

## SCOTTISH NATURAL HERITAGE

### SCIENTIFIC ADVISORY COMMITTEE

#### NATURAL HERITAGE INDICATORS

##### Summary

- 1 Eight natural heritage indicators have been comprehensively revised and updated, in the light of earlier discussion with the Committee on. These, and an additional indicator on land cover change, are presented here for consideration by a sub-group of the Committee.

##### Action

- 2 **The Committee sub-group is asked to:**
  - **note actions taken in response to the Committee's previous consideration of the indicators (para 4 – 5)**
  - **endorse, subject to further comments, the revised indicators for reporting back to the Committee, and then consideration by Management Team and Board (para 6 – 8).**

##### Preparation of Paper

- 3 This paper has been prepared by Ed Mackey (Evidence Base Unit).

##### Background

- 4 At the 31<sup>st</sup> meeting of the Committee, Ed Mackey introduced eight natural heritage indicators. The minutes (AP1 SAC/2008/03/17) state that Ed was to contact Colin Campbell, Beth Scott and Malcolm Ogilvie to discuss the paper further; Colin Campbell and Lyn Jones could also assist if so required.
- 5 In the light of these discussions, the eight indicators have been comprehensively revised. An additional indicator, on land cover change, has also been prepared at the Committee's suggestion. Actions taken to fully address the Committee's comments are set out in **Appendix 1**.
- 6 A summary of the indicators is shown in **Table 1**, below. The indicators themselves are presented in **Appendix 2**.
- 7 It is important to move this work on. Attention needs to be given to new aspects of the Corporate Strategy and Government priorities. Indicators can be adapted and improved through time, but a line needs to be drawn in order that they can be put to use. A key consideration is the launch of the new Corporate Strategy, for which indicators present part of the evidence base. In commenting, reviewers might consider a triage assessment for each indicator, e.g. acceptable now / acceptable with modification / unacceptable.

- 8 When approved by Management team and Board, the indicators can be placed alongside others on the [SNH web site](#).

**Table 1**  
**Summary of Results**

1	River Quality	less polluted	2006	↑
2	Information Provision	4.7 million records	2007	↑
3	The Timing of Seasonal Events	4 days earlier / decade	2006	←
4	Habitat Connectivity	Wood, heath	2008	□
5	Visual influence of built development	31% unaffected	2008	↑
6	Built Development	1.5% increase / year	2008	□
7	Land cover	Reduced semi-natural	1998	↕
8	Conservation Management	63% of Scotland	2008	□
9	Tourism	27% increase in GTBS	2007	↑

**Assessment categories**

<b>Trend (across the entire time series)</b>	
Increase	↑
Divergent (components increased and decreased)	↕
Fluctuate (variation with little / no overall change)	↔
Decrease	↓
Timing of seasonal events - earlier	←
Timing of seasonal events - later	→
Baseline (commencement of a time-series)	□
No data (under development)	○
<b>Data confidence</b>	<b>high</b> <b>satisfactory</b> <b>low</b>

**Appendix 1**  
**Actions taken in response to Committee comments**

#	Indicator	Committee comment	Response
1	River Quality	<p>Trend may be confusing when the unclassified data are included.</p> <p>Length of river improved needs to be highlighted.</p> <p>SEPA will be changing its sampling strategy and this will result in a discontinuity of the data.</p> <p>The definition of what is a river needs to be included.</p> <p>Data should be expressed as percentage of classified lengths.</p>	<p>Unclassified removed to show trends more clearly for 1999-2006 and 2005-2006.</p> <p>Length is now the metric for the indicator.</p> <p>This has occurred before. The indicator will be amended accordingly.</p> <p>Definition, based on the Digitised River Network, included.</p> <p>Classified lengths and their % change are now reported.</p>
2	Information Delivery	<p>Volume of biological records available was not necessarily a full measure of information use, there are still questions about how effectively this data is used and of the level of the effective usage of the National Biodiversity Network.</p>	<p>A long-standing request to the NBN has not yet provided an answer to this but it is being pursued.</p>
3	Seasonal Events	<p>Not necessarily representative of all species which occur in these habitats merely those for which a long run of data was available.</p> <p>In some cases the use of just one indicator species was inadequate to represent a particular environment.</p> <p>For the dipper, it is unclear what is controlling the seasonality of different egg laying times.</p> <p>May be worthwhile to consider another indicator for freshwater systems.</p> <p>The category “deterioration” should perhaps be changed to “cause for concern”.</p>	<p>The commentary refers to the underlying review of 525 datasets. The three selected are on the basis of their contrasting ecological characteristics and the strength of their response signal.</p> <p>Causality is not part of the phenology analysis, but the ecological implications are temperature and the availability of invertebrate prey in freshwater streams.</p> <p>The 525 datasets were reviewed included, for example, fish and amphibians, but the dipper is the only one with a reasonable time series.</p> <p>No additional datasets are known.</p> <p>The phenology assessment is ‘earlier’ (see <b>Table 1</b>). This may be cause for concern or a sign of</p>

			adaptation to changing conditions.
4	Habitat Networks	Still a fundamental question of whether connectivity is good for all species and whether it is therefore a good indicator to use.	This is clarified in the text. The analysis for Scotland – a world leader in functional connectivity modelling – improves on reliance solely on UK / European indicators (which will be in use anyway) through the use of higher-resolution data, more rigorous analysis and locally-tailored applications.
5	Landscape	It should be stressed that for landscape it is change that is measured, and that this does not necessarily represent deterioration.	The indicator is now purely descriptive.
6	[Land Cover]	This one should perhaps concentrate on landscape features as they relate to habitat change.	An additional indicator of land cover change has been prepared.
7	Built Development	<p>The criteria used that of the measurement of a road presence or absence in a square is not regarded as being a very sensitive measurement.</p> <p>Information from other sources relating to how much building is actually taking place in the countryside may contradict some of the data presented.</p>	<p>The method has been comprehensively revised and updated to create a 2008 baseline. Soil sealing can be compared with 2005, but change statistics on e.g. road length will only be available in future updates.</p> <p>The new method provides a more informative, consistent and detailed account.</p>
8	Positive Management	No trend available as yet.	Data improvements mean that the updated indicator for 2008 has established a baseline for tracking change.
9	Tourism	<p>Other data sources may need to be identified at present as NNR visits alone may be a poor indicator of what is happening across the great width of the tourism sector.</p> <p>NNR visitor rates may be a good proxy for looking specifically at natural heritage tourism.</p> <p>We must be careful in using this indicator as tourism is very dependent on external factors such as fuel costs and the international situation.</p> <p>It is important to have input for these assessments from those with a background in economics, this will strengthen the reliability of the data.</p>	<p>The indicator has been changed to reflect tourism more generally.</p> <p>NNR visits have been reviewed for possible use elsewhere.</p> <p>The indicator is based on published VisitScotland data.</p> <p>Economics is part of broader work that goes beyond the scope of the indicator.</p>

	Assessment	Red, green amber status given to some indicators required explanation and context.	<p>The assessment is now neutral and so enables further interpretation by SNH and others according to purpose (e.g. in relation to the 2010 target).</p> <p>The SNH assessment (<b>Table 1</b>) refers simply to increase / decrease / divergent / fluctuation / earlier.</p>
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## Appendix 2

### 1 River quality

Scotland's fresh waters, 30,000-or-more lochs and lochans and over 10,000 burns and rivers, are strong visual components in the landscape. The interplay of rainfall, altitude, geology, soil type, landform and land use has resulted in a diversity of fresh waters and associated assemblages of habitats and species. Good water quality is fundamental to the health and status of Scotland's freshwater environment, to quality of life, and to the wildlife associated with rivers, streams, lochs, canals, ponds and reservoirs.

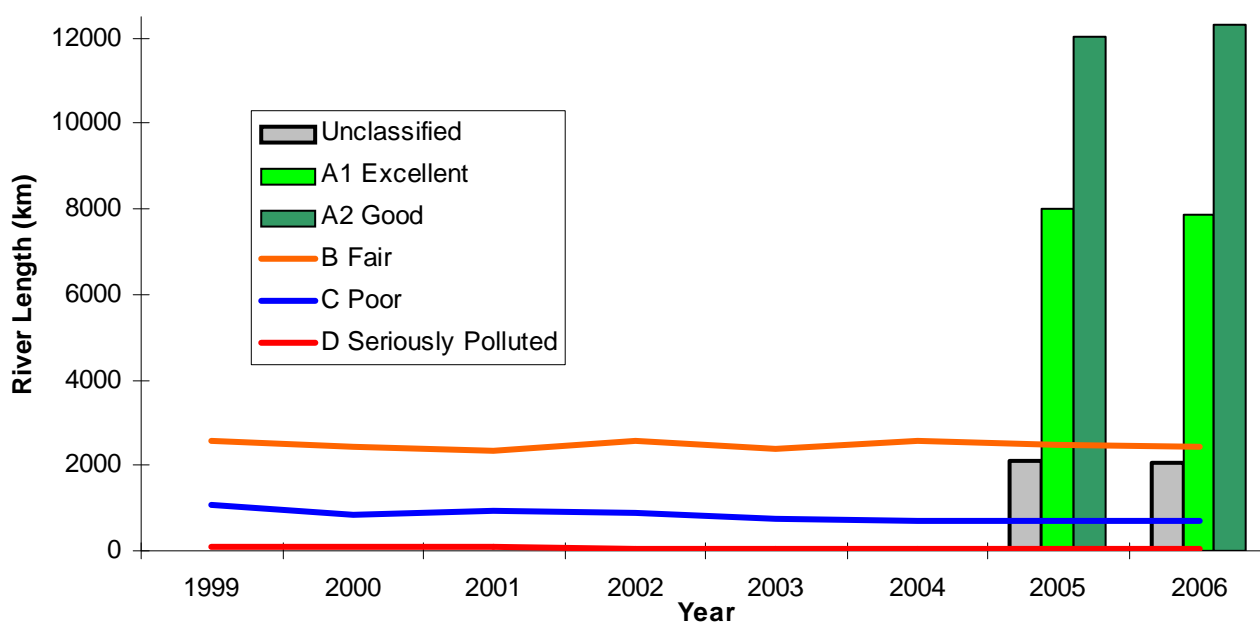


#### Evidence

Water quality is assessed annually by the Scottish Environment Protection Agency (SEPA). Of an estimated 56,200 km of river in Scotland, around half (25,429 km) was assessed in 2006. The time series for poorer quality rivers is consistent from 1999 but expanded monitoring of good quality rivers from 2005 onwards means that comparisons with previous years would be misleading.

#### River Quality, 1999 – 2006

Source - SEPA



#### Assessment

Of the monitored river length (25,429 km) between 2005 and 2006:

- **Excellent decreased by 142 km**, from 8,003 km to 7,861 km (-2%)
- **Good increased by 280 km**, from 12,053 km to 12,333 km (+2%)
- Monitoring extended to 51 km of formerly unclassified river, which decreased in length from 2,126 km to 2,075 km (-2%)

Between 1999 and 2006:

- **Fair decreased by 152 km**, from 2,577 km to 2,424 km (-6%)
- **Poor decreased by 378 km**, from 1,077 km to 698 km (-35%)
- **Seriously polluted decreased by 56 km**, from 91 km to 35 km (-61%)

<b>Trend</b>	<b>Increase</b>
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<b>Data confidence</b>	<b>High</b>
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## Commentary

Water quality assessment is based on chemical, biological and aesthetic conditions.

The selection of river monitoring sites comes from the [digitised river network](#) (DRN), based on 1:50,000 Ordnance Survey data. The DRN includes:

- All mainland and islands rivers with a catchment area of 10 km<sup>2</sup> or more (the 'baseline network').
- Mainland and islands stream stretches with a catchment of less than 10 km<sup>2</sup> which are classified as fair, poor or seriously polluted.
- Together, they are known as the 'classification network'.

The increase in good quality length between 2005 and 2006 (by 280 km) appears in-part due to a downgrading of excellent river quality length (by 142 km). Importantly, however, between 1999 and 2006 the poor quality categories all decreased (by 586 km overall). The overall trend therefore is an increase in river quality.

This is corroborated by the return of wildlife, such as otter (*Lutra lutra*) and salmonid fish (notably trout *Salmo trutta* and salmon *Salmo salar*) to formerly polluted river systems of the Central Belt, and estuarine invertebrates and fish to the Clyde and Forth estuaries.

In addition to running water bodies, the monitoring of ecological status under the Water Framework Directive will in future include standing, ground and coastal waters.

## Source Data and Updates

Results are from the SEPA web site <http://www.sepa.org.uk/rgc/map.asp>. The full report and supporting data can be found at: <http://www.sepa.org.uk/data/classification/index.htm>.

## UK Indicators

The UK biodiversity indicator of [rivers of good biological quality](#) shows an increase in quality from 1990 onwards, however, methodological differences between countries meant that a combined indicator could not be produced for the UK as a whole. In 2006, 88% of Scotland's rivers were of good (classes A and B) quality.

## References

Anon. 2007. Scottish Environment Protection Agency National Water Quality Classification 2006. [www.sepa.org.uk/pdf/data/classification/water\\_qual\\_class\\_2006.pdf](http://www.sepa.org.uk/pdf/data/classification/water_qual_class_2006.pdf)

Smith, I.R. & Lyle, A.A. (1994). Running waters. In *The Fresh Waters of Scotland: a National Resource of International Significance*, eds. P.S. Maitland, P.J. Boon, & D.S. McLusky. London: John Wiley and Sons Ltd, pp. 17-74.

## 2 Information provision

In 1620 a wildcat, *Felis silvestris*, was spotted near Eccles in the Scottish Borders, making this sighting of a rare and iconic species the first known biological record in Scotland. Since then, biological recording of Scotland's species has increased exponentially with millions of records accumulated by many local and national recording schemes and societies, and public bodies such as SNH. By the end of 2007, nearly 5million of these plant and animal records were held electronically in a UK database, the [National Biodiversity Network](#) (NBN).



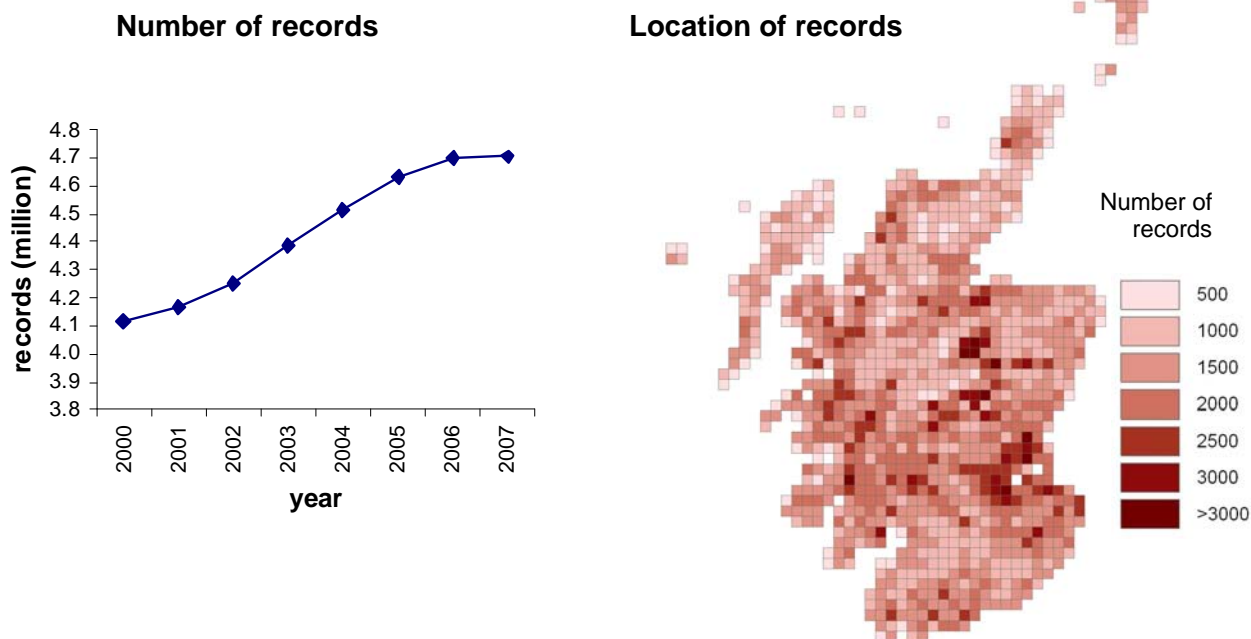
Scottish wildcat ©Pete Cairns

### Evidence

The NBN was established to champion wildlife data collection by mainly volunteer recorders. It provides support to recorders by setting data collection and management standards. The NBN Gateway is the recognised, definitive source of data on species in the United Kingdom for public and professional use, enabling new and historic records to be accessed and viewed as distribution maps, and also downloaded as raw data. The NBN currently lists over 80 [data providers](#) across the UK, with interests ranging from spiders to seaweeds.

### The biological records of Scotland

Data on the National Biodiversity Network at the end of 2007



### Assessment

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#### Distribution of records

- The location of biological records shows confirmed wildlife sightings. Apparent absences elsewhere may be because people have looked but not found them, or not looked for them. Species that are difficult to identify (with few specialist recorders) are prone to under-recording.

#### Quantity of records

- 4 million records pre-date 2000 and 0.7 million records since the year 2000.

**Trend** Increase

**Data confidence** High

## Commentary

A long history of recording, mainly by volunteer enthusiasts, has built up an exceptional knowledge base of wildlife in Britain. In 1995 the Coordinating Commission for Biological Recording concluded that an estimated 60 million-or-so species records were held in a variety of forms by 2000-or-more organisations. However, as a collection they were largely unknown, inaccessible and unusable. The NBN now provides web-based access to a sizeable part of this. By the end of 2007, nearly 28 million records from 300 datasets across the UK were available through the NBN gateway.

In December 2007, the NBN held 4.7 million records for Scotland: flowering plants (55%); birds (17%); lichens (8%); butterflies (6%); fungi (4%); terrestrial mammals (3%); moths (2%); spiders (2%); fish (1%); amphibians; and marine mammals.

Date	# records	% records
1600s	13	<1
1700s	1,405	<1
1800s	5,1126	1
1900s	3,980,863	85
2000s	670,767	14
Total	4,704,174	100

Scottish Natural Heritage, for example, has supported the establishment and development of the NBN, and has invested in the digitisation of paper-based records in Scotland. It provides public access to the NBN through the public information portal, SNHi ([www.snh.org.uk/snhi](http://www.snh.org.uk/snhi)).

## Source data and updates

Wildlife records are added to the NBN (<http://www.searchnbn.net>) on a continuous basis. The data shown in this account are correct up to the end of 2007.

## UK Indicator

No equivalent.

## References

National Biodiversity Network (<http://www.searchnbn.net>) .

Biological Recording in Scotland (<http://www.brisec.org.uk/info.php>).

Burnett, J., Copp, C. and Harding, P. 1995. *Biological recording in the UK: present practice and future development*. Vol 1, Full Report; Vol 2, Appendices; Summary Report Coordinating Commission for Biological Recording, Ruislip, England.

### 3 The timing of seasonal events

Seasonal events, such as migration, bud-burst and egg laying are influenced by temperature. Changes in climate can therefore be expected to affect the yearly timing, or phenology, of natural events in terrestrial, freshwater and marine ecosystems. Adaptation may be at risk where responses are not uniform. For example, inter-dependent events such as the presence of pollinators and plant flowering, or insect prey and chick hatching, must remain broadly synchronised. As a biological response, phenology (the timing of seasonal events) is largely independent of factors such as land management and so complements other indicators of climate change.



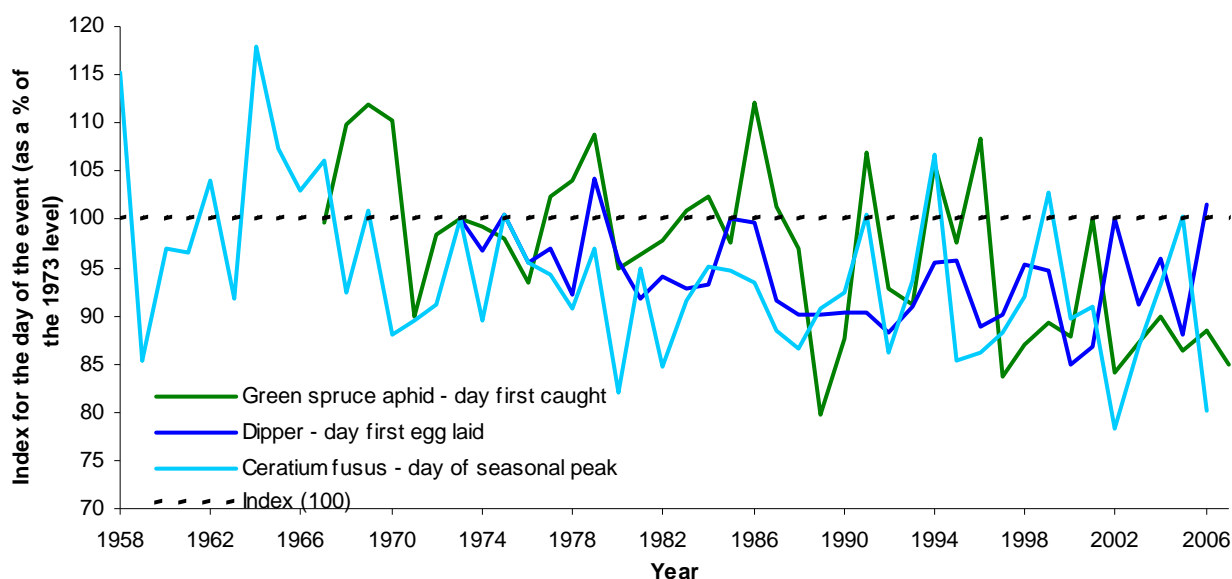
Dipper *Cinclus cinclus*

#### Evidence

A review of phenological records in Scotland in 2006 illustrated a change in events such as the arrival and departure of migratory birds; egg laying among birds and amphibians; the appearance of aphids, moths and butterflies; the flowering of plants; and marine plankton blooms. Asynchronous timing (i.e. events not moving in the same direction or at the same rate) that may affect life cycle opportunities, competition and food availability was evident. An overall tendency towards earliness was especially evident in the first capture date of the green spruce aphid, *Elatobium abietinum*; first egg laying of the dipper, *Cinclus cinclus*; and peak abundance of the phytoplankton *Ceratium fusus*.

#### Phenology in terrestrial, freshwater and marine ecosystems

*Signs of earliness exhibited by three species from terrestrial, freshwater and marine ecosystems.*



#### Assessment

- **Terrestrial:** mean first capture date of the green spruce aphid advanced by 4.3 days/decade, equivalent to 8 days per 1°C warming.
- **Freshwater:** mean first egg laying date of the dipper advanced by 3.0 days/decade, equivalent to 4 days per 1°C warming.
- **Marine:** peak phytoplankton *Ceratium fusus* abundance advanced by 5.3 days/decade, equivalent to 12 days per 1°C warming.
- All three results are statistically significant. Although the direction of change is the same, the rates of change are different.

<b>Trend</b>	<b>Earlier</b>
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<b>Data confidence</b>	<b>High</b>
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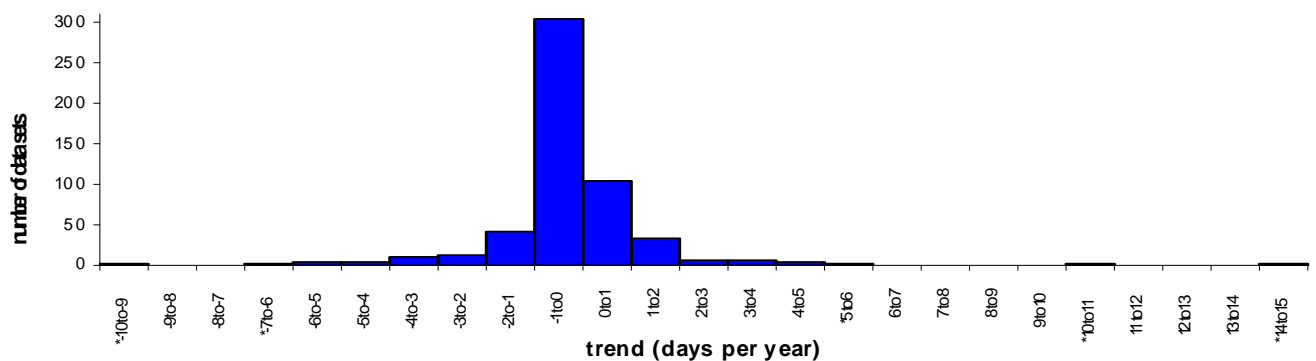
## Commentary

The phenology of species in Scotland is changing. Temperature is the major driver; sunshine and rainfall have less influence. Change is most marked among species towards the lower end of food webs, such as plants, aphids and plankton. The implication is that higher life forms must adapt accordingly. The green spruce aphid, although a forest pest, contributes the diet of many birds. The dipper, a bird of upland streams, is reliant on a plentiful supply of invertebrate prey. The dinoflagellate *Ceratium fusus*, with other phytoplankton, is a basic building block of oceanic food webs. As species associated with terrestrial, freshwater and marine ecosystems respectively, they show a clear temperature response.

The distribution of terrestrial observations overall (below) shows only a slight tendency towards earliness. For the most part, little or no change is evident. Asynchrony raises more concerns than uniform adaptation would but little statistical significance can be attached to that at present. Of 525 terrestrial data sets, 21% showed significantly earlier and 2% significantly later events (95% significance level by linear or weighted-linear regression). The three species selected for the indicator provide a clear response. They are not necessarily representative of all species but are relatively easy to monitor through time.

### Earliness and lateness exhibited in the data

Negative = earlier phenological event; positive = later; \* denotes a single dataset.



### Source data and updates

Aphid data since 1967 are from the four Scottish suction traps (Ayr, Dundee, East Craigs, Elgin) operated to the Rothamsted Insect Survey protocol ([www.rothamsted.bbsrc.ac.uk/insect-survey](http://www.rothamsted.bbsrc.ac.uk/insect-survey)). Dipper data since 1973 are Scottish records from the British Trust for Ornithology Nest Record Scheme ([www.bto.org](http://www.bto.org)). Plankton data since 1958 are for northern North Sea from the Continuous Plankton Recorder of the Sir Alister Hardy Foundation for Ocean Science ([www.sahfos.ac.uk](http://www.sahfos.ac.uk)). All are currently available annually.

### UK Indicator

The [UK Spring Index](#) is based on four terrestrial events. First flowering of hawthorn, first flowering of horse chestnut and first flight of the orange tip butterfly were 10-12 days earlier between 1998-2006 compared with 1900-47. First sighting of the migratory swallow showed little or no change.

### Data Sources and References

Sparks, T.H., Collinson, N., Crick, H., Croxton, P., Edwards, M., Huber, K., Jenkins, D., Johns, D., Last, F., Maberly, S., Marquiss, M., Pickup, J., Roy, D., Sims, D., Shaw, D., Turner, A., Watson, A., Woiwod, I., & Woodbridge, K. (2006). Natural Heritage Trends: Phenological indicators of climate change. *Scottish Natural Heritage Commissioned Report No. 167* (ROAME No. F01NB01).

## 4 Habitat connectivity

Habitat loss and fragmentation have been identified as major threats to biodiversity. Functional connectivity is dependent on species dispersal abilities, the size and spatial arrangement of habitat patches, and the nature of land cover and land use in the intervening matrix. The available evidence suggests that habitat corridors and matrix structure can enhance connectivity. In conjunction with management measures such as invasive species control, the ability of many native species to adapt to climate change will rely upon landscapes being permeable to their dispersal.



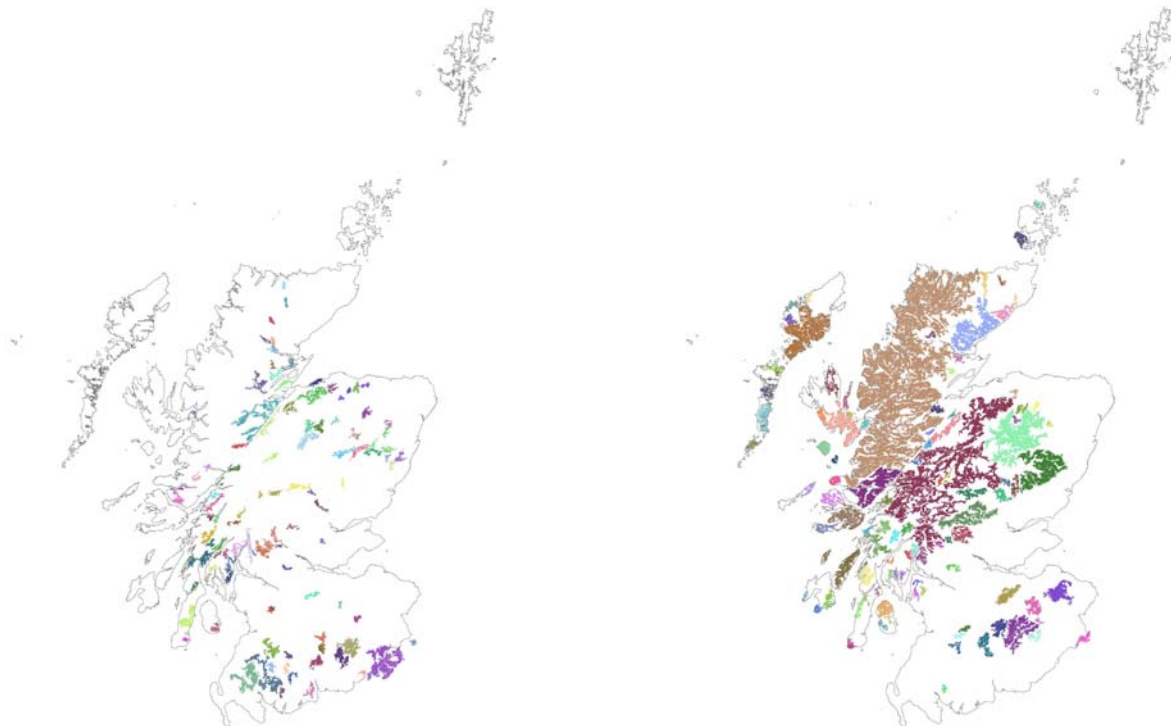
Meikleour, Peter McPhail

### Evidence

Biological and Environmental Evaluation Tools for Landscape Ecology ([BEETLE](#)) can be applied at a variety of scales to target biodiversity conservation action and to evaluate landscape change. The GIS package allows ecological assessments to be undertaken on the basis of species dispersal assumptions relating to, for example, habitat quality, fragmentation and functional connectivity. The woodland and heathland examples, shown here, are being extended to other networks.

### Woodland and heathland habitat networks, 2008

*Largest 100 networks illustrated for clarity – each colour indicates a separate network*



*woodland generalists networks*

*heathland generalists networks*

### Assessment

#### **Woodland generalists @ 1km dispersal**

- 59,186 networks; 2,059,657 ha total extent; 210,436 ha largest network area; 34 ha mean area.

#### **Heathland generalists @ 1km dispersal**

- 3,265 networks; 2,699,558 ha total extent; 955,855 ha largest network area; 826 ha mean area.

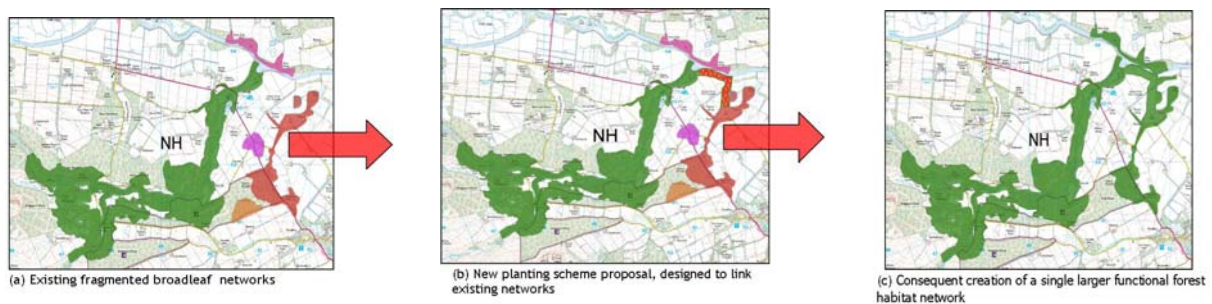
Trend	Baseline
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Data confidence	Satisfactory
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## Commentary

Mounting evidence of climate change impacts on biodiversity includes changes in the timing of seasonal events, species distributions, community composition, ecosystem functions and suitable space. Published advice on promoting resilient populations includes conserving protected areas and other high quality habitats, reducing sources of harm, conserving the range and ecological variability of habitat and species, taking action to control the spread of invasive species, and enhancing the ecological viability of the wider landscape. Improving habitat quality (through protection, restoration and creation) and enhancing connectivity between the wider functional networks these habitats create can allow native species to disperse, and also improve the resilience of the landscape and improve prospects for species survival.

The spatial modelling of habitat networks provides an objective basis for national-scale assessment and the targeting of interventions locally. The example below illustrates how native woodland planting enabled four fragmented networks in NE Scotland to be linked. In this case, an increase in woodland extent of just 6% resulted in a 400% increase in functional connectivity.



## Source data and updates

A variety of habitat and species data from 1988 to 2006 were analysed. Six datasets, such as Land Cover Map 1998, contributed to the national analysis and 12 were used at the regional scale. Periodic updates through time rely on habitat data, such as Countryside Survey Land Cover Map 2007.

## UK Indicator

A UK indicator is in preparation, possibly based on 'mean network area'. This would be consistent with the approach here.

## Data Sources and References

Anon. (in prep). *Habitat Connectivity – Developing an indicator for UK and country level reporting: Phase 1 Pilot Study*. Defra Research Contract CR0388 by Forest Research and Centre for Ecology and Hydrology.

Anon. (in prep). *What is the evidence for the development of connectivity to improve species movement, as an adaptation to climate change?* Defra Research Contract CR0389 by Forest Research and Centre for Evidence-Based Conservation.

Hopkins, J.J., Allison, H.M., Walmsley, C.A., Gaywood, M. and Thurgate, G. (2007). *Conserving biodiversity in a changing climate: guidance on building capacity to adapt*. Department for Environment, Food and Rural Affairs, London.

Moseley, D., Ray, D., Humphrey, J., and K. Watts (2007). *Forest Habitat Networks Scotland*. Contract report to Forestry Commission Scotland, Forestry Commission GB and Scottish Natural Heritage.

## 5 Visual Influence of built development and land use change

Landscape is ‘...an area, as perceived by people, whose character is the result of the action and interaction of natural and / or human factors’ (European Landscape Convention, 2002). ‘Character’ defines a landscape’s particular sense of place and comprises a distinct and recognisable pattern of elements. Scotland’s rich and varied landscapes continually evolve in response to society’s needs. The extent and pace of change is greater than it has ever been. Human activity, in the form of land use and built development, has a major influence on landscape character.

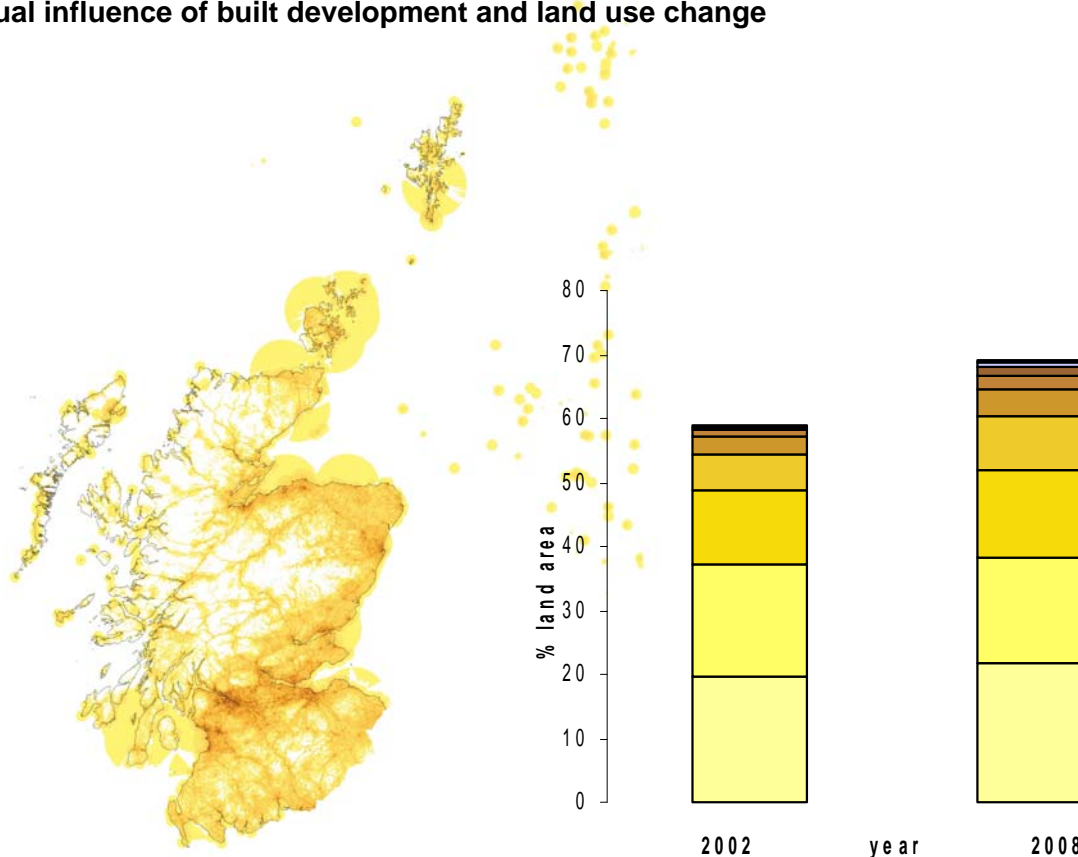


### Evidence

The theoretical visibility of built development on land and at sea between 2002 and 2008 has been mapped from 16 spatial datasets, taking account of visual attributes such as height and the modifying influence of topography:

- Airfields, major bridges, motorways, trunk roads, ‘A’ roads, ‘B’ roads, minor roads, railways;
- Wind turbines (operational), other tall structures, overhead lines, offshore surface structures;
- Buildings, artificial light, extraction industries, modified land use (e.g. plantation forest).

### Visual influence of built development and land use change



### Assessment

According to the theoretical visibility map of land between 2002 and 2008:

- The extent of Scotland unaffected by any form of visual influence declined from 41% to 31%; during that time, a dominant change was wind farm development (from 18 operational in 2002 to 47 in 2008).
- Half of Scotland was influenced by one (22%), two (16%) or three (14%) visual influences in 2008.
- The extent of four or more visual influences increased from 10% to 17%.

**Trend** Increase

**Data confidence** High

## Commentary

The theoretical visibility of built development and modified land use can be defined and mapped in a GIS model. Based on established standards and expert judgement, a buffer width is assigned to each form of development, according to visual attributes such as height. Consequently, tall structures such as wind turbines, pylons and masts have relatively large buffers whereas low or flat structures such as roads have relatively small buffers. Importantly, the rules are transparent (allowing values to be debated and, if necessary, changed) and the method is repeatable (semi-automatic on an annual basis).

When mapped, visual influence appears as a series of overlapping areas according to whether one or more form of development or modified land cover are theoretically visible from any given point. On a flat surface, such as at sea, a tall structure has a circular zone of visibility. The screening effect of topography is taken into account on land. The model specifies only whether or not a feature is theoretically visible within its buffer zone, i.e. 'visibility' is the same close to the development as at the periphery of the zone (no decay factor).

The 2008 extent of visual influence (% land area) for each component is as follows:

	%		%
Tall structures without wind turbines	46	Light sources viewed from satellite	6
Non semi-natural land cover classes	38	Non trunk A roads	5
Building density (low)	34	B roads	5
Wind turbines (operational)	20	Building density (high)	3
Minor roads (all)	13	Trunk roads	3
Extraction industries	8	Minor roads outwith urban or forest areas	2
Airfields	7	Railways	2
Overhead lines	7	Major bridges	1

The mapping of theoretical visibility provides a consistent record through time and context for landscape character and perception studies. In the 1990s, a national programme of Landscape Character Assessment (LCA) identified over 275 different 'landscape character types', reflecting the diversity of landscapes in Scotland. Landscape Character Assessment is now advocated by the European Landscape Convention to help secure the protection, management and planning of all landscapes in Europe.

Theoretical visibility forms part of a programme of work to identify indicators that can help to describe and monitor landscape character change.

### Source data and updates

Data are mainly from Ordnance Survey (used under licence) and can be updated annually.

Light data are from the US Defense Meteorological Satellite Program Operational Linescan System (DMSP LOS) sensor, averaged across the year in 2003 with ephemeral events such as fires removed.

### UK Indicator

No equivalent.

### References

Council of Europe (2002), *European Landscape Convention*, CoE, Strasbourg.

Scottish Natural Heritage (2007). *Scotland's Living Landscapes: Places for People*. SNH, Perth

Windfarm footprint map <http://www.snh.org.uk/strategy/renewable/sr-rt01.asp>

## 6 Built development

Scotland's [population](#) of 5.12 million (2.31 million households) in mid-2006 is projected to rise to 5.37 million in 2031.

Glasgow, with 0.58 million people is the largest city. Around four fifths of the Scottish population live in settlements. Those with more than 3,000 people (171 settlements) extend across 1,445 km<sup>2</sup> of Scotland, or 2% of the land area. Settlements are distinctive components of the built landscape, within which transport, energy and communications infrastructure, as well as industry and housing, extend much more widely throughout Scotland.



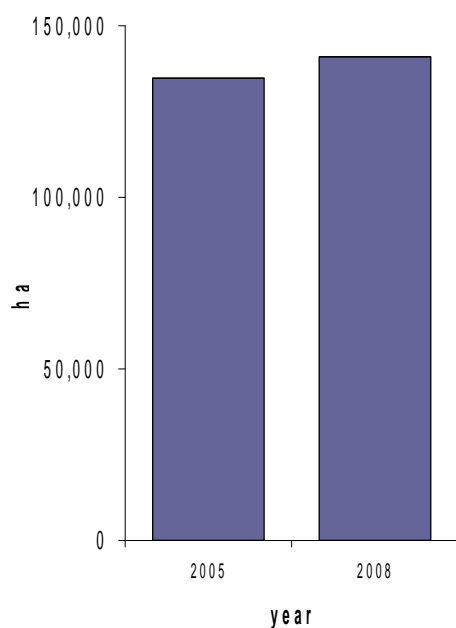
### Evidence

The analysis of built development is based on seven spatial datasets: roads; overhead lines; tall structures; extraction industries; camping and caravan sites; property (commercial and domestic) and wind turbines. The extent of soil sealing buildings, roads and paved-over areas such as car parks provides an indication of 'physical footprint'. The presence of different types of development at the 1km<sup>2</sup> scale illustrates the distribution and intensity of built development.

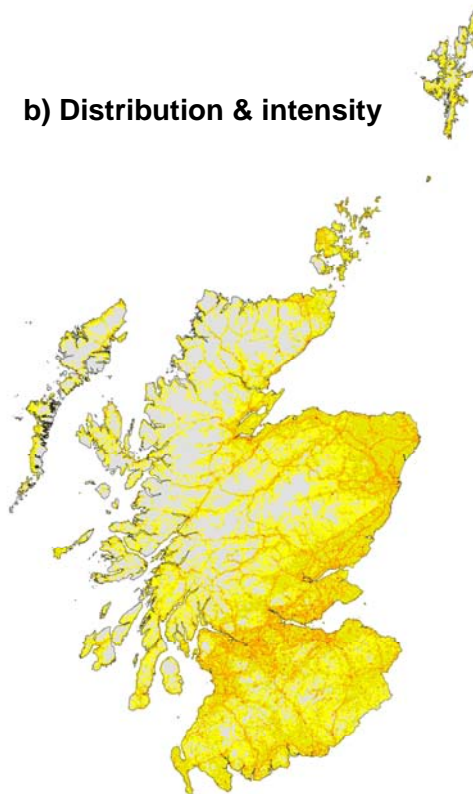
### Built development 2008

Land area: 7,880,800 ha

a) Soil Sealing



b) Distribution & intensity



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Scottish Natural Heritage 100017908 [2008]

### Assessment

- Between 2005 and 2008, soil sealing increased by 4.5% (6,103 ha), from 134,820 to 140,923 ha (1.8% of Scotland).
- In 2008, one or more types of development were present within 56,103 kilometre squares (66% of Scotland). The 2008 analysis establishes a baseline for change estimation in future.

<b>Trend</b>	<b>Increase</b>
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<b>Data confidence</b>	<b>High</b>
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## Commentary

The spatial analysis (mainly from Ordnance Survey MasterMap) shows that In 2008, Scotland contained 2,536,297 million properties, 130,551 km of roads, 6,051 km overhead lines and 4,808 tall structures (such as masts and pylons). Extraction industries, such as hard rock quarrying and sand & gravel extraction, numbered 7,619 sites; camping and caravanning 813 sites, and wind farms 47 sites.

Their overall extent at the 1km<sup>2</sup> scale was 56,103 km<sup>2</sup>, or 66% of Scotland. This is accounted for by the road network (the MasterMap Integrated Transport Network excludes tracks), i.e. in two-thirds of Scotland you are never further than 1 km from a road.

Across 25% of Scotland (which contained only one type of development), a road would be the only feature present.

Across 29% of Scotland (where two types of development occurred), the likelihood is road(s) and building(s), given that properties occupied 36% of squares.

Only 10% of Scotland contained three types of development and 2% (as expected from the settlement extent) contained four or more.

In summary, roads occupied 65% of 1km squares; properties 36%; overhead lines 8%; extraction industries 7%; tall structures 3%; camping and caravanning sites 1%; and wind turbines less than 1%.

## Source data and updates

Data are mainly from [Ordnance Survey](#) (under licence) and can now be updated annually.

## UK Indicator

No equivalent.

## References

Internal methodology (SNH).

## 7 Land cover

Following signature of the Biodiversity Convention at the Earth Summit in Rio de Janeiro in 1992, the UK Biodiversity Action Plan set out a programme of action to conserve and enhance biological diversity throughout the UK. A classification of 'broad habitats' was defined for consistent reporting and as context for 'priority' habitats and species requiring conservation action. The UK and surrounding seas were classified into 37 broad habitats of which 20 occurred in Scotland. Of those, 16 were sufficiently widespread to be reported on in the latest Countryside Survey of 2000 (CS2000).

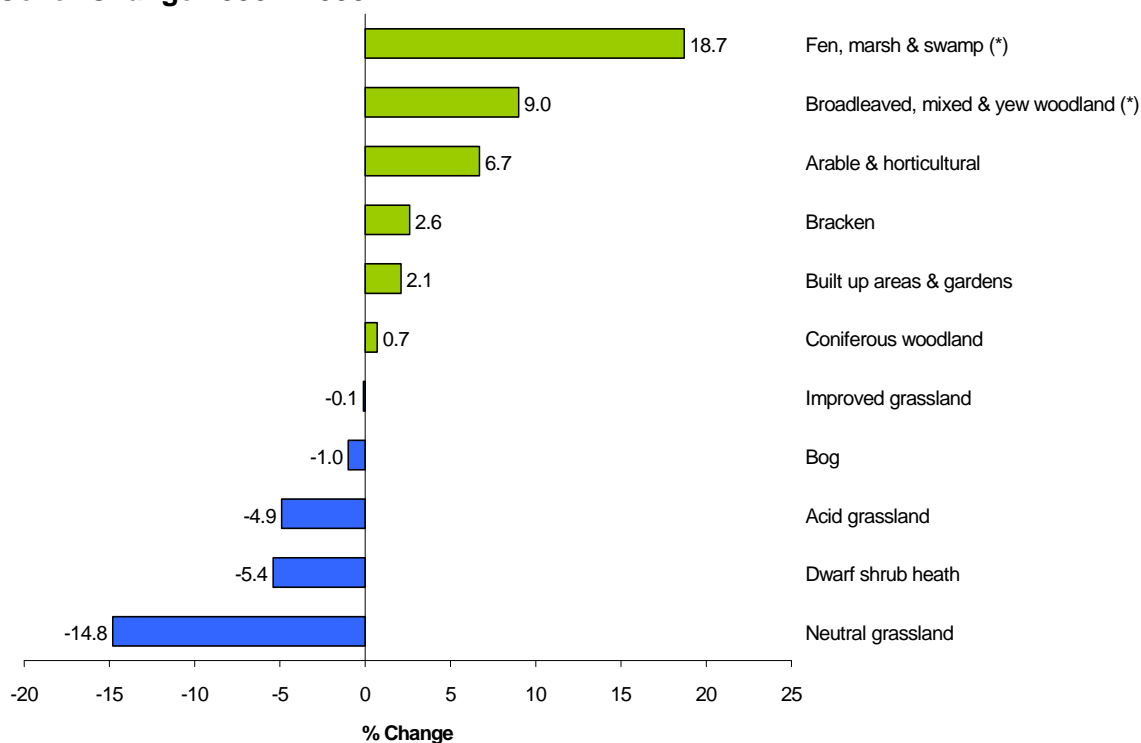


Ochill Hills

### Evidence

With a sample size of 195 1km squares in 1990 and 203 in 1998, the CS2000 spatial coverage was around 0.25% of Scotland's land area. The increased sample size in 1998 was required for improved estimation of habitat extent, but change was based on 193 squares that were common to both surveys.

### Land Cover Change 1990 – 1998



### Assessment

In terms of the balance of semi-natural land cover:

- **Fen, marsh & swamp** increased significantly ( $P < 0.05$ ), by around 19%. Gains from grasslands and bog appeared to be associated with increased rushiness of wet grasslands, with shaded conditions and increased rankness of vegetation.
- **Broadleaved, mixed & yew woodland** increased by 9%, consistent with widespread planting and woodland restructuring throughout the 1990s.
- **Others** are more extensive and, although not statistically significant individually, pointed to an expansion of intensively managed habitats and a reduction of semi-natural habitats.

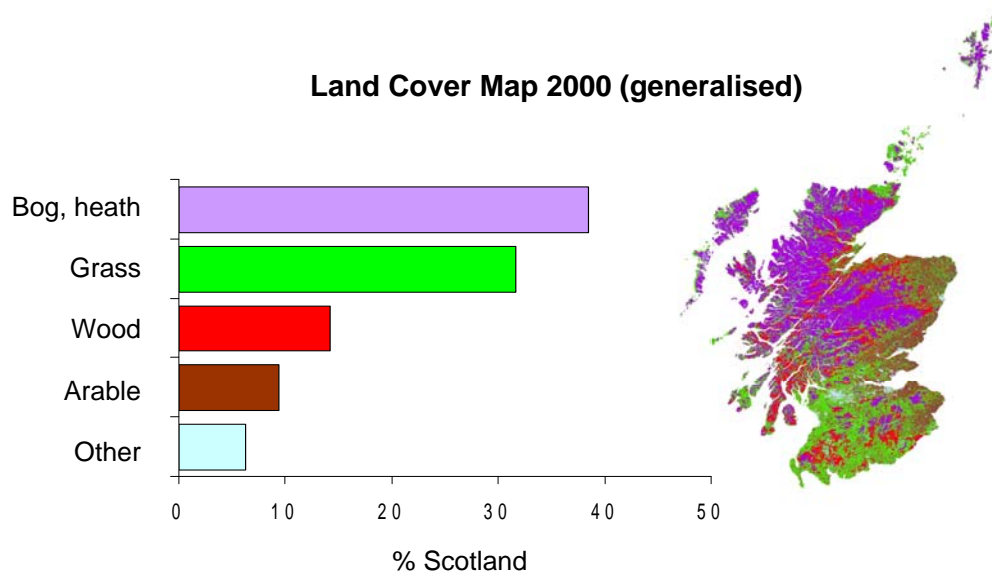
Trend | Divergent

Data confidence | High

## Commentary

Clearance of the post-glacial ecological climax woodland dates back to the Neolithic, some 5,000 years ago. By medieval times, 1,000 years ago, much of the country was denuded of trees. International trade influenced the economics of farming and forestry from the latter-half of the nineteenth century onwards. A developing forest sector slumped in the face of cheap timber from abroad and, until the 1930s, moorland management tilted from sheep in favour of grouse. Weak farming and forestry sectors were backdrops to both World Wars. Subsequent policies, including the Forestry Act 1945 and the Agriculture Act 1947, took a more strategic approach to national security. Their influence spanned four decades, including membership of the European Economic Community in 1973.

Between 1947 and 1988 (when land cover change was assessed by the National Countryside Monitoring Scheme), forestry and to a lesser degree farming, mainly accounted for a 17% reduction in semi-natural land cover in Scotland.



The 1990 estimate of moorland extent was 41,370 km<sup>2</sup>, being 49% bog, 26% dwarf shrub heath, 19% acid grassland, 5% neutral grassland and 1% calcareous grassland. Although individual broad habitat declines between 1990 and 1998 were not statistically significant, the body of evidence pointed to a continued reduction of semi-natural habitats. Moorland declined by 4% overall, from 41,370 km<sup>2</sup> in 1990 to 39,720 km<sup>2</sup> in 1998, a rate comparable to previous decades.

### Source data and updates

The Countryside Survey was repeated in 2007. The updated UK account will be published in November 2008, with more detailed results for Scotland in April 2009.

### UK Indicator

No equivalent.

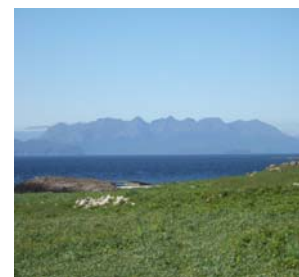
### References

Mackey, E.C., Shewry, M.C. & Tudor, G.J. (1998). *Land Cover Change: Scotland from the 1940s to the 1980s*. The Stationery Office, Edinburgh.

McGowan, G.M., Palmer, S.C.F., French, D.D., Barr, C.J., Howard, D.C., Smart, S.M. Mackey, E.C. & Shewry, M.C. (2002). *Trends in Broad Habitats: Scotland 1990-1998*. Scottish Natural Heritage Commissioned Report F00NB03.

## 8 Conservation management

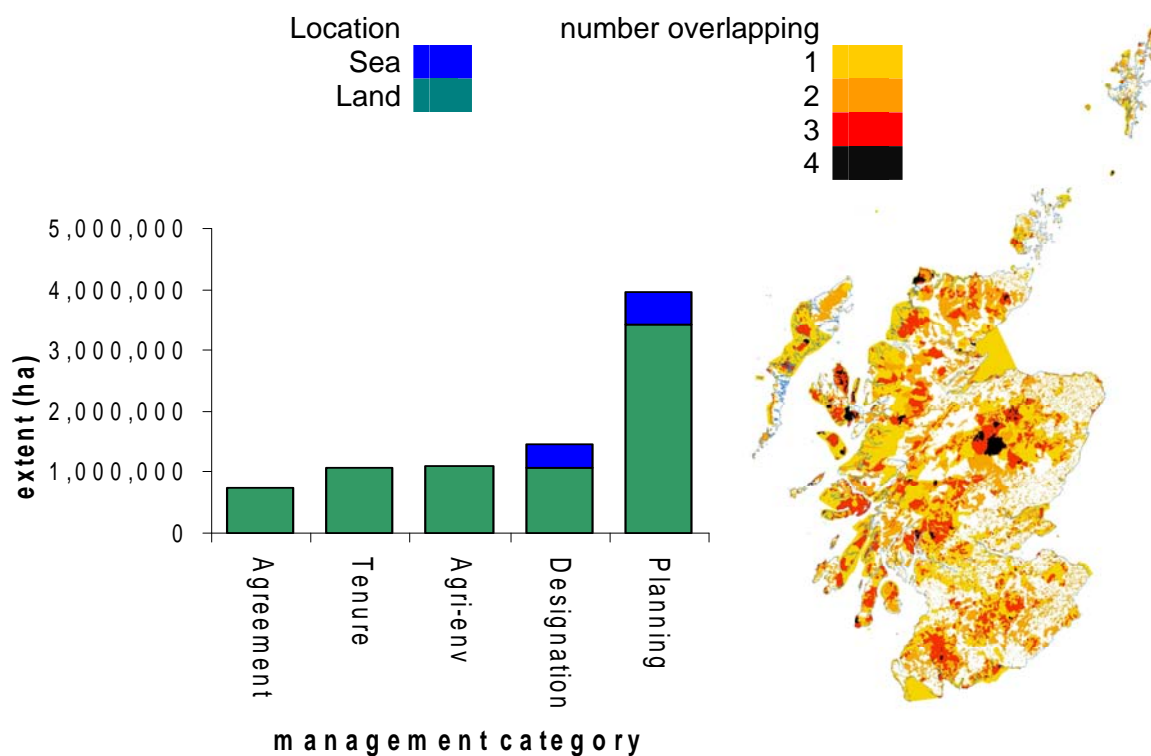
Land, coast and sea are managed for a variety of purposes, including the conservation of their biological, physical or visual character. Parts of Scotland are of national or international importance and afforded special protection, but they do not sit in isolation. Conservation value more widely may be reflected also in management agreements, ownership by conservation bodies, land management through agri-environment schemes, or policy zonation within Local Plans. Collectively they reflect values placed on conservation within the context of multiple and productive use.



### Evidence

Spatial data on tenure, management agreements, agri-environment schemes, designated sites and planning policies were collated by Scottish Natural Heritage (SNH) from its own and other datasets provided by Scottish Government, Non-Governmental Organisations and Local Councils. A distinction between land and sea is made at the Mean High Water Springs (high tide level). Management categories may overlap spatially, as seen when mapped.

### Conservation Management 2008



### Assessment

Within a total land area of 7,880,800 ha, **63%** (4,954,114 ha) was covered by one or more form of management / tenure / policy (plus 845,295 ha of sea). The overlapping (i.e. non-additive) components of this are as follows:

- **9%** (747,438 ha) had a positive management agreement (plus 8,993 ha sea)
- **13%** (1,062,753 ha) was secured by tenure (plus 19,700 ha of sea)
- **14%** (1,088,449 ha) was under agri-environmental management (plus 471 ha of sea)
- **14%** (1,072,771 ha) was designated for nature conservation (plus 378,580 ha of sea)
- **43%** (3,411,160 ha) was covered by planning policy (plus 545,313 ha of sea)

<b>Trend</b>	<b>Baseline</b>
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<b>Data confidence</b>	<b>High</b>
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## Commentary

Although data are available for previous years, it was only in 2008 that the mapping of spatial extent became sufficiently comprehensive to establish a baseline.

- Of 7 management agreements (9% of Scotland, four being for forest / woodland), the largest is Scottish Natural Heritage (6%).
- The largest among 13 land owning bodies (13% of Scotland) is Forest Enterprise (8%).
- Scottish Government agri-environmental scheme agreements covered 14% of Scotland.
- National (SSSI) and international (SAC, SPA) nature conservation sites covered 14% of Scotland.
- Planning policies (43% of Scotland) included local landscape designations (28%), National Scenic Areas (13%), National Parks (7%), local nature conservation sites (4%) and urban greenspace (2%).

## Source Data and Updates

Twenty nine source datasets were included in the analysis, from the following organisations:

- **Management Agreements:** SNH, Forestry Commission Scotland, Historic Scotland, Deer Commission Scotland.
- **Tenure:** SNH, Forest Enterprise, Ministry of Defence, Scottish Government (crofting), Local Authorities, Crown Estates, National Trust, Scottish Wildlife Trust, Royal Society for the Protection of Birds, Woodland Trust, John Muir Trust, Wildfowl and Wetlands Trust.
- **Agri-Environment Schemes;** Scottish Government.
- **Nature conservation sites:** SNH.
- **Planning Policies:** Local (Authority) Plans licenced by Landmark.

To be updated annually.

## UK Indicators

[UK biodiversity indicators](#) of sustainable use include woodland and agri-environment:

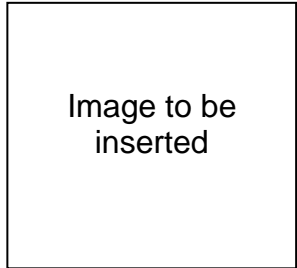
- Between 2001 and 2007 the proportion of [woodland under certified management](#) increased from 37% to 45% (55% certified in Scotland).
- Between 1992 and 2007, the area under [agri-environment agreements](#) increased from 0.3 million ha to 3.4 million ha (19% UK agricultural land), plus 5 million ha entry-level schemes in England & Wales. In Scotland this included Countryside Premium, Rural Stewardship and Land Management Contracts.

## References

SNH (unpublished). Indicator method.

## 9 Tourism

Scenery and wildlife attract visitors to Scotland. In 2007, 92% of visitors identified 'scenery' and 72% identified 'nature and wildlife' as key to their Scottish holiday (Visitor Experience Survey). The 'top 20' paid and unpaid attractions included a Country Park (Culzean), two mountains (Cairngorm and Ben Nevis), a National Park (Loch Lomond and the Trossachs) and a wildlife visitor centre (Scottish Seabird Centre, North Berwick).

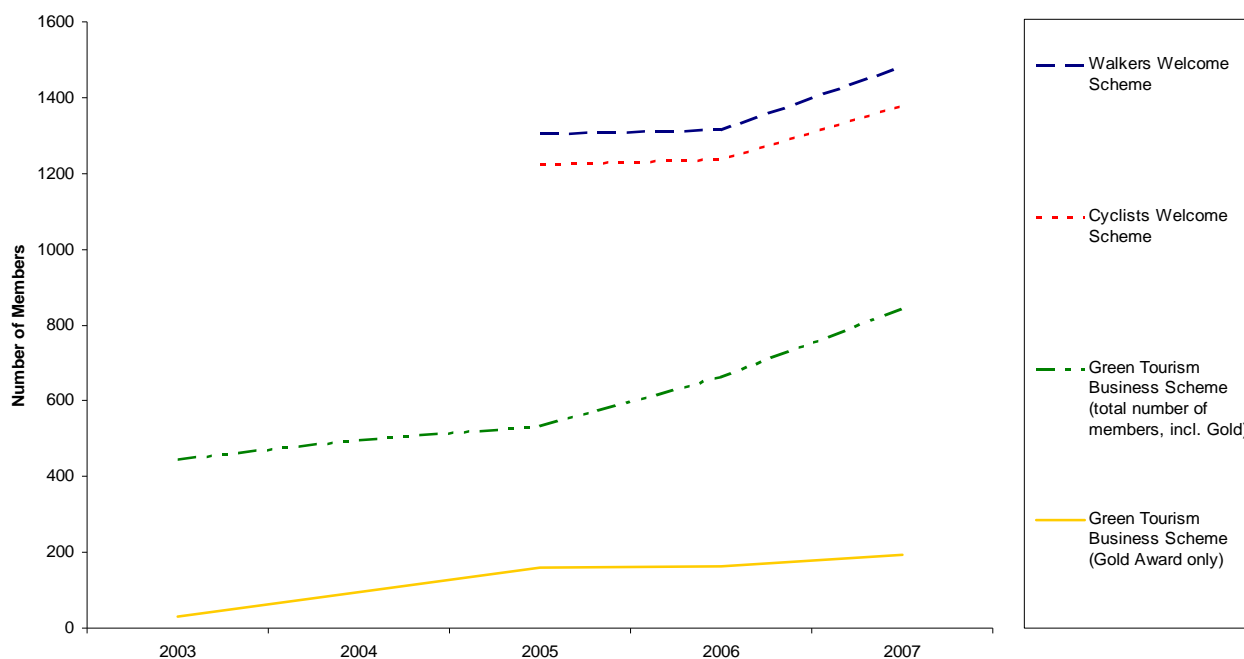


The network of 55 National Nature Reserves, two National Parks, 40 Scenic Areas and two Geoparks reflect part of the extent and diversity of scenic and wildlife opportunities for visitors to Scotland.

### Evidence

Tourism business membership schemes accredited by VisitScotland encompass aspects of natural heritage enjoyment, such as Walkers and Cyclists Welcome Schemes, and environmental awareness within the Green Tourism Business Scheme (GTBS).

### Membership in Green Tourism Business and Walkers & Cyclists Welcome Schemes



Source: VisitScotland

### Assessment

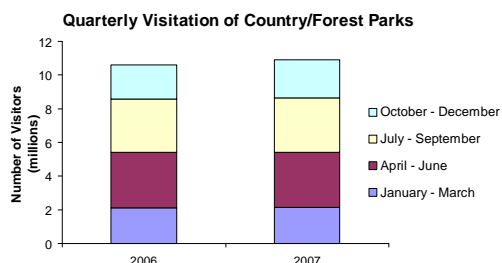
- Walkers Welcome Scheme: increased by 14% between 2005 and 2007, to 1,482 members.
- Cyclist Welcome Scheme: increased by 13% between 2005 and 2007, to 1,379 members.
- Green Tourism Business Scheme: increased by 27% between 2006 and 2007, to 842 members.
- At the end of 2007 23% of GTBS members met the gold standards, an increase of 18% over 2006.

**Trend** Increase

**Data confidence** Satisfactory

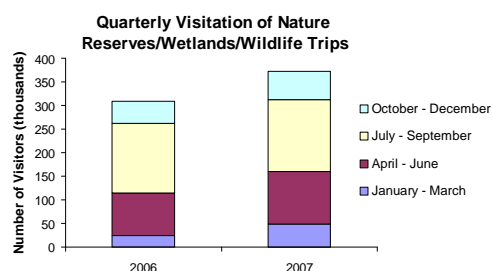
## Commentary

The VisitScotland Walkers and Cyclists Welcome Schemes reflect a growing provision for enjoying the outdoors. Enjoying the outdoors needn't be restricted to the summer months. In fact, the Visitor Attraction Monitor shows that seasonality has rather little influence on some activities.



Source: Visitor Attraction Monitor

Visits to Country or Forest Parks were spread quite evenly throughout 2006 and 2007, with around 30% of annual visits in both spring and summer compared with 20% in both autumn and winter.



Source: Visitor Attraction Monitor

Visits to Nature Reserves or Wetlands / Wildlife Trips increased between 2006 and 2007. Spring (30% of annual visits) and summer (41%) were most popular, but autumn (13%) and winter (16%) still accounted for almost a third of the annual total.

The GTBS is a UK-wide sustainable tourism certification scheme in which businesses are assessed against environmental criteria, including provision for biodiversity. By the end of 2007, 9% of all VisitScotland quality assured tourism businesses (businesses which had received a Tourist Board star grading) had joined GTBS.

## Source data and updates

Data on business membership schemes by VisitScotland Quality and Standards.

The Visitor Attraction Monitor is an annual survey. Responses from 18 Country / Forest Parks and 9 Nature Reserves / Wetlands / Wildlife Trips formed the 2007/2006 comparison report.

## UK Indicator

No equivalent.

## References

The 2007 Visitor Attraction Monitor, conducted on behalf of VisitScotland by the Moffat Centre, Glasgow Caledonian University.

The Visitor Experience 2007, conducted on behalf of VisitScotland by Harris Interactive.