# An ecological footprint analysis of

# Angus

## *- Scotland -*

Prepared for

**Angus Council**

Prepared by

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## Executive Summary

The main aim of the Angus-wide Ecological Footprint project was to estimate the environmental sustainability of the lifestyle of Angus residents using the ecological footprint as the indicator of consumption. In tandem with this, the region's current ecological capacity was also calculated in order to compare demand with available supply.

This report sets out the findings and is accompanied by an interactive spreadsheet model which enables the testing of various consumption scenarios and permits the assumptions used within the study to be varied in response to new or changed findings.

These first calculations of the region's ecological footprint and biocapacity used the most recent official published sources, typically 2001 data, supplementing these with information from individuals in the Angus Council and from a variety of government departments.

Data availability was good but incomplete. Where consumption data was not available it was estimated using Scottish national data. The consumption data used to calculate the ecological footprint and biocapacity of the region is set out in full in this report. This includes:

- Direct energy use (domestic and services)
- Materials and domestic waste arisings
- Food consumption
- Personal transport
- Land use

The ecological footprint is broken down into its constituent components and compared with United Kingdom (UK) figures. The total ecological footprint of Angus was found to be 4.78 gha per capita. This compares favourably to the UK figure of 5.45 gha.

However, similar with the UK, the Angus ecological footprint exceeds the average sustainable 'earthshare' of 1.90 gha per capita. Thus, if everyone on the planet consumed as much as the average Angus resident we would require 2.5 planets to sustainably support global resource consumption.

The per capita ecological footprint of Angus is also compared to the bioproductive capacity of the region. This illustrates how the low population density of Angus (50 people per $km^2$) results in a higher local biocapacity. The total biocapacity of Angus is 4.52 gha per capita with a resident's ecological footprint of 4.78 gha per capita. This can be compared to the UK's population density of 244 people per $km^2$ and a local biocapacity of 1.64 gha per capita (ONS, 2000a). In conclusion, Angus' land area is not large enough to sustain local consumption patterns, and in theory would require an extra 6% of land in order to do so.

## Contents

## Sustainable Development

### *National and International*

The UK Government was one of 178 governments that adopted a declaration at the Earth Summit in Rio de Janeiro in 1992, committing them to making development sustainable. A number of initiatives have arisen out of this Rio Summit at both the national and international levels.

In 2001 a consultation report *Checking for Change* (Scottish Executive, 2001), with help from various organisations and individuals, looked at the different indicators available for measuring sustainable development in Scotland. This effectively led to the publication of *Meeting the Needs…Priorities, Actions and Targets for Sustainable Development in Scotland* (Scottish Executive, 2002a), which set out a vision for sustainable development in Scotland. *Meeting the Needs…* also identified resource use, energy and transport as priority areas that need to be addressed. A list of 24 indicators was produced and has been described in the *Indicators of Sustainable Development for Scotland* (Scottish Executive, 2003) report. Ecological footprinting, even though not an indicator, has been recognised by the Scottish Executive, who have funded a project to analyse Scotland's Resource Flow and Ecological Footprint[1].

The Regional Stepwise™ ecological footprint methodology, used in this report, is entirely compatible with the EU common indicators approach. It has been adopted by the European Commission as part of their European Common Indicators Project and is likely to be adopted by the UK Audit Commission (2002) as part of their *Quality of Life Indicator* set.

[1] For further information on this project see www.scotlands-footprint.com

***Sustainable development in Angus***

Angus Council is one of those local authorities committed to the concept of sustainable development. Following on from the Rio Summit it undertook a series of consultations and policy reviews on the future of the area.

In November 1996, an Environmental Strategy Group was formed and comprised representatives from each department in the Angus Council. Their remit was to develop an environmental strategy for the Council and by 1998 a strategy was drawn up and published (Angus Council, 1998). The six main principles of the Environmental Strategy aiming to achieve sustainability are:

- To integrate environmental and sustainability considerations into Council strategy, policy and programme formulation;
- To work in partnership with other agencies, businesses, Community groups and individuals;
- To consult and involve people more fully where decisions affect our environment;
- To work towards sustainability by balancing economic, social and environmental considerations for both present and future generations;
- To recognise that working towards sustainability will be a continuing process requiring flexibility and adaptability; and
- To monitor and report on progress towards sustainability.

The subsequent *Sustainable Angus* report further supported these action points and committed Angus to sustainability by stating:

*'Angus Council supports the principle of sustainable development and is committed to improving the quality of life for present and future generations in Angus. By a process of integrating responses to environmental, social and economic issues, the Council will help to maximise human welfare while enhancing the environment in Angus.'*

(Angus Council (a))

The Angus *Environmental Strategy Action Plan* goes on to mention the importance in raising awareness so that residents fully appreciate the environmental impact their day-to-day activities have. Twenty-five action points were put forward to assist Angus in education and awareness raising, one of them being:

> *' Investigate the potential to incorporate and integrate sustainability indicators into the Council's measurement of performance…'*
>
> (Angus Council, 1998)

It is within this context that Best Foot Forward was asked to undertake the first ecological footprint analysis (EFA) of Angus[2].

[2] Further information about EFA is contained in Appendix A.

## Aim of the Angus-wide Ecological Footprint Project

Commissioned by Angus Council, the aim of the Angus-wide Ecological Footprint project was to undertake the first ever ecological footprint and biocapacity analyses of the Angus Council area in Scotland.

Specific study outputs were to:

1. undertake secondary data research using official data sources
2. utilise these to calculate the main components of the region's ecological footprint (the impact on the environment), and
3. determine the locally available biocapacity (supply)

Outputs include:

1. A report which:
    a. describes the results of the component-based ecological footprint analysis
    b. describes both the resource 'demand' (the ecological footprint) and regional 'supply' (the biocapacity), and
    c. assesses the sustainability of Angus
2. An interactive spreadsheet tool which presents the component results

This project was completed by staff at Best Foot Forward Ltd, Oxford to budget. It satisfies all the outputs above.

This document constitutes the project report (Output 1 above). The spreadsheet tool (Output 2) is supplied on the computer disc that accompanies this report.

## Profile of Angus

Angus is one of the 32 councils across Scotland. The region is bounded by Perth and Kinross to the west, Dundee to the south, Aberdeenshire to the north and the North Sea to the east. Angus has a residential population of 110,230 (Angus Council, 2000) and 46,600 households (Audit Scotland, 2001).

The land area of Angus extends to two thousand one hundred and eighty one square kilometres (2,181 $km^2$) (ONS, 2000a); with an estimated 70% pastureland, 15% woodland and 11% arable land (MLURI, 2001). Angus is recognised for its scenic, landscape and environmental qualities with a number of these protected as statutory designations (Angus Council, 2000). There are four sites designated as Special Areas of Conservation and Protection, three national and one local nature reserve, three RAMSAR (wetland) areas, and numerous sites identified for their geological importance. A small part of north-west Angus (Caenlochan) is included in Scotland's 40 National Scenic Areas. Angus has over 2,000 historic buildings that are designated as Listed Buildings and over 200 are listed as Ancient Monuments, of which 17 are in the care of the Secretary of State. The glens and upper Highlands, to the north and west of Angus, are of great importance. The glens (Isla, Prosen, Clova, Ogil, Lethnot and Esk) are included in the Cairngorms Partnership Area. Angus has over 50km of coastline, inhabited by around 50% of the total Angus population (Angus Council, 2000).

Industry and business in Angus is mixed, however key sectors are general and oil related engineering, food production and processing, textiles and tourism (Angus Council, 2002a).

Agriculture and construction both employ the least people (5.84% of Angus jobs) compared with the manufacturing industry (20.69%) and services sector (67.64%) (ONS, 2000a).

## Resource Consumption

This section reviews and summarises the available data on the energy and materials consumption of Angus residents. Such data is required to perform the ecological footprint calculations. Data assumptions are presented in Appendix B.

***Data Availability***

This project relies on existing data obtained primarily from government departments, such as the Scottish Environment Protection Agency (SEPA) and or via personal communications with Angus Council and other Angus experts. Sources are referenced in the relevant data sections below.

Where local data was not available, estimates of consumption were made by proxying Scottish or UK data (as appropriate), and adjusting for population size.

The use of such proxy data does tend to mask regional differences in consumption and this should be borne in mind when considering the figures presented here. In future analyses it is hoped that the use of proxy data could be reduced either by undertaking more primary research or by drawing on improved official data sources.

For the analyses, data for the year 2001 was used where possible. However, where this was not feasible, the most recent data was used. Resource data is presented below, under the following categories:

- Direct energy use
- Materials & waste
- Food & drink
- Personal transport
- Built land

### *Direct Energy Use*

Available and estimated domestic and service sector energy data is presented in Table 1, and where available with fuel types. Angus' domestic energy consumption was assembled from several sources, while service sector consumption was based on UK data. (See Appendix B for assumptions and notes).

**Table 1: Energy consumption for 2001/02**

| **Fuel type** | **Per capita consumption** (kWh) |
|---|---|
| **Domestic energy** | 10,092 |
| *of which…* | |
| Electricity (incl. renewables) | 1,577 |
| Natural gas & LPG | 7,752 |
| Heating oil, kerosene & gas oil | 763 |
| **Services energy** | 3,728 |
| *of which…* | |
| Hotels & restaurants | 623 |
| Health & education | 451 |
| Community, social & personal | 606 |
| Office & administration | 651 |
| Commerce | 717 |
| **Total** | **13,820** |

Sources: Angus Council, 2002b; Scottish Executive, 2002b and Utley *et al*, 2000.

### *Materials & Waste*

The SEPA's *Waste Data Digest 2002* provided Angus-specific waste data. The data on domestic waste arisings and management, which was utilised in this report, is set out in Table 2. (See Appendix B for assumptions and notes).

**Table 2: Angus' domestic waste, by management type for 2000/01**

| **Waste management** | **%** | **Per capita weight** (kg) |
|---|---|---|
| **Domestic waste** | | 343 |
| *of which…* | | |
| Landfilled & incinerated | *87.56%* | 300 |
| Composted | *4.16%* | 14 |
| Recycled | *8.28%* | 28 |

Source: SEPA, 2002.

### *Food & Drink*

Food consumption data for Angus was not available. It was therefore estimated using Scottish and UK proportions. Data is shown in Table 3. (See Appendix B for assumptions and notes).

**Table 3: Angus' domestic food consumption for 2000**

| **Food type** | **Per capita consumption** (kg) |
|---|---|
| **Domestic food** | **869** |
| *of which…* | |
| Animal-based | 309 |
| Plant-based | 560 |

Sources: DEFRA, 2000 and Eurostat, 2001.

### *Personal Transport*

Personal transport data for Angus residents was incomplete and national UK data had to be used for the majority of modes. However, by using a variety of sources it was possible to estimate Angus-specific residents travel for car and bus. Scottish national data was used for rail, waterborne, air and motorbike travel.

A breakdown of personal transport data is shown in Table 4. (See Appendix B for assumptions and notes).

**Table 4: Angus' personal transport, by mode for 1998/2000**

| **Transport mode** | **Per capita travel** (pass-km) |
|---|---|
| **Personal transport** | **17,671** |
| *of which…* | |
| Car | 15,059 |
| Bus & coach | 1,490 |
| Rail, tram & metro | 729 |
| Waterborne | 13 |
| Air | 343 |
| Motorbikes or scooters | 37 |

Sources: Clark, 2002 and Scottish Executive, 2002c.

### *Land Use*

Accurate land use data was not available for Angus, therefore Scottish proportions were used to estimate a breakdown of the region's 2,181 $km^2$ (ONS, 2000a). Land type and area are given in Table 5 below. (See Appendix B for assumptions and notes).

**Table 5: Angus' land use, by type**

| **Land type** | **Scotland land use** (%) | **Angus land use** ($km^2$) |
|---|---|---|
| Arable | 11.3 | 246 |
| Pasture | 69.2 | 1,510 |
| Built land | 2.5 | 54 |
| Sea | 2.0 | 43 |
| Woodland | 15.1 | 329 |
| **Total land area** | **100.0** | **2,181** |

Sources: ONS, 2000a and MLURI, 2001.

## Angus Ecological Footprint Results

**The ecological footprint of Angus is**

**525,602 gha**

**or 4.78 gha per capita**

Table 6 and Figure 1 summarise the ecological footprint of Angus by component. Figure 2 shows the same data aggregated into fewer categories reflecting the European Common Indicator Programme (ECIP)[3] component definitions – this is useful for comparative purposes. The spreadsheet model, supplied in conjunction with this report, also expresses the Angus footprint in terms of the ECIP components and provides comparative data for the UK. ECIP figures for other EU-15 countries are compared with the Angus results in Figure 3.

Table 6 also provides comparative data against UK figures, which illustrate that based on available data, the average Angus ecological footprint is lower than the UK average. This difference is primarily due to lower per capita food consumption and waste generation, which in turn can be attributed to the slightly higher levels of composting and recycling in Angus (over 12.4% of waste is recycled or composted). Without any recycling or composting, Angus' ecological footprint would be 4.86 gha per capita (still less than the UK per capita average of 5.45 gha).

Apart from waste, Angus's personal transport footprint is higher than that of the UK (see Appendix B for further explanation). The domestic energy footprint for Angus is also slightly higher than the UK (the former perhaps reflecting a colder climate). Other component values are broadly similar.

[3] See Appendix C for more information about ECIP.

**Table 6: The ecological footprint of Angus, by component**

| Component | Total Angus footprint (gha) | Per capita Angus footprint (gha) | Per capita UK footprint (gha) |
|---|---|---|---|
| **Ecological footprint** | **525,602** | **4.78** | **5.45** |
| *of which…* | | | |
| Domestic energy | 68,455 | 0.62 | 0.60 |
| Services energy | 29,131 | 0.26 | 0.37 |
| Materials & waste | 165,171 | 1.50 | 1.98 |
| Food | 156,999 | 1.43 | 1.55 |
| Personal transport | 83,171 | 0.76 | 0.62 |
| Built land | 22,675 | 0.21 | 0.32 |

**Figure 1: The ecological footprint of Angus, by component**

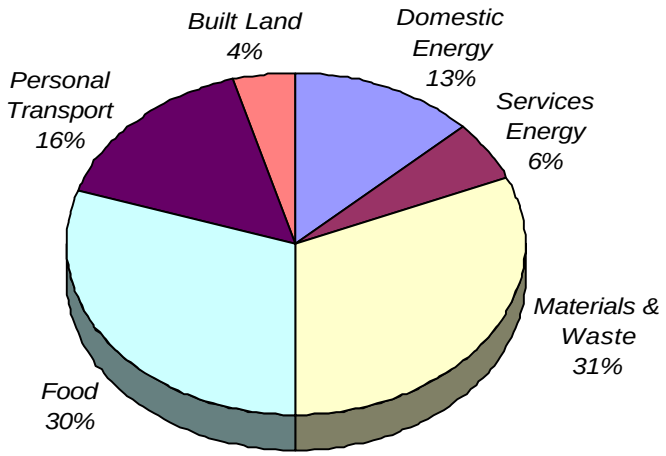



**Figure 2: The ecological footprint of Angus, by ECIP components**

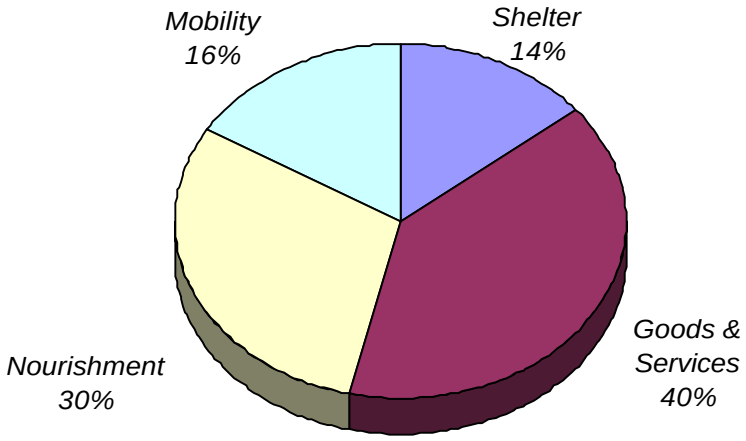
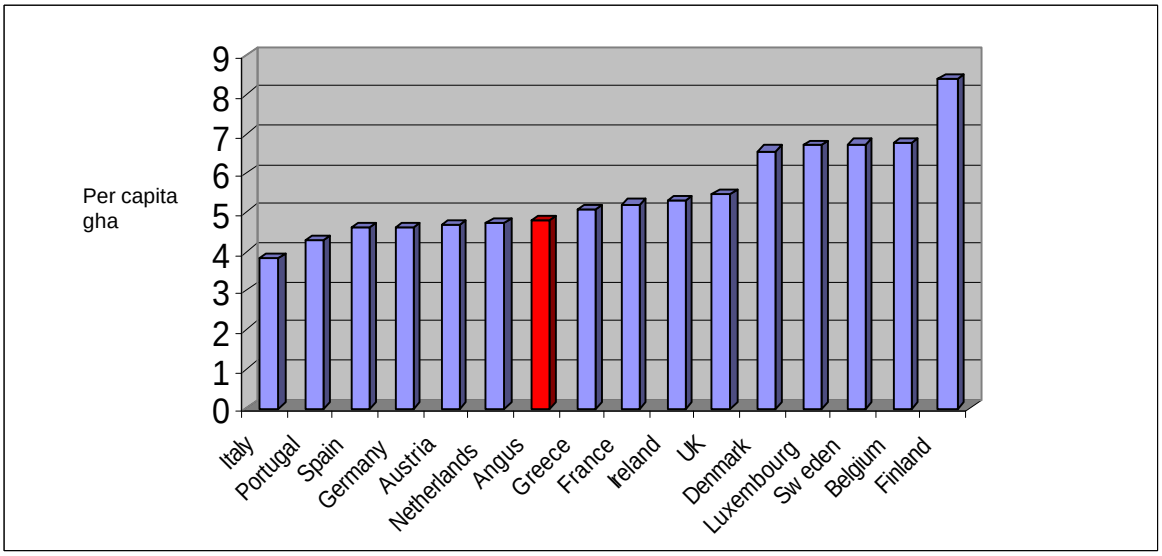


**Figure 3: Angus' per capita footprint compared with EU-15 countries**




***Direct Energy (Domestic & Services)***

Direct energy use by households and services amounted to 19% of the total Angus ecological footprint, with domestic energy being the larger component of the two. Looking at the domestic supply, natural gas and LPG produced the largest footprint followed by electricity and fuel use for space heating (heating oil, kerosene and gas oil)[4].

[4] Of all the energy types, LPG and gas have the lowest emissions per unit used, but the largest ecological footprint. This is because gas heating tends to be used for space heating, which usually is the biggest form of energy consumed.

**Table 7: Angus' direct energy ecological footprint**

| Fuel type | Total footprint (gha) | Per capita footprint (gha) |
|---|---|---|
| **Domestic energy** | **68,421** | **0.62** |
| *of which…* | | |
| Electricity | 20,037 | 0.18 |
| Natural gas & LPG | 41,799 | 0.38 |
| Heating oil, kerosene & gas oil | 2,881 | 0.03 |
| **Services energy** | **29,131** | **0.26** |
| *of which…* | | |
| Hotels & restaurants | 762 | 0.01 |
| Health & education | 8,514 | 0.08 |
| Community, social & personal | 6,075 | 0.06 |
| Office & administration | 6,256 | 0.06 |
| Commerce | 7,524 | 0.07 |
| **Total** | **97,552** | **0.89** |

***Materials & Waste***

The total footprint of materials and waste for Angus was 165,171 gha. This is 31% of the total footprint and therefore the largest component (environmental impact). Using UK trade proportions, this equates to 42,459 gha attributable to net traded goods and 81,356 gha attributable to UK-produced goods (here referred to as nationally-produced goods).

Wood products (such as paper and timber) are also significant, with a footprint of 34,786 gha. Less significant are other plant-based and animal-based goods (for example, clothing), which have a relatively low impact. See Table 8 for a breakdown. Given the limited data on waste content it was not possible to provide a more detailed breakdown of disposed materials.

**Table 8: Angus' materials & waste ecological footprint**

| Categories | Total footprint (gha) | Per capita footprint (gha) |
|---|---|---|
| **Materials & waste** | **165,171** | **1.50** |
| *of which…* | | |
| Net traded goods (energy only) | 42,459 | 0.39 |
| Nationally-produced goods (energy only) | 81,356 | 0.74 |
| Plant-based (excl. wood products)* | 5,607 | 0.05 |
| Animal-based** | 964 | 0.01 |
| Wood products | 34,786 | 0.32 |

Notes: *includes crop land ** includes pasture and fishing

### *Food & Drink*

The estimated ecological footprint for foodstuffs consumed by Angus residents was 156,657 gha (or 1.42 gha per capita). At a little under 30%, food was the second largest component of the overall footprint. Table 9 shows the breakdown of the food ecological footprint. The largest component in the food ecological footprint was animal-based foods.

**Table 9: Angus' domestic food ecological footprint**[5]

| Food category | Total footprint (gha) | Per capita footprint (gha) |
|---|---|---|
| **Food** | **156,657** | **1.42** |
| *of which…* | | |
| Animal-based | 117,216 | 1.07 |
| Plant-based | 39,441 | 0.36 |

### *Personal Transport*

The ecological footprint of personal transport in Angus was 83,171 gha (0.76 gha per capita). Personal travel constituted 16% of the total footprint. Table 10 shows the

[5] The ecological footprint is a combination of consumption and impact per consumption unit. Because meat products are higher up the food chain and thus embody many more resources than plant based products, their impact per consumption unit is vastly higher. For example, the UN Population Fund (2001) state that it takes 4-5kg of feed to produce 1kg of meat. Therefore, even though meat consumption is lower (see table 3), the impact of that consumption is greater than that for plant-based products.

breakdown of the personal transport ecological footprint. The largest component by far was car travel (0.65 gha per capita), followed by air travel (0.05 gha per capita). It should be noted that apart from car and bus travel, the remaining transport modes are based on Scottish averages, this is due to the lack of Angus specific transport data.

**Table 10: Angus' personal transport ecological footprint**

| **Transport mode** | **Total footprint** (gha) | **Per capita footprint** (gha) |
|---|---|---|
| **Personal transport** | **83,171** | **0.76** |
| *of which…* | | |
| Car | 71,959 | 0.65 |
| Bus & coach | 3,051 | 0.03 |
| Rail, tram & metro | 1,817 | 0.02 |
| Waterborne | 156 | 0.00 |
| Air | 6,030 | 0.05 |
| Motorbikes or scooters | 158 | 0.00 |

### *Built Land*

The footprint of built, or degraded land, was 22,675 gha (0.21 gha per capita) or 4% of the total Angus ecological footprint (see Appendix B Land Use assumptions for more detail).

Using UK average figures, it was possible to estimate built land use for Angus in more detail (see Table 11 below).

**Table 11: Angus' built land ecological footprint**

| **Land type** | **Total footprint** (gha) | **Per capita footprint** (gha) |
|---|---|---|
| **Built land** | **22,675** | **0.21** |
| *of which…* | | |
| Housing land | 6,702 | 0.06 |
| Transport-related land (roads, ports etc) | 3,433 | 0.03 |
| Commercial/industrial land (incl. hydro) | 12,540 | 0.11 |

## The Biocapacity of Angus

***Biodiversity***

In accordance with *Living Planet Report* (Loh *et al.*, 2002), the main findings of this study are presented excluding biodiversity. However, in an attempt to account for the bioproductive resource requirements of non-human species in the area an estimate is made below.

Ecologists estimate that non-human species may require between 10% (Loh *et al.*, 2002) and 75% (Noss and Cooperrider, 1994)) of the bioproductive resources of the planet. The Brundtland Commission (WCED, 1987) estimated that this requirement was 12%. This estimate has been adopted for calculating the ecological footprint of Angus' biodiversity.

To gauge the biodiversity responsibility of each Angus resident, the amount of land to be 'set-aside' for biodiversity relates to the ecological footprint, for example the bigger your ecological footprint the bigger your responsibility for biodiversity.

**The biocapacity of Angus is**

**493,993 gha**

**or 4.52 gha per capita**

The actual geographical size of Angus is 218,100 hectares (2,181 $km^2$ (ONS, 2000a)). The biocapacity of Angus is derived from the bioproductivity of this land and the surrounding sea. Bioproductivity is expressed here in global hectares for comparability with the ecological footprint. 'Actual' hectares are converted to global hectares by adjusting for land type and quality. Given that land in Angus is much more productive than the global average, the biocapacity of Angus – expressed in global hectares – is double that of the actual land area (493,993 gha[6]). Sea area is assumed to be of average UK size (per capita) and average UK productivity. This

[6] Numbers do not add up to the total (493,993 global hectares) due to rounding.

gives a sea biocapacity of 39,060 gha (see Appendix D for Best Foot Forward's position on fishing quotas).

***Sustainability Assessment***

Comparing the ecological footprint of the resident population with the biocapacity of the region it is possible to estimate regional sustainability. Looking at the bigger picture, one can compare the footprint and the globally available average biocapacity or 'earth share'.

As can be seen in Table 12, the consumption (ecological footprint) of Angus residents exceeds both local and global average sustainable supply.

**Table 12: Angus' ecological footprint, excluding biodiversity, shown against local biocapacity and the global earthshare**

| **Average earthshare** (gha) | **Biocapacity of Angus** (gha) | **Ecological footprint of Angus** (gha) |
|---|---|---|
| 1.90 | 4.52 | 4.78 |

**If everyone in the world lived like the average**
**Angus resident we would require 2.5 planets**
**to sustainably support consumption**

This assessment indicates that the 'average' Angus resident is using 250% of the average earthshare, compared to the UK figure of 333%.

A biocapacity ecological footprint of 4.52 gha reflects the low population density and high bioproductivity of the region.

## Appendix A: Ecological Footprint Analysis

***What is Ecological Footprint Analysis?***

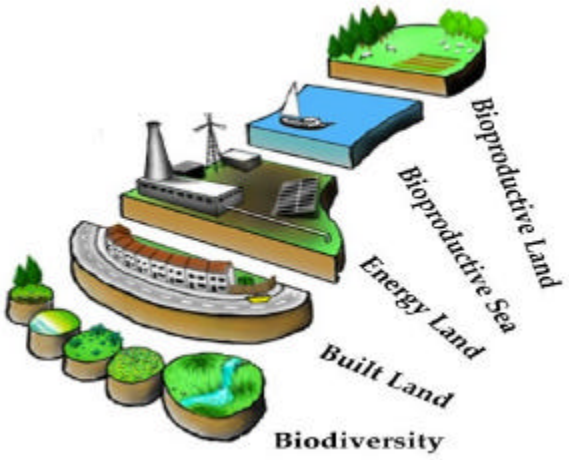
Co-originated in the early 1990's by Professor William Rees and Dr. Mathis Wackernagel, ecological footprint analysis[7] has rapidly taken hold and is now in common use in many countries at national and local levels; for example, the UK, Mexico, the United States, Canada, Holland, Denmark, Sweden, Norway, Italy, Spain and Australia. The ecological footprint of a region or community can be said to be the bioproductive area (land and sea) that would be required to sustainably maintain current consumption, using prevailing technology.

Imagine a glass dome over Angus, what area would this dome have to cover to ensure that the Angus population could maintain their current lifestyles using only the bioproductive space within the dome?

For the purposes of the ecological footprint calculation, land and sea area is divided into four basic types; bioproductive land, bioproductive sea, energy land (forested land and sea area required for the absorption of carbon emissions) and built land (buildings, roads etc.). A fifth type refers to the area of land and water that would need to be set-aside to preserve biodiversity (see Figure 4).

[7] Those wishing to go beyond the outline given in this report are recommended to read *Sharing Nature's Interest* by Chambers, Simmons and Wackernagel, 2000, www.ecologicalfootprint.com

**Figure 4: Land types used for ecological footprint analysis**




*Example 1:* A cooked meal of fish and rice would require bioproductive land for the rice, bioproductive sea for the fish, and forested 'energy' land to re-absorb the carbon emitted during the processing and cooking.

*Example 2:* Driving a car requires built land for roads, parking, and so on, as well as a large amount of forested 'energy' land to re-absorb the carbon emissions from petrol use. In addition, energy and materials are used for construction and maintenance.

Once a total ecological footprint for a region is calculated, this figure can be used in certain ways. For example, by comparing the use of bioproductive area by an 'average' Angus resident with the available average 'earthshare', one can estimate ecological sustainability. The earthshare is calculated by dividing the total amount of productive land on the planet by the population. Loh *et al*. (2002) estimate the average 'earthshare' to be about 2 gha[8]. This earthshare can be considered as the maximum, equitable footprint allowance, without depriving either future generations or those now living.

An annual *Footprint of Nations* study, published as part of the *Living Planet Report* (Loh *et al*., 2002), provides a national context for considering regional ecological

[8] The actual figures given by Loh *et al* (2002) are 1.9 gha for an average earthshare. Figures are rounded in this report.

footprints (see also Wackernagel *et al.*, 2000 and Lewan & Simmons, 2001). Based on 2000/01 data, the ecological footprint of the UK was 5.45 gha per person compared with a bioproductive capacity of just 1.5 gha – a deficit of almost 4 gha.
Globally, the average ecological footprint was 2.3 gha in 1999, excluding biodiversity – as opposed to an available capacity of 1.9 gha - suggesting that the human population is using over time, more natural resources than can be sustained.

***The EcoIndex™ Methodology***

The Regional Stepwise™ ecological footprint calculations in this report follow the EcoIndex™ Methodology. This is compatible with the method used by the European Common Indicators Programme (ECIP) (www.sustainable-cities.org) to allow for benchmarking of cities and regions across Europe. The ECIP method is described in more detail in Appendix C (see also Lewan and Simmons (2001)).

The EcoIndex™ Methodology, developed by Best Foot Forward (see Chambers *et al*, 2000), uses a 'component' (or 'bottom-up') approach to perform ecological footprint analysis. Though different data sources are used, the calculation method is wholly compatible with, the 'compound' (or 'top-down') approach used by Wackernagel *et al.* in the *Footprint of Nations* studies (1997, 1999, 2000 and 2002), which uses international trade statistics as a starting point.

The EcoIndex™ Methodology, wherever possible, uses full life cycle impact data to derive ecological footprint conversion factors for key activities (the 'components'). For example, to calculate the ecological footprint of a car passenger travelling one kilometre, fuel use, materials and energy for manufacture and maintenance of the vehicle, and the share of UK roadspace appropriated by the car are accounted for (Table 13). This conversion factor is then applied to the number of passenger-kilometres travelled.

**Table 13: An example analysis for the Footprint of UK car travel (per passenger-km)**

| Component | Inputs | $CO_2$ emissions | Built land | Footprint |
|---|---|---|---|---|
| Petrol | 0.094 litres | 0.22 kg | | 0.000031[ii] area unit-yrs |
| Maintenance & Manufacture | 0.0423 litres equivalent | 0.10 kg | | 0.000014[iii] area unit-yrs |
| Road Space | 258,175 ha | | [a] 817,043 area units (1) | |
| Car Road Share | [b] 86% | | | |
| Car kms | [c] 362,400,000,000 | | | |
| *Average Occupancy* | [d] *1.6 persons* | | | |
| *Calculation* | | | *(a+b)/c/d* | *i+ii+iii* |
| **Footprint** | | | 0.0000012[i] area unit-yrs | **0.000046** area unit-yrs/pass-km |

A similar approach is used to derive a range of ecological footprint component values, representing the main categories of impact, before summing them to calculate a total ecological footprint for Angus. The key components used in this study are:

- Direct energy (Domestic and Services)
- Materials & waste
- Food & drink
- Personal transport
- Built Land

Each of these key components is made up of smaller sub-categories. For example, Direct Energy is sub-divided into electricity, gas and domestic heating oil. Each of these sub-categories can be broken down further.

Using this component approach enables the calculation of ecological footprints at any level – for a product, organisation, activity or region.

**Box 1: Take only pictures - leave only footprints**

It is important to note that ecological footprint analysis is a ‘snapshot’ methodology. It tells us how much bioproductive area would be required based on a specific data set - it does not attempt to predict future or past impacts.

It is likely that, due to technology changes and variations in material flows into the economy, the ecological footprint will change over time.

In the period which data is recorded some of the input flow of materials will stay in the economy, as stock, and some will flow out as waste. In both cases these materials were considered to have been ‘consumed’.

### *Study Boundaries*

Any study of resource consumption faces boundary issues - what to include and what to exclude. One approach is to include all consumption that takes places within certain geographical bounds . This is known as the 'geographical principle'. The other common approach is to consider only the consumption attributable to those living within a geographic area (the 'responsibility principle'). This latter approach is favoured by WWF in their *Living Planet Report* (Loh *et al*, 2002) and is the approach adopted in this report.

A further discussion of the geographical and responsibility principle can be found in Lewan and Simmons (2001).

## Appendix B: Angus Data Assumptions

***Domestic Energy***

Energy data for Angus was collected from various sources. Household electricity and gas consumption per capita was based on the Scottish national household average of 3,880 kWh and 19,070 kWh respectively (ESRU, 2002). Both figures were adjusted to per capita consumption using Angus's average household population (Angus Council, 2002b).

Total domestic energy consumption for Angus in 2001 was 2.5 million GJ (Angus Council, 2002b). This was broken down using Scottish national energy proportions for domestic oil (6%) and coal (6%) (Utley *et al*, 2000). Based on Scottish Executive (2002b) data it was calculated that 10.4% of electricity was sourced from renewable energy (hydro and other renewable sources).

No data was available for district heating, wood fuel and other domestic energy. It was assumed that consumption of these is negligible.

***Services Energy***

Energy consumption by service sector was not available for Scotland and it is not known how much Angus residents consume. However, service sector spending was available for Scotland and is about 5.8% lower than the UK average (ONS, 2000a).

The service sectors covered in this project are defined according to the Statistical Classification of Economic Activities in the EU (NACE Rev.1) (European Communities, 2002).

- Hotels & restaurants (NACE 55)
- Health & education (NACE 80, 85).
- Other Community, social & personal service activities (NACE 90-93).
- Offices & administration (NACE 60-67, 70-75, 99).
- Commerce (NACE 50-52).

To apportion the impact of services, it was assumed that their usage is proportional to spending on services. Excluded from this calculation are those services that are normally provided from general taxation (education and health) and those that relate to other categories (food, goods and mobility). Service use was assumed to be evenly distributed throughout the Area's population.

Service sector spending includes the following categories of spending:

- Communication
- Recreation & culture
- Restaurants & hotels
- Miscellaneous goods & services

Excluded are - health & education, food & drink and clothing, furnishings & utilities etc. as these are related to goods or to services provided partly or wholly by the region.

***Materials & Waste***

Municipal waste data was used as a proxy for personal resource consumption. This necessitates a couple of key assumptions. Firstly, that personal material consumption is proportional to household waste arisings. Secondly, that the content of the waste can be assumed to be the same as the UK mix.

Tonnages of landfilled and incinerated household waste were used to proxy materials consumption (any benefit from 'energy-from-waste' is accounted in direct energy data). Tonnages of recycled and composted materials were first multiplied by a factor (default 50%) before being added to the landfilled and incinerated tonnages to reflect the embodied energy savings that accrue when recycling and or composting. Recycled materials are assumed to reduce the need for virgin resource consumption. Similarly, composted materials are assumed to displace their more energy-intensive manufactured equivalents. Clearly, these assumptions can be challenged where materials are selectively ‘mined’ from waste for recycling. However, this requires considerable data on the waste content – information, which was not available here.

It should be noted that the method used assumes that the proportion of stock (those materials retained within the economy) is the same across regions. Evidence suggests that the vast majority of retained materials are used for construction (roads, housing and so on) and have a long lifespan.

SEPA's *Waste Data Digest 2002* states that the local authority of Angus produced 27,460 tonnes of household waste (SEPA, 2002). It was therefore estimated that 343 kg of waste is generated per capita. Recycling and composting rates for Angus households was not available, but was available for Angus' local authority waste (which includes household, commercial etc waste). Calculations show that Angus recycled and composted 12.44% of its waste, which is approximately 43 kg of household waste per capita per year.

No data on the consumption of wood products was available for Angus or Scotland – so the UK average was used.

***Food***

Food consumption data specific to Angus was not available so Scottish data was used instead. In order to scale Scottish food consumption against UK food consumption, the *National Food Survey* (DEFRA, 2000) was used. This estimated that food consumption in Scotland was 4% lower than in the UK. The UK figure of 906 kg per capita (European Communities, 2001) was adjusted to 869 kg per capita for Angus.

***Personal Transport***

Personal transport data for Angus was scarce. Scottish figures provided by the *Statistical Bulletin Travel Series* were mostly used (Scottish Executive, 2002c). The *Scottish Household Survey* (Clark, 2002) did have information for car and bus travel in Angus, suggesting that the two modes were 68% and 31% higher respectively than national Scottish averages. These percentages were applied to Scottish national transport figures to give an estimate of 15,059 pass-km per capita for car transport and 1,490 pass-km per capita for bus transport in Angus (Scottish Executive, 2002b).

Scottish air and ferry (waterborne) transport data was combined to give a total of 356 pass-km per capita. Based on UK proportions of air and ferry transport (96.3% and 3.6% respectively) it was assumed that Scottish residents travelled 343 pass-km per capita by air and only 13 pass-km per capita by ferry. Similarly, Scottish data was used for motorbike and rail transport.

***Land Use***

The total land area for Angus was 2,181 $km^2$ (ONS, 2000a). Unfortunately, a land use type breakdown was not available for Angus so Scottish proportions were applied instead (see Table 5).

Built land was apportioned to different categories (housing, transport and industrial/commercial) based on UK proportions. For the purpose of calculating biocapacity, it is assumed that all built land is of average UK national arable productivity.

The yield and equivalence factors used were those for the UK (Loh *et al*, 2002). Fishing grounds were assumed to be the UK per capita average.

## Appendix C: European Common Indicators Programme (ECIP)

The European Common Indicators Programme (ECIP) is a monitoring initiative focused on sustainability at the local level. A partnership of different organisations and levels are working together, in a joint effort to find comparable data and a better understanding of sustainability in local communities across Europe. Ten common local sustainability indicators were identified through a bottom-up process. Used in combination with other indicators and other evaluation methods, the European Common Indicators can contribute to a comprehensive local or regional monitoring strategy.

Over 100 local and regional authorities have so far signed the adoption agreement and are now testing the indicators, and refining the monitoring initiative based on practical experiences.

Support services are provided to participating authorities during the testing phase: technical support (scientific expertise, helpdesk, workshops, etc.), methodological development, pilot activities on the Ecological Footprint, good practice collection and exchange, dissemination activities, and evaluation, reporting, recommendations and guidelines.

For further information on the ECIP programme visit www.sustainable-cities.org/ or see Lewan and Simmons (2001).

## Appendix D: Sea Biocapacity

Best Foot Forward cannot comment on the politics behind the decisions about fishing quotas. The ecological footprint is an indicator and Best Foot Forward do not make political recommendations based upon our findings. We prefer that the ecological footprint can be taken into the community for those closest to the study to decide what action should be taken. Biocapacity may indeed rise with reduced fishing, if the ecosystem and population have not been degraded 'beyond repair' by the past unsustainable use of fish. If availability does go down, this is an indication of the unsustainable use of fish before quotas were introduced.

To enable regional comparisons the whole of the UK sea area is equally distributed between the population. Therefore, biases involved by simply living by the coast are overcome.

## Glossary

**Biological capacity** refers to the total of the biologically productive areas. See also 'biologically productive areas'.

**Biologically productive areas** are those areas of a country or region with quantitatively significant plant and animal productivity. Biologically productive areas of a country or region comprise its biological capacity. Arable land is potentially the most productive area.

**Carbon Dioxide ($CO_2$)** is a gas, which is naturally emitted by living organisms as well as during the combustion of fossil fuels. The latter is problematic since it leads to increased concentrations in the atmosphere.

**Ecological footprint** is the land and water area that is required to support indefinitely the material standard of living of a given human population, using prevailing technology. (Measured in global hectares).

**Embodied energy** of a commodity is the energy used during its entire life cycle for manufacturing, transporting, using and disposing.

**Fossil fuels** are coal, natural gas and fuels derived from crude oil (for example, petrol and diesel).

**Global hectares (gha)** One global hectare is equivalent to one hectare of biologically productive space with world average productivity.

**Gross Domestic Product (GDP)** is a measure of the total flow of goods and services produced over a specified time period. It is obtained by valuing outputs of goods and services at market prices.

**Hectare** one hectare (ha) is 10,000 square metres (100 x 100 metres). One hectare is equivalent to 2.47 acres.

**Inert waste** is chemically inert, non-combustible, non-biodegradable and non-polluting waste.

**Natural Capital** refers to the stock of natural assets that yield goods and services continuously. Main functions include resource production (such as fish, timber or cereals), waste assimilation (such as $CO_2$ absorption, sewage decomposition) and life support services (UV protection, biodiversity, water cleansing and climate stability).

**Net traded goods** are net imports of goods, i.e. imports of goods minus exports of goods = net imports of goods. Net traded and nationally produced goods are products that do not embody (include) bioproductive land or sea resources. Energy and non-bioproductive landed are accounted for in the goods. However, only energy impacts are aligned in component-based ecological footprinting methodology.

**Per capita** is a measure per person within a specific population.

**Productivity** is measured in biological production per annum and hectare. A typical indicator of biological productivity is the biomass accumulation of an ecosystem.

**Proxy** is normally used to compensate for a lack of raw data. It is an estimation derived from an existing data set using a statistical modifier. For example, deriving local water consumption data by using average per capita consumption of a region in which the locality is part.

**Recycling** is the process of collecting, sorting, cleansing, treating and reconstituting materials that would otherwise become waste, and returning them to the economic stream as raw materials for new, reused or reconstituted products.

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