makers, half of these visiting due to the natural environment)	143,724 (2005 data) or 6.6% of total for Scotland (includes hotels, camping sites, restaurants and bars)	Total tourism expenditure in 2011 was £4,508 million (2011 prices)[19]
Activities Indirectly Dependent on Above Product/Industry Groups				
Tanning and dressing of leather; manufacture of luggage, handbags, saddlery and harness	99%	99% (based on 20:1 water use to hide use in production, with 80% of hides included as from LFA)	1,000 (may not be FTEs, 2003) or 0.05% of total for Scotland	£30.5 million (GVA at basic prices, 2007)
Footwear	99%	99% (based on 20:1 water use to hide use in production, with 80% of hides included as from LFA)	No specific data found for footwear, but likely to be small % of total for Scotland	£0.4 million (GVA at basic prices, 2007)
Production of mineral waters and soft drinks	97%	97% (bottled water production (100% water) : soft drink production (65% water) / ratio of bottled water to soft drink production in Scotland of 10:1)	1,939 (2005) or 0.09% of total for Scotland	£119.2 million (GVA at basic prices, 2007)
Beers and ales	95%	95% (water makes up circa 93% of the beverage by weight plus 29% of other third based on 36% of inputs from Scottish agriculture to Scottish food industry and 80% of this is compliant with environmental pollution controls)	1,229 (malt and beer, 2005) or 0.06% of total for Scotland	£94.3 million (GVA at basic prices, 2007)

[19] *This is the cumulative tourism figure for 2011 provided by Scottish Tourism separate to the Input-Output tables:* Scottish Tourism (2011), The key facts on tourism in 2011, http://www.visitscotland.org/research_and_statistics/tourismstatistics/national_statistics/tourism_in_scotland.aspx

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Sector	**Link to Environment**	**Justification**	**Employees**	**Expenditure/GVA**[17]
Grain mill products, starches and starch products	80%	80% agricultural output compliant with environmental pollution control	582 (grain mill products, starches and starch products, 2005) or 0.03% of total for Scotland	£17 million (GVA at basic prices, 2007)
Agricultural and forestry machinery	78%	78% (80% of agriculture and 70% of forestry compliant, based on relative proportions)	No specific data found, but likely to be small % of total for Scotland	£19.1 million (GVA at basic prices, 2007)
Spirits and wines	76%	76% (2/3rds of input to product is water - Scotch Whisky Distilling Industry, Sector Report plus 29% of other third based on 36% of inputs from Scottish agriculture to Scottish food industry and 80% of this is compliant with environmental pollution controls)	8,000 (distilled potable alcoholic beverages, 2005) or 0.4% of total for Scotland	£1,429.3 million (GVA at basic prices, 2007)
Wood and wood products, except furniture	37%	37% sawing and planing of wood (Net imports = 63% of hard and soft woods in UK)	7,911 (not FTEs, 2005) or 0.4% of total for Scotland	£422.7 million (GVA at basic prices, 2007)
Bread, rusks and biscuits; manufacture of pastry goods and cakes	29%	29% (36% of inputs from Scottish agriculture to Scottish food industry and 80% of this is compliant with environmental pollution controls)	10,632 (manufacture of bread, fresh pastry goods and cakes, rusks and biscuits, preserved pastry goods and cakes, 2005) or 0.5% of total for Scotland	£485.6 million (GVA at basic prices, 2007)

Table 1: Industry Sectors with the Greatest Links to the Environment – Based on 2003 Input-Output Tables and Expert Opinion (and agreed with SNH Steering Group)				
Sector	**Link to Environment**	**Justification**	**Employees**	**Expenditure/GVA[17]**
Other food products	29%		2,258 (other food products, 2005) or 0.1% of total for Scotland	£109.7 million (GVA at basic prices, 2007)
Production, processing and preserving of meat and meat products	28%	28% (based on relative turnover)	7,701 (production and preserving of meat, poultry meat and meat and poultry meat products, 2005) or 0.4% of total for Scotland	£212.2 million (GVA at basic prices, 2007)
Processing and preserving of fish and fish products; fruit and vegetables	28%	28% (based on relative turnover)	11,426 (production and preserving of fish and fish products, processing and preserving of potatoes, processing and preserving of fruit and vegetables nec, 2005) or 0.5% of total for Scotland	£282.1 million (GVA at basic prices, 2007)
Vegetable and animal oils and fats	28%		0% of total for Scotland (no manufacturers in Scotland in 2005)	£2 million (GVA at basic prices, 2007)
Prepared animal feeds	26.4%	26.4% (two-thirds of feed is imported, one third is sourced from Scotland of which 80% is compliant with environmental pollution control)	1,085 (manufacture of prepared feeds for farm animals, pet feeds, 2005) or 0.05% of total for Scotland	£49.6 million (GVA at basic prices, 2007)
Construction	22.2%	22.2% (60% timber frame buildings in Scotland, 37% of which Scottish timber)	124,279 or 5.7% of total for Scotland	£7,554.4 million (GVA at basic prices, 2007)

Given the clear importance of Scotland's natural environment to its economy, the following section emphasises the negative consequences that freeloaders may cause to both the environment and the economy. The refusal of freeloaders to participate in environmental protection undermines the ability and willingness of legitimate operators to invest in sustainable environmental management and their capacity to improve or utilise the natural environment as part of their economic activity.

2. Freeloaders and Meeting the Costs of Environmental Protection

In the context of this paper freeloaders are a type of what is referred in the economic literature as "Free riders". These are people or organisations that make emissions to air, land or water or abstract water without complying with accepted standards of environmental protection and without holding appropriate environmental licences. Freeloaders are likely to be operating illegally and may be criminal enterprises with other undesirable practices. Sites that operate without licences derive an unfair commercial advantage over legitimate operators and can cause significant harm to the environment limiting other people's access to good quality environments. This can undermine the ability and willingness of legitimate operators to invest in environmental protection and improvement or utilise the natural environment as part of their economic activity. Investigating and addressing freeloader activity is part of the Scottish Environment Protection Agency's (SEPA's) better regulation agenda.

The general literature on free riders typically considers users of public goods or public property resources (such as air and water) which are in essence free to access. Free riders impact on the provision of such goods by allowing others to bear the costs of their provision (or maintenance) while they themselves enjoy the benefits. This results in "market failure" in which the good or service is over consumed while funds available to provide and protect the service are not reflective of the benefits derived, resulting in under-provision and a welfare loss to society.

Environmental protection is therefore regarded as a "public good", as access to many environmental services cannot realistically be prevented. However, in some circumstances one party's use of the environment (e.g. abstraction of water) can prevent others from making use of it (i.e. has the characteristics of a "private good"). This mixture of joint provision of public and private goods from the environment justifies government's intervention to ensure an efficient provision and protection of the environment, and maximise society's welfare, rather than leaving the market to operate in a state of failure.

The protection of the environment through regulation recognises the need to ration access to environmental carrying capacity. This protects society at large from deposition of substances in the environment that are harmful and from over exploitation of natural resources that would ensue if access to the environment and the use of the environmental carrying capacity were not restricted.

The environmental regulatory system essentially rations access to the environment to "safe" levels through establishing both limits and proscribing processes to minimise potential harm (including prohibition of some types of emissions altogether). In addition the charges that are

part of the regulatory system also allows for the costs of undertaking these actions to be shared appropriately between users (licence holders) and general taxation.

Freeloaders in this context impose costs on society and regulated organisations by bringing about a series of "market failures":

- Freeloaders may directly cause damage to the environment and their activities may be harmful to the environment, to users benefiting from ecosystem services and to human health. This could be the case of un-regulated water pollution that would deteriorate its ecological status while resulting in polluted fish that could then be consumed by humans.
- Freeloaders use up environmental carrying capacity that would otherwise be available for prudent users to make use of efficiently. This has the dual effect of increasing restrictions and increasing the level of abatement effort required (and therefore cost) by those within the regulatory regime. This might be the case, for example, when water pollution upstream leads to the need for regulated users to adapt their use of flows downstream.
- In gaining free access to the environment, freeloaders overuse environmental assets by using the environment in preference to other inputs that would have to be purchased. When environmental assets are scarce, this can be socially inefficient.
- When the costs of regulation are paid for by users of the environment, freeloaders do not contribute to the overall costs of regulation and environmental monitoring, increasing the costs faced by honest participants or resulting in under funding of the regulatory system.
- The costs of finding and prosecuting freeloaders impose additional financial burdens that increase the costs of environmental regulation, resulting in increased charges to honest participants and/or increased contributions from general taxation. This however depends on the financial implications of prosecution, as sufficiently high fines providing the possibility to eliminate this financial burden (see below).

Freeloaders are therefore not simply obtaining an advantage for themselves but also disadvantaging (and imposing costs on) honest operators and the community at large.

A system of recovering the costs imposed by freeloaders would recover both the value of the benefit they obtain by non compliance with environmental licences and the costs imposed on others of their actions. Calculation of the value of this would be complex, but it is clear that the cost of their actions to society are not limited to the avoided cost of regulation, or the cost of investigation and prosecution.

In general, freeloaders are engaging in practices that they know to be damaging to society (and most must understand that their activity is illegal). They nevertheless make a judgement (if not a calculation) that their private interests and opportunity are "worth" the risk that they will be caught and penalised. However it should also be noted that in some cases, freeloading might arise from insufficient knowledge on the regulation and its requirements, and on the negative externalities resulting from freeloading.

Although this is a simplification of this kind of calculation it might be helpful to think of it as something like this; if the benefits obtained by freeloading are greater than the scale of consequences of being caught (e.g. fines) multiplied by the probability of being caught, then the freeloading activity makes "sense" from a private user's perspective.

Freeloading may occur if:

Private Benefits of non-compliance ≥	**Scale of consequences (e.g. fines) x Probability of (discovery) facing the consequences**

The rational response by the regulatory system when faced with a freeloading problem should therefore be to either increase the consequences (e.g. fines, legal proceedings) or the probability of discovery (and having to face those consequences) or a combination of both. However, it should also be noted that, in the absence of an adequate enforcement regime, the greater the costs of compliance faced by operators the greater the potential temptation of non-compliance.

From the discussion above it is also likely that it will be in the interests of honest operators in the same industry to support this regulatory effort, both by reporting freeloaders and/or by contributing (with information and/or financially through their licence fees) to the effort that goes into their discovery.

3. Ecosystem Services, the UKNEA and the Value of Ecosystem Services in Scotland

Drawing upon the quantitative data that demonstrates the importance of the natural environment to Scotland's economy, this section looks at Scotland's benefits from 'ecosystem services'. The concept of ecosystem services, defined by the Millennium Ecosystem Assessment (MEA, 2005)[20] as *the benefits ecosystems provide to people,* has attracted substantial attention from policy-makers worldwide over the last decade. Specifically, ecosystem services are those components of nature that are directly consumed, used or enjoyed by people.

Ecosystem services have gained more attention in the UK due to international studies (TEEB)[21] and the UK's National Ecosystem Assessment (UKNEA)[22]. The UKNEA's ecosystem services categories (see below) were developed from these preceding studies. However, Scotland's ecosystem services had previously been analysed in detail in 2003 and the benefits provided by Scotland's ecosystem services were estimated at a minimum of £17 billion per year (in 2001 prices, Williams et al, 2003)[23]. It was not possible to directly link the total value for the

[20] Millennium Ecosystem Assessment (2005), Ecosystems and Human Well-being: Biodiversity Synthesis. World Resources Institute, Washington, DC, http://www.maweb.org/documents/document.354.aspx.pdf

[21] TEEB (2010) The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB. www.teebweb.org

[22] UK National Ecosystem Assessment (2011), The UK National Ecosystem Assessment: Synthesis of the Key Findings. UNEP-WCMC, Cambridge, http://uknea.unep-wcmc.org/

[23] Williams et al. (2003), The Value of Scotland's Ecosystem Services and Natural Capital, *European Environment*, Vol.13 (2), pp. 67-78.

ecosystem services to the Scottish economy (because many of these benefits will fall wholly outside the economy).

One reason that ecosystem services concepts are considered useful to environmental regulators are because they combine ecological and economic principles to help understand how the natural environment supports human welfare. It recognises the importance of ecological functions (like pollination or absorption of pollutants), but defines the consequences of these in economic terms, based on their usefulness to people. It supports the basic process through which environmental economists analyse the economic value of the natural environment: firstly understanding the relationship between the environment and human welfare (e.g. higher water quality increases the potential recreational value of a loch); secondly quantifying it (i.e. if water quality increases by a certain amount, how much does recreational use rise?); and thirdly supporting attempts to value the environmental change (i.e. what is the value of the increased recreational use in this example?).

The UKNEA uses four **ecosystem services categories:**

- **Provisioning services** - are those that are associated with clear use of the environment and the generation of money for the economy, such as agricultural produce, drinking water and timber.
- **Regulating services** - are those that people obtain from the regulation of ecosystem processes. They include genetic resources; flood and coastal protection; climate regulation; waste breakdown and detoxification; and water, air and soil purification.
- **Supporting services** - are necessary to ensure the provision of all other ecosystem services. Supporting services depend on the fundamental components of our environment such as clean air, water, soil and geodiversity. As such, they do not have direct "service users", but their value is embedded into the values of other services.
- **Cultural services** - are those that give rise to spiritual enjoyment, increased knowledge, quality of life and happiness. They include benefits such as wildlife watching, education and spiritual experience.

The **key findings of the UKNEA** include that:

- The natural world, its biodiversity and its constituent ecosystems are **critically important** to our well-being and economic prosperity, but are **consistently undervalued** in conventional economic analyses and decision making.
- The UK's ecosystems are currently delivering some services well, but others are still in **long-term decline**.
- The UK population will continue to grow, and its demands and expectations continue to evolve. This is likely to **increase pressures** on ecosystem services in a future where climate change will have an accelerating impact both here and in the world at large.

The UKNEA included analysis of the UK's ecosystem services, and concluded for Scotland that:

- Provisioning services from Scotland's ecosystems contribute significant quantities and varieties of raw materials, as well as other economic values to Scotland.
- Regulating services also contribute significantly to Scotland's economy through hazard (e.g. flood and erosion protection), air, soil and wind regulation. The value of pollination services alone to Scottish agriculture has also been conservatively estimated at about £43 million per annum.
- Supporting services function effectively in Scotland's ecosystems through nutrient and water cycling.
- Scotland benefits from diverse, highly valued and extensive cultural services from ecosystems. For example, nature-based tourism in Scotland is estimated to provide about £1.4 billion in income, and about 39,000 full-time equivalent jobs.

The UKNEA identified that actions taken and decisions made now will have **consequences far into the future** for ecosystems, ecosystem services and human well-being. It is important that these are understood, so that we can make the best possible choices, not just for society now but also for future generations. It showed that pollution, of air and water, is still seen as one of the most significant drivers of change along with the intensification / conversion of natural habitats to farmland and the exploitation of natural resources.

The evidence from the UKNEA is significant in determining approaches to improve environmental regulation, for example because:

- It strongly indicates that current environmental protection and improvement activities are not yet fully protecting ecosystem services.
- How we choose to manage ecosystems into the future will significantly influence the levels of services we obtain from them.

While attempts are made to assess today's values of some services, there are significant uncertainties in available knowledge for estimating the change in ecosystem services' values that might be expected from "better environmental regulation (see below).

4. Predicting the Impacts of Better Protecting the Environment

Understanding the economic principles and values discussed in the sections above is one important factor in designing better environmental regulation. Economic theory suggests that options to protect the environment should only be pursued when the total costs of protection to society are less than total benefits (i.e. environmental protection delivers a net benefit to society). However, the complex nature of the links between the environment and economic activity mean that the costs and benefits of regulations that protect the environment can be hard to predict. Experience has shown that in ex-ante assessments of the economic effects of environmental regulations, costs are typically overestimated (EAC, 2005)[24] and benefits often underestimated. More evidence is required on the link between environmental regulation and economic growth.

The reasons for cost overestimates include the static assessment of costs that does not account for innovation, and the nature of the economic benefits realised from the environment. These reasons are both discussed in this section. There are of course other factors, in addition to the economic costs and benefits, which are relevant when making policy decisions. These should not be ignored, but are not covered here.

4.1 Predicting the dynamic impacts of protecting the environment

The reasons for overestimating the costs of environmental protection are that they often make a static assessment of costs, but fail to recognise dynamic benefits. Those affected by regulations are inclined to identify what costs the regulations will have on their current activities. They often fail to anticipate (dynamic) changes to economic activity in response to the environmental regulations. However, the costs of environmental regulations can also be underestimated, for example when they have unintended effects (such as when waste regulations restrict the reuse of materials).

The reasons for underestimating benefits also include the static/dynamic problem, whereby potential efficiencies and reductions in costs (resulting in indirect benefits) gained from new approaches are not anticipated. An example of such cost reductions is when greenhouse gas control policies stimulate more careful management of, and therefore reduced, energy consumption which itself leads to benefits. Overall, the insufficient integration of policy assessments and existing knowledge gaps can result in the under-estimation of the ancillary benefits of any given policy.

A Defra paper (Everett et al. 2010)[25] highlighted that policies aimed at pricing environmental resources correctly can incentivise innovation and greater efficiency in resource use both in the near and longer term. At a macro-economic level, there is some evidence of short-term trade-offs between environmental regulation and growth (or productivity), but these effects have typically been found to be small or even insignificant. Longer term impacts are, if anything, small gains. Furthermore, smart policy making, such as better environmental regulation that

[24] EAC (2005), House of Commons Environmental Audit Committee, April 2005, Pre-Budget 2004 and Budget 2005: Tax, Appraisal and Environment, Recommendation 13. Session 2005-6, HC 261

[25] Everett, T. et al. (2010), Economic Growth and The Environment, Defra, London, http://www.defra.gov.uk/publications/files/pb13390-economic-growth-100305.pdf

minimises regulatory burden while stimulating innovation, can limit short-term negative impacts (Everett et al. 2010).

Economic efficiency gains arise from the incentives created by better environmental regulation to use resources wisely and innovate. The incentives that sectors face as a result of environmental protection measures can be can be strongly influenced by charges relating to the environment (e.g. fines from not complying with regulations). The extent of economic benefits in this area will depend on a sector's ability to pass on the costs they face to their consumers, which is influenced by their product differentiation, where their competition comes from, and the nature of the markets they operate in. The vast scale of potential economic benefits for businesses in the UK arising from better resource use is clear, and it has been estimated that over £6.4 billion in cost savings could be achieved per year through low or no-cost measures to improve their resource efficiency (Everett et al. 2010). It is unclear however whether the full cost savings would result from better environmental regulation alone.

The theory that the right kind of environmental regulation can stimulate more efficient use of resources through innovation is encapsulated in view that "economic competitiveness and environmental performance are compatible, if not mutually reinforcing. Low pollution and efficient energy use are signs of the highly productive use of resources. Policies that stimulate improvements in environmental quality, then, may actually foster improvements in competitiveness that underpin a rising standard of living in the long run" (Esty & Porter, 2001)[26]. Analysing a range of economic, social and environmental variables, Esty & Porter found no evidence to suggest that improving environmental quality hindered economic progress, indeed they found that strong environmental performance was positively correlated with business competitiveness. These findings build on earlier work by Porter (known as the Porter Hypothesis) that asserts that firms who improve their resource use when subjected to strengthened environmental regulations may gain a first-mover advantage against rivals from other jurisdictions, leading to greater international competitiveness. The reasons for these efficiency gains are associated with environmental regulation being a trigger to update management systems, procedures and technologies that have over time become relatively inefficient (Gabel & Sinclair-Desgagne, 1997)[27].

4.2 The nature of the economic benefits realised from the environment

Environmental benefits are also difficult to estimate because of the different types of benefits people gain from the environment. Traditionally, economics used only the market prices (costs and revenues) and consumer behaviour as measures of human welfare. However, there are many other, not traded ('non-market') goods and services including many ecosystem services that influence welfare and hence have economic values. Provisioning services (e.g. recreational

[26] Esty D. & Porter M (2001), Ranking National Environmental Regulation and Performance: a Leading Indicator of Future Competitiveness? The Global Competitiveness Report 2001-2002, OUP, New York, http://www.isc.hbs.edu/GCR_20012002_Environment.pdf

[27] *While standard economic theory may assume that internally firms are efficient, this is likely to be unrealistic in many cases. For example, work by Landis Gabel and Bernard Sinclair-Desgagne suggests a mechanism by which regulation can stimulate internal efficiency*:

Gabel H.L. & Sinclair-Desgagne, B. (1997). The Firm, Its Routines and the Environment, INSEAD Working Paper, http://flora.insead.edu/fichiersti_wp/inseadwp1997/97-05.pdf

fishing) and cultural services (e.g. enjoying the view of a protected shoreline or landscape) have direct use values. Indirect services (values) include regulating and supporting services (e.g. the ability of a healthy shoreline and near-shore ecosystem to provide for a healthy community of fish that in turn supports a productive fishery). Their values are however partly "internalised" into values of direct services, making the aggregation of indirect and direct service values methodologically challenging. There are also non-use values that flow from ecosystems that are associated with individuals' preferences for others to enjoy the services (altruistic value), for passing on a clean environment to future generations (bequest value) and for the sake of the environment itself (existence value).

Over the long term, another value of protecting ecosystems is that it makes them more resilient, and makes the benefits humans obtain from them more reliable. For example, Cardindale et al. (2012)[28] summarised evidence from a systematic review of relevant studies on a series of relationships between biodiversity and ecosystem services, and that found diverse ecological communities are more productive and more stable. Climate change is already impacting upon natural resources and ecosystem services that support human well-being. However enhanced management (through better regulation and investment in green infrastructure) can help mitigate these impacts and support adaptation efforts (World Bank, 2008)[29]. The high economic and social costs of inaction in the face of climate change and continued biodiversity loss have also been well documented (MEA, 2005). Thus another outcome of better environmental regulation is that it helps to ensure that the opportunities for long-term economic development and nature protection are kept intact, a key element in addressing growing risk and uncertainty in a changing world.

4.3 Social Impacts

The environmental and economic issues discussed in the previous three sections have significant social consequences. It is beyond the scope of this paper to identify all of these consequences or analyse them in detail. However, the following four social impacts of environmental protection reflect the importance of these issues.

Firstly, environmental regulation can have important distributional consequences. In different circumstances, social concerns can conflict or complement efficient environmental protection principles such as the polluter pays principle. For example, some water treatment costs that are paid by all households are spent to deal with diffuse pollution caused by agriculture. Transferring those costs to agriculture may save money on the whole (it being, generally, cheaper and more beneficial to reduce pollution rather than treat it) but may have negative social consequences (e.g. by reducing the competitiveness of rural economies), even though it would be in line with the polluter pays principle. The strong influence of the natural environment on rural businesses (as characterised in Table 1, e.g. in agriculture, food and drink, tourism), and the role of those businesses in providing for local incomes and jobs, suggests the environment also has an important influence on social cohesion in those communities.

Secondly, environmental quality can be an important factor in socio-economic regeneration of communities, particularly where environmental damage is present as part of post-industrial decline. A good quality natural environment has been recognised as playing a role in urban

[28] Cardindale et.al (2012), Biodiversity loss and its impact on humanity, *Nature*, Vol. 486, pp. 59-67
[29] World Bank (2008), Biodiversity, Climate Change and Adaptation: Nature-Based Solutions for the World Bank Portfolio, http://siteresources.worldbank.org/INTBIODIVERSITY/Resources/Biodiversity_10-1-08_final.pdf

regeneration of the Thames Gateway and improvements in water quality have been a contributing factor in regeneration of urban areas, such as Salford Quays in Manchester (Environment Agency, 2003)[30].

The UKNEA (2011) looked at future values for urban green space amenity in the UK under different future scenarios. The valuations ranged from losses of £1.9 billion per year to gains of £2.3 billion per year. The broad range of values is a product of whether or not increases in urban green space keep pace with increases in urban populations. They reflect the very high amenity value of natural environments in urban areas. Maintaining the quality of the natural environment is an important factor in maintaining these values into the future.

Thirdly, the quality of the natural environment can have a strong influence on public health. The health benefits of good quality environments are described by Mitchell and Popham (2008)[31]. They include the specific health damage costs associated with different pollutants like PM10 (Defra, 2006)[32]; and the positive effects of a high-quality environment through increased physical activity (Bird, 2004)[33], and improved mental health (Bird, 2007)[34]. If the number of inactive people in Scotland could be cut by 1% annually, £85.2 million in economic benefits could be gained in five years (SEPA, 2008)[35].

Fourthly, there is the issue of fairness in terms of equal access to environmental goods. The locations and lifestyles of different social groups can mean they have more or less access to the natural environment, and benefit to a greater or lesser extent from environmental protection and improvements.

5. Consequences of Environmental Regulation

This report has emphasised the many different ways that the natural environment interacts with economic activity and the importance of the natural environment for Scotland's economy. It has also outlined how society's welfare may be impacted by the way environmental regulations are designed and implemented. These impacts are therefore a key factor in determining the way SEPA's charges should best be structured. In deciding where to target its regulatory efforts it is clear that a wide range of costs and benefits, both within economic activity and to society more widely, need to be considered.

SEPA can potentially influence the performance of the Scottish economy both negatively (through increased costs to some businesses) and positively through better environmental

[30] Environment Agency (2003), Regeneration Benefits of the Environment Programme for the Periodic Review of the Water Industry (PR04), http://www.environment-agency.gov.uk/static/documents/Business/obafinal15dec_629786.pdf

[31] Mitchell, R & Popham, F. (2008), Effect of exposure to natural environment on health inequalities: an observational population study. *The Lancet*, Vol. 372 (9650), pp. 1655-1660.

[32] Defra (2006), An Economic Analysis to Inform the Air Quality Strategy Review Consultation. London, UK, Department for Environment, Food and Rural Affairs, Commissioned Report No. 398

[33] Bird W. (2004), Natural Fit: Can Green Space and Biodiversity Increase Levels of Physical Activity? RSPB, http://www.rspb.org.uk/Images/natural_fit_full_version_tcm9-133055.pdf

[34] Bird W. (2007), Natural Thinking: Investigating the links between the Natural Environment, Biodiversity and Mental Health, RSPB, http://www.rspb.org.uk/Images/naturalthinking_tcm9-161856.pdf

[35] SEPA (2008), The Natural Health Service, SEPA View, 34, www.sepa.org.uk/publications

regulation that drives innovation (by incentivising resource efficiency) and preserving environmental features that important sectors rely on.

The extent of these impacts will depend on the structure of the charging system adopted by SEPA, in particular the element of charging that are designed to encourage better environmental performance. Both the size of the incentive provided by charges, and the rules through which charging rates are varied (i.e. the way that different levels of environmental performance that have different charging levels are defined), will influence the extent of these impacts.

The report's findings emphasise that in the long term better regulation that leads to environmental protection can stimulate more efficient use of resources and innovation, leading to sustainable net economic gains

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