Scottish Natural Heritage
Dualchas Nàdair na h-Alba
All of nature for all of Scotland
Nàdar air fad airson Alba air fad

NCA index technical document

Scottish Natural Heritage

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Natural Capital Asset (NCA) index

This document outlines the background to Scottish Natural Heritage's (SNH) NCA project, the initial analysis conducted and next steps for completing development of the index.

It also asks for comments from interested parties as to how the index can be improved.

1. BACKGROUND

Natural capital is becoming a key policy concept. Various studies over the last couple of decades have highlighted the importance of recording natural capital for moving towards a more sustainable economy, and in 2010 one hundred scientists at the Linnean Society identified improving measures of national wealth "to take account of natural capital" as the best way to save biodiversity. It was also raised as a key issue in sessions at the 2009 Scottish Environment LINK conference, and forms part of the Aichi Biodiversity Targets

The term 'natural capital' is increasingly being embraced, for example in the recent TEEB (The Economics of Ecosystems and Biodiversity) report, which found that there has been a failure of markets to adequately consider the value of ecosystem services. This resurgence of interest in natural capital is a result of the evolution of ecosystems thinking following publication of the Millennium Ecosystem Assessment and development of the ecosystem approach.

Governments around the world are grappling with how to move 'beyond GDP' in terms of measuring the success of their economies. A joint report entitled "Monitoring economic performance, quality of life and sustainability" commissioned by the Franco-German Ministerial Council (published in January 2011) looked at this. One of the conclusions with regard to measuring the sustainability of economic growth was that a summary indicator of "natural capital should be incorporated in a comprehensive dashboard." This 'dashboard of indicators' would include measures such as income distribution, health, education, greenhouse gas emissions, etc. However, no natural capital indicator was found to be currently available.

The need to have additional measures beyond GDP was given greater impetus in the UK following the recent Government Economic Service Review. One report of which states that: "a sole focus on GDP whilst not correctly valuing all changes in the stocks of assets (including natural capital) might mean that high growth in the short term at the expense of our capacity to grow in the future is not prevented." (*Economic growth, wellbeing and sustainable development, JY Chan, Defra; July 2010*). The conclusion in the over-arching Review report was that there is a need for 'asset check' indicators of natural capital to determine sustainability of the economy.

So what exactly is natural capital and what is SNH's interest in it? Natural capital is the extension of the economic notion of capital (manufactured means of production) to environmental goods and services. Natural capital is thus the stock of natural ecosystems that yields a flow of valuable ecosystem goods or services into the future. Since the flow of services from ecosystems requires that they function as

whole systems, the structure and diversity of the system are important components of natural capital. In governmental accounting, a capital asset is defined as any asset used in operations with an initial useful life extending beyond one reporting period. Generally, government managers have a "stewardship" duty to maintain capital assets under their control. SNH is specifically tasked with the purpose to promote care of Scotland's natural assets, help people enjoy them, enable greater understanding and awareness of them, and promote their sustainable use, now and for future generations.

Therefore, this project aims to develop an index of Scotland's natural capital assets to help inform decisions on the degree to which economic development is being managed sustainably. The NCA project developed out of SNH's Trends & Indicators work, with an initial commissioned research project[1] which included a workshop with external stakeholders. It is hoped that the index will form a useful addition to the indicator information that SNH already publishes, and may be more widely adopted. It should be noted that the results published in this document are from use of the pilot index and subject to change as the index methodology develops, so we caution against over-reliance on the findings (especially numerical values) at this stage.

2. INITIAL ANALYSIS

The basic structure for the index is based on that devised by the Netherland's Environment Agency[2] and amounts to ecosystem area multiplied by ecosystem quality for each ecosystem. Seven ecosystems[3] are identified. These are comprised of 'broad habitats', which is an established habitat classification and reporting system:

Table 1: Ecosystems as defined by broad habitats

Coast – dunes, cliff, beach and tidal mud flats
Freshwater - lochs, rivers and fens
Cropland - arable land and improved grazing
Woodland – woods/forests, including commercial forestry
Greenspace – urban parks, gardens, etc
Grassland – rough/semi-natural grasslands
Moorland - heather moor, montane and peatland/bog

'Broad habitats' were used in the Countryside Survey of 2007, which has generated a wealth of information on the countryside. This approach is also the basis for many conservation initiatives, such as the UK Biodiversity Action Plan (BAP) and it provides a basis for area measurements. In addition, the broad habitat definitions used here are compatible with those used for the UK National Ecosystem Assessment (NEA), upon which this work has heavily relied.

For the overall index the individual broad habitat indices are combined with an ecosystem service weighting attached to each broad habitat:

[1] Hambrey,J.& Armstrong, A. (2010). *Piloting a Natural Capital Asset Index*. Scottish Natural Heritage.
[2] *The Natural Capital Index framework* (2007), summary prepared by Ben ten Brink for the 'Beyond GDP: measuring progress, true wealth, and the well-being of nations' conference, Brussels.
[3] Off-shore marine habitats are excluded for this analysis since it presents various difficulties which make it unique. It is recommended that a separate marine index is produced.

$$\text{NCA Index} = \sum \text{Coast NCA}^{\text{ES weighting}} + \text{Freshwater NCA}^{\text{ES weighting}} + \ldots$$

This use of ecosystem services as the framework for weighting changes in quality within the broad habitat indices, as well as weighting the components of the overall index, is a development of the approach used by the Netherland's Environment Agency. Further details of this are presented below.

i). Ecosystem area

The area is based on data for the broad habitats identified above (see Appendix 1 for relative split of Scottish land cover). Various sources are used to ensure annual updating wherever possible: Forestry Commission (woodland statistics), Scottish Government (agricultural statistics – moving average used), Greenspace Scotland (urban greenspace), Land Cover Maps (other broad habitats). Over the short-term (such as a decade) there is little variation in the area of most broad habitats. The exception is for forestry and farmed lands. For the latter, there is some loss to forestry and urban expansion, but also movement between grasslands and cropland, and *vice versa*. Over longer periods of time area can be an important driver of overall change for each of the broad habitats.

ii). Ecosystem quality

A number of indicators are to be used to quantify changes in the quality of each broad habitat (or more specifically the quantity or quality of ecosystem services from that habitat). Quality indicators have been linked to each of the following three ecosystem service headings (see Appendix 2 for more detail):

- Provisioning
- Regulating[4]
- Cultural

The choice of quality indicator is based on relevance and regularity of collection. However, in most instances data availability has been limited and indicators chosen as proxies for changes in ecosystem services are less than ideal. In some cases extrapolation has been used where data is not collected annually. In other instances the link to relevance is weak. This highlights the absence of information about much of our natural environment. Data collection can be expensive, but without such knowledge evidence-based policy making will not be realised. A number of new data sets are due to become available over the coming years (e.g. Biodiversity Surveillance Strategy for Scotland) and it is hoped that developments in technology may allow more cost-effective gathering of information about what is taking place across Scotland's terrain.

In most instances multiple indicators of ecosystem service categories for a broad habitat are available. So the accuracy of these as a proxy for the category of ecosystem services must be assessed as the bundle of indicators taken together (since individual indicators may reflect multiple ecosystem services). Where there are multiple indicators these are weighted (based on data quality and relevance to the

[4] Note that Supporting services are listed alongside Regulating in the data tables, however, they apply across the three ecosystem service headings and an attempt has been made to adjust other ecosystem service values to account for this, whilst avoiding double-counting.

ecosystem service). The ecosystem service category score for each broad habitat is calculated by use of the expert judgement of SNH specialist advisors for each of the broad habitats. The split of ecosystem services for each broad habitat is given in the table below:

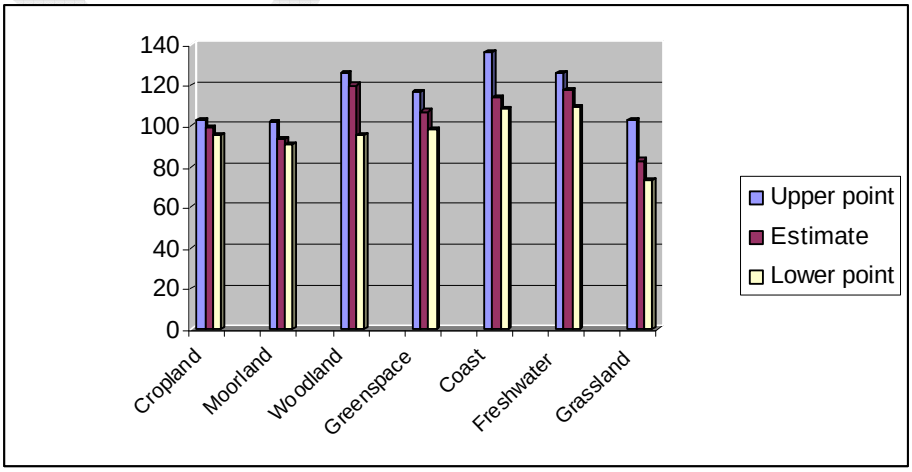
Table 2: Proportion of ecosystem services under the main category headings for each broad habitat

Ecosystems services:	Coastal	Cropland	Grassland	Moorland	Woodland	Freshwater	Urban
Provisioning	2.1	24.0	4.3	0.03	6.4	67.7	0.01
Regulating+supporting	35.9	49.9	82.2	91.97	77.3	21.4	30.7
Cultural	62.1	26.1	13.5	8.0	16.3	10.8	69.3

This shows that over half the value of urban greenspace and coastal broad habitats lies in their cultural value (e.g. recreation). Whilst for grasslands, moorland and woodland the regulating and supporting values dominate. Freshwater's value lies mostly in its provisioning service. Whereas cropland could be said to be truly multi-functional in the split of ecosystem services it delivers, having similar cultural and provisioning value (the latter being second only to water in proportion).

The individual weightings assigned to each quality indicator are to be found in the data tables listed in Appendix 3. Since these have a fairly strong influence over the indices for each broad habitat, they need to be further refined. To illustrate the point, the figure below shows the current point value estimate of the index for each broad habitat for the year 2009 as well as the possible upper and lower points based on a re-weighting of the quality indicators in favour of those increasing or decreasing to 2009. The difference is most dramatic where there are only a couple of indicators for a broad habitat and with very large change values over time. Thus, giving a great weighting to them will dramatically shift the index. This is especially true where there are fewer quality indicators overall for a broad habitat. Generally, the upper and lower points indicated below are unrealistic in terms of reflecting changes in broad habitats, and future adjustments in weightings will not change the broad habitat indices to such a great extent. To make the index more robust SNH's intends to canvas views more widely in Scotland on the weightings, including holding external workshops, as well as collecting some additional data to help in this endeavour.

Figure 1: Natural capital estimates for year 2009, with upper and lower estimates



iii). Sub-Index calculation

The quality (weighted ecosystem quality indicators) value is multiplied by the broad habitat area to generate an index for each of the broad habitats. This is repeated for each year from 2000 to 2009 (2009 being a preliminary estimate as some 2009 data was not available at the time). These are shown in the following diagrams. It should be noted here that, given the caveats expressed about indicator weightings, above, and the reliability of the underlying data, there is less confidence in values for any one year and changes of ±5%. The indices are not designed to provide accuracy for any one year, but their strength lies in detecting changes over time. So it is the overall trend that should be highlighted, and the drivers for this explored.

Figure 2: Changes in the natural capital of Scottish cropland in the 21st century

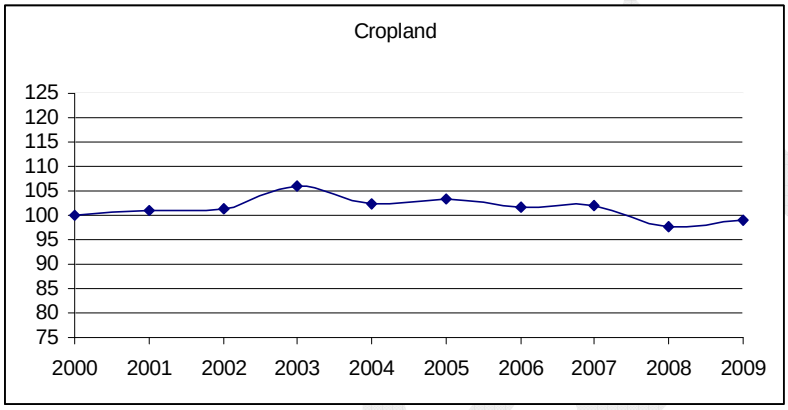
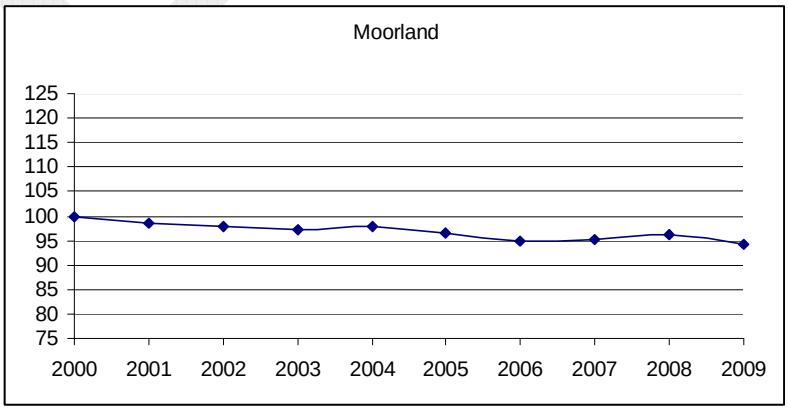


Figure 2, above, shows that the natural capital of cropland in Scotland has been on a bumpy plateau over the last decade. However, there was a general rising trend in the first half of the decade, as a result of land in agri-environment or set-aside. The rise between 2000 and 2003 is significant[5]. This trend was reversed in the latter half of the decade, with a significant fall between 2003 and 2008, despite farmland bird population recoveries. The decline occurred in provisioning, regulating & supporting, and cultural ecosystem services. This decline was driven by a combination of factors – falling livestock numbers, a reduction in the area of set-aside, fodder crops, and mixed farming, an increase in non-native invasive species, a decline in the species richness of improved grasslands, and loss of hedgerow length and quality.

Figure 3: Changes in the natural capital of Scottish moorland in the 21st century



[5] The term significant is not used here as denoting importance, or formal statistical significance, only that the index has moved beyond a ±5% change over a period of time, reflecting a likely real change.

Figure 3, above, shows that the natural capital of moorland in Scotland has been in steady decline over the last decade, mainly as a result of a reduction in regulating & supporting but also cultural services. By the second half of the decade this trend had become significant, largely driven by a decline in bird species, encroachment of bracken and decline in plant biodiversity on both bogs and heaths. Although more designated heath sites reached favourable condition, the opposite was true for bog sites. A rise in venison production was off-set by a decline in red grouse numbers.

Figure 4: Changes in the natural capital of Scottish woodland in the 21st century

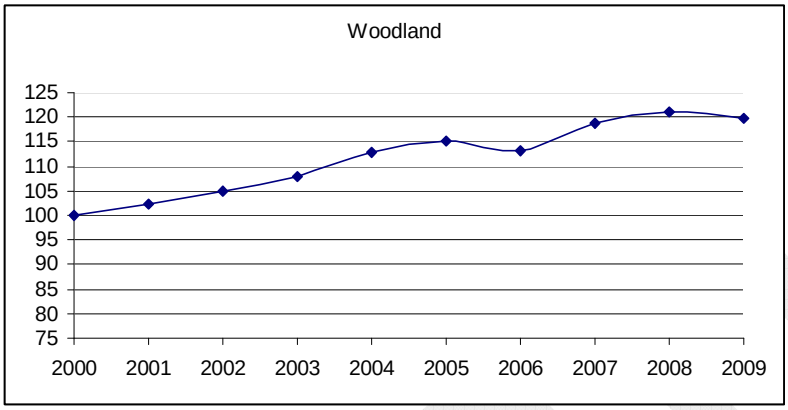


Figure 4, above, shows that the natural capital of woodland in Scotland rose rapidly (across all ecosystem service categories) over the first half of the last decade, with a slower rise over the second half. This increase was significant and was largely as a result of designated woodland sites reaching favourable condition, and increases in the area of forests certified and the populations of woodland birds. It is worth noting that, despite this rise, some regulating & supporting indicators declined (species richness in broadleaf woods and conifer forest). Although the area of woodland increased over this time period it only had a small impact on the woodland index.

Figure 5: Changes in the natural capital of Scottish urban greenspace in the 21st century

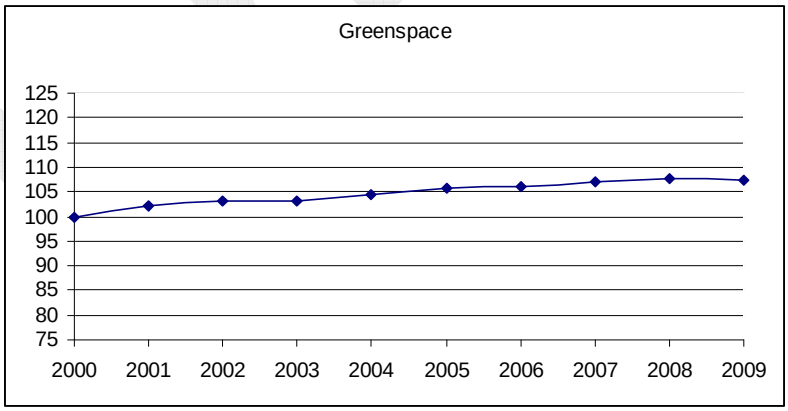


Figure 5, above, shows that the natural capital of urban greenspace in Scotland rose steadily over the last decade, to a level where this change was significant. This was as a result of net improvements in regulating & supporting ecosystem services (as measured by urban background nitrogen dioxide levels and the green network policy area). The increase in greenspace natural capital would have been greater if there had not been deterioration in some aspects of cultural services (urban bird populations and amount of derelict urban landscape).

Figure 6: Changes in the natural capital of Scottish coast in the 21st century

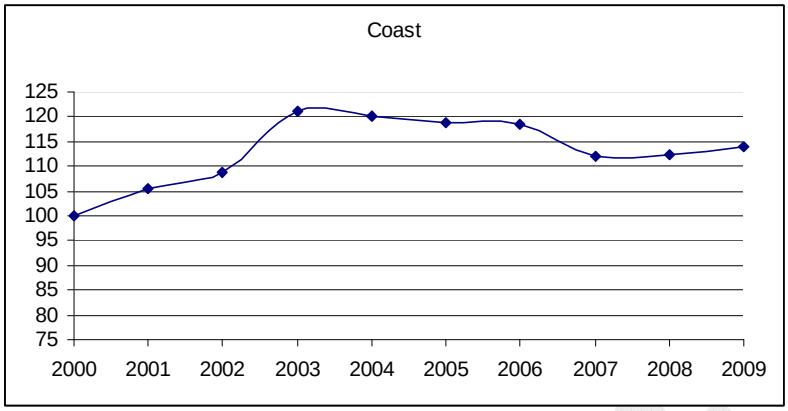


Figure 6, above, shows that the natural capital of Scotland's coast rose significantly over the last decade as a whole (across all ecosystem service categories), but that there was a rapid increase in the early part of the decade followed by a slow decline. The decline since 2003 has been significant. The decline occurred in regulating/ supporting and cultural services. This is as a result of bathing water quality and beach litter improvements being followed by declines in both of these along with coastal birds. There was also a growing problem with non-native invasive species. Set against this is a steady increase in designated sites reaching favourable condition.

Figure 7: Changes in the natural capital of Scottish freshwater in the 21st century

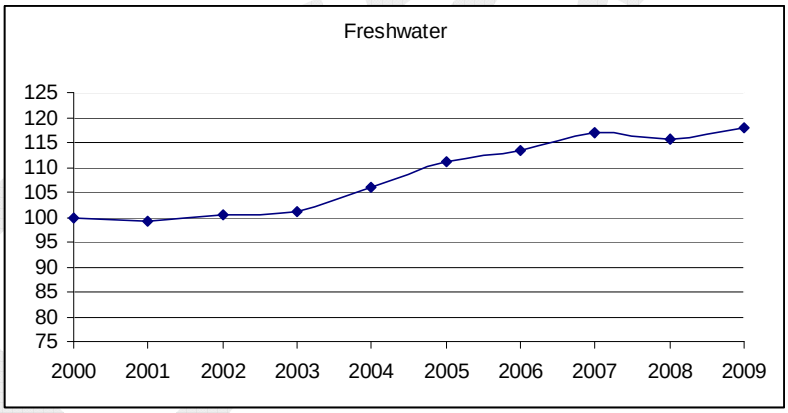


Figure 7, above, shows that the natural capital of Scotland's freshwater rose significantly over the last decade (across all ecosystem service categories), with a particularly rapid rise between 2003 and 2007. This was largely driven by improvements in water quality, such as nitrates and orthophosphate in rivers at safe levels, but also freshwater macroinvertebrate diversity, designated sites, as well as salmon catches. This improvement in water quality appears to have levelled off in recent years, although there is still an upward trend. Although there was a net increase in regulating & supporting services, some aspects saw a decline.

The last broad habitat to be assessed is rough grassland, which shows the largest decline, by nearly one-fifth, but with large swings. The reasons for this are explored below.

Figure 8: Changes in the natural capital of Scottish grassland in the 21st century

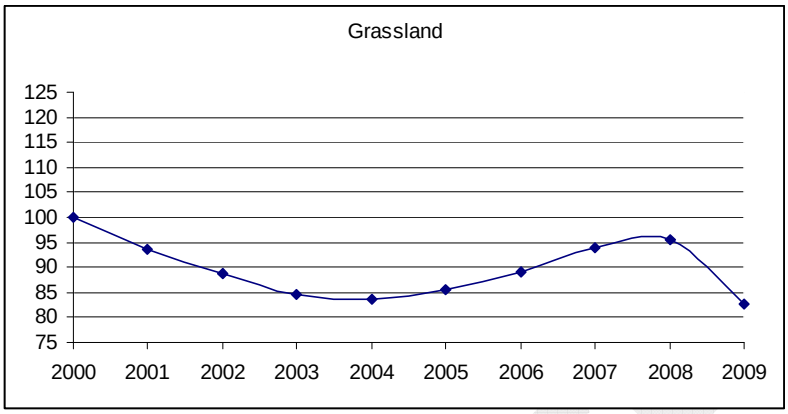
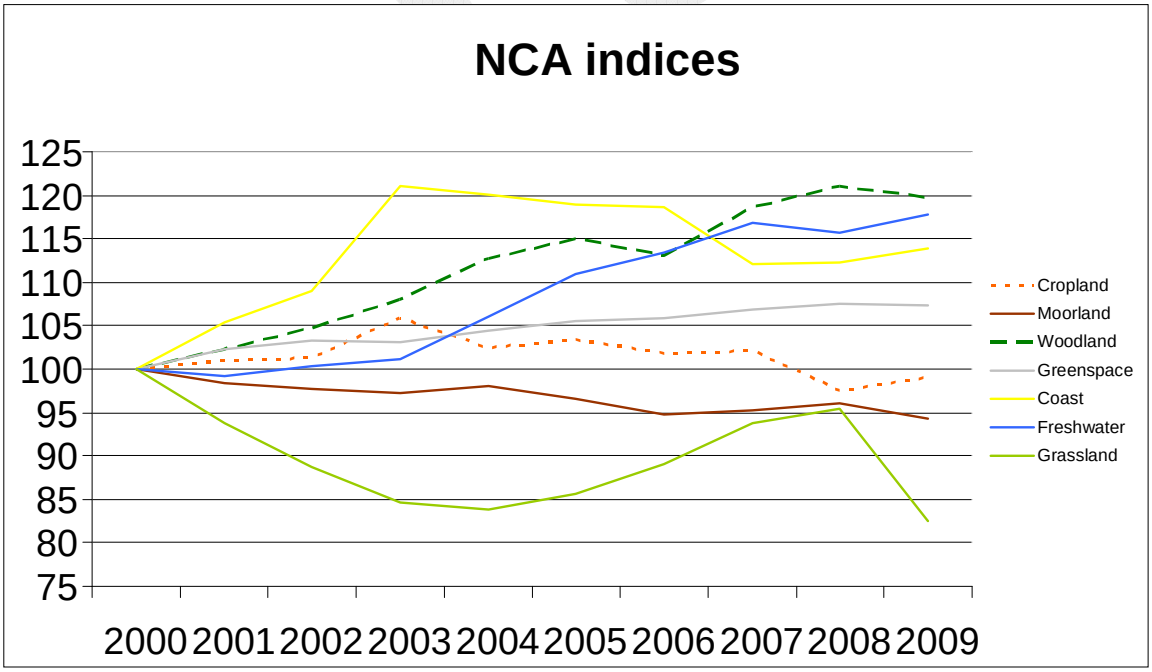


Figure 8, above, shows that the natural capital of Scotland's grassland fell significantly over the last decade, with a rapid dip between 2008 and 2009. This was largely driven by an interaction between quality and area. The first dip was largely caused by a drop in area, as this grassland was shifted into more intensive agricultural management. Although the 2009 fall in area was not as great as 2004 it was compounded by a drop in most ecosystem services (e.g. grazing, hay meadow, and to some extent species richness), which combined led to the overall ultimate low in 2009.

The changes in natural capital of all the broad habitats are shown below (Figure 9) for ease of comparison.

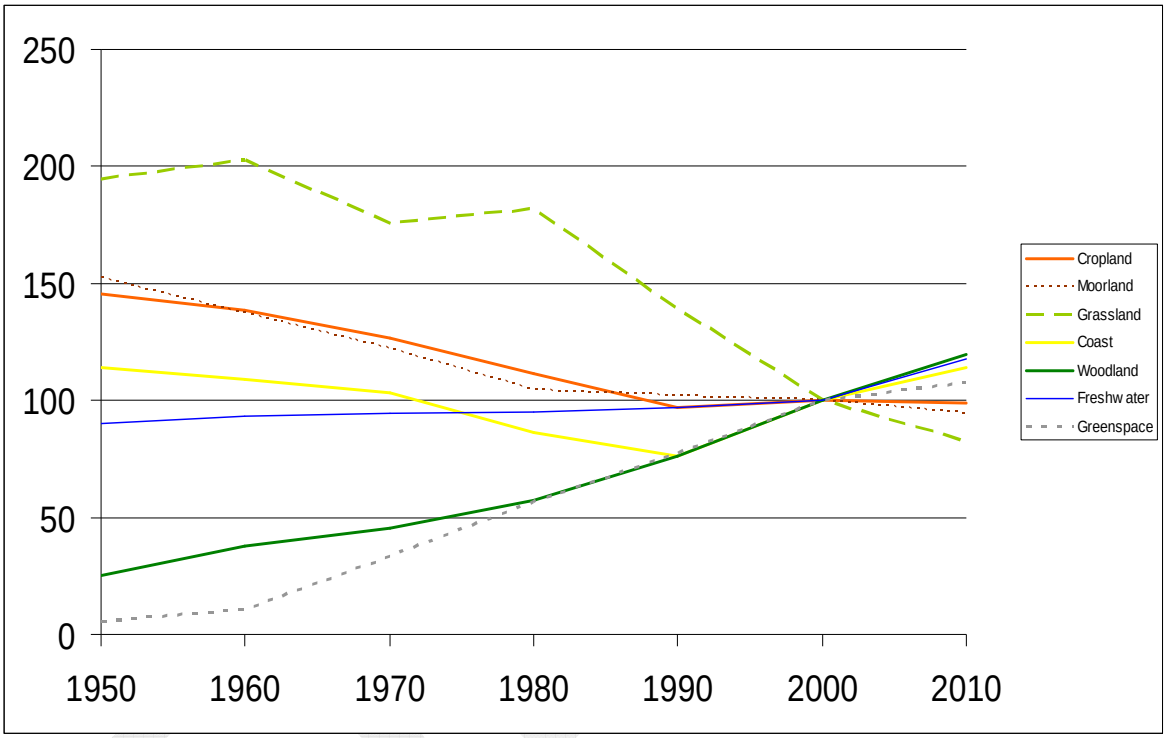
Figure 9: Changes in the natural capital of all Scottish broad habitats in the 21st century



From this it is clear that four broad habitats (woodland, freshwater, coast and urban greenspace) are showing an improvement in natural capital between 2000 and 2009, one (cropland) is fluctuating, whilst two are declining (moorland and grassland). However, looking at the changes since the year 2000 does not really provide enough

information to understand where we are in relation to historical change to our natural capital. Back-casting trends can help to put in context the more recent changes. Using a similar approach (but with different and fewer indicators due to lack of data) an indicative projection back to 1950 was also produced to put the 21st century NCA index into context. The indices are not strictly comparable due to the use of different data sets and the starting period of 1950 is rather arbitrary as much change had already occurred in Scotland. However the back-casting does provide an indication as to changes over recent decades.

Figure 10: Changes in the natural capital of all Scottish broad habitats 1950-2009



It can be seen in the above figure that that the trends observed over the last decade are continuations of those observed over a longer period of time. Since the 1960s there has been a rapid decline in grassland natural capital and an almost equally rapid rise in woodland. This is almost entirely driven by a shift between the two land uses as grassland was afforested (note that moorland was also afforested during this period). However, the natural capital increase of woodland is also partly due to an increase in the per unit area ecosystem services across all categories (as a result of a shift to more broadleaf planting from the 1980s onwards, as well as an increase in timber production from the earlier planting). There is also a sharp increase in greenspace cultural services (as a result of the setting up of formal recreation areas and Local nature Reserves, as well as more gardens as a result of growing urbanisation) and regulating & supporting services (due to an improvement in air quality after the 1960s as pollution became more closely regulated).

Although freshwater shows a long upward trend this hides a number of different changes taking place in this broad habitat. There is a mixed picture over this period in terms of regulating & supporting services (with some chemical improvements from the 1980s, with some species benefitting from this, but with declines in other native species, and a rise in invasives). In terms of provisioning and cultural services there

was a fall in salmon catch and weights. However, set against these changes is an increase in the area of freshwater habitat. Coast shows a decline in natural capital until around 1990 as result of increasing pollution, after which time bathing water quality increases as a result of implementation of EU directives (improving both provisioning and cultural services), although there is also some improvement in ecology (impacting regulating & supporting and cultural services) from the 1980s.

Moorland shows a fairly rapid decline until the 1980s as a result of a decline in regulating & supporting and cultural services driven by bracken encroachment on heather moorland and peatland drainage. Some of the negative trends have continued at a slower pace since then, although the drainage of peatlands has reversed (improving regulating & supporting services). Cropland falls fairly rapidly until the 1990 despite an increase in provisioning services, as a result of a decline in cultural services (such as hedgerows and farmland birds), along with excess nitrogen application impacting on regulating & supporting services. The levelling-off to 2000 could be interpreted as a result of the combination of agri-environment schemes, nitrate legislation and set-aside improving regulating & supporting ecosystem services.

What this historical context shows is that to a certain extent there is a zero sum game being played, since as Mark Twain remarked about land, “they're not making it anymore”, and so an expansion in area of one use (e.g. woodland) is at the expense of another (e.g. grassland). Essentially this is ecosystem conversion, and we are collectively making a decision about the relative importance of these ecosystems. It should be noted that in 1950 Scotland was still relatively denuded of woodland compared to the pre-Roman 'Caledonian Forest' cover, and the current 17% land cover is still less than nearly every EU Member State (e.g. 32% Germany, 42% Portugal, and 75% Sweden). The current aim is to increase woodland cover to 25% in Scotland, which will mean further loss of grasslands (plus other broad habitats).

However, what is also clearly observed is that given a fixed (or even declining) resource, we can manage the ecosystem to deliver a net increase in services from that ecosystem, and so improve Scotland’s natural capital. This is most clearly demonstrated through the improvement in Scotland’s coastal and freshwater ecosystems, where pollution controls have increased the regulating & supporting functions of these ecosystems, which in turn can have cultural service benefits. The importance of controlling pollution can also be demonstrated for provisioning services in coastal ecosystems, where deterioration in water quality would put at risk shellfish harvesting. It is also clear that funding sensitive land management on cropland and moorland over recent decades has halted a fairly rapid decline in natural capital.

iv). Overall Index

We cannot just add up the different broad habitats weighted to area to produce an overall index. Each of the broad habitats should be further weighted according to its relative ecosystem service value. Otherwise the implicit assumption would be that a unit of one habitat type is just as desirable as another, so that replacing one with the other would have no impact on our stock of natural capital. This is clearly not the case. So, the ecosystem service weighting of the broad habitats uses as a starting point ecosystem service valuations for a limited number of mainly direct uses, with identification of ‘non-use’ values (which include values such as potential genetic resource, spiritual values, health benefits, and biodiversity value). These latter can be

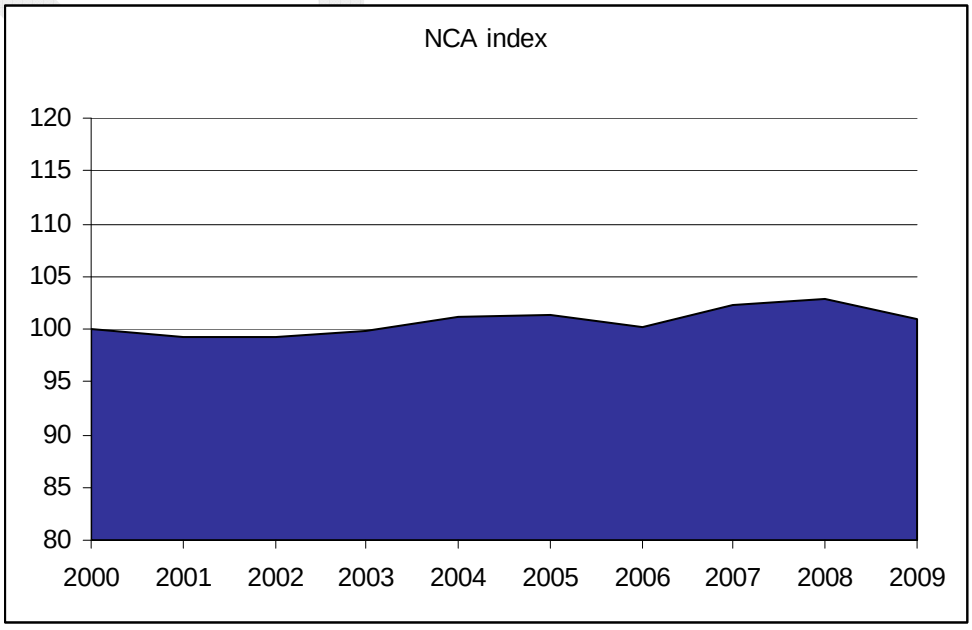
difficult to ascertain in monetary format from the general public (i.e. when a large amount of background information would first be needed). Therefore, a focus group of SNH experts in each of the broad habitats in Scotland scored both these additional values and the direct use values (with reference to the initial monetary quantitative data). These scores were combined with additional data from various other sources (e.g. UK NEA, Macaulay's 'Field guide to an Ecosystem Approach', reports by Jacobs et al (2004) and Eftec (2005), as well as the Scottish Biodiversity List priority habitats and species (including public choice), Scottish Recreation Survey, etc), to develop a score per unit area of an ecosystem.

The findings from this non-monetary valuation of ecosystem services are that a unit area of freshwater habitat is significantly more valuable in terms of ecosystem service values than a similar unit area of the other broad habitats. For example, an additional hectare of freshwater habitat is worth two times as much as an additional hectare of woodland. Coastal habitats are identified as being the second most valuable. The reason behind coast's relatively high value per unit area is that it has a high recreation and tourism value at the aggregate level but occupies the smallest area of the broad habitats. The ecosystem service score is given for each of the habitats:

Broad Habitat:	Score:
1. Freshwater	27.0
2. Coastal	17.5
3. Moorland	13.5
4. Woodland	13.5
5. Urban greenspace	12.0
6. Rough grassland	12.0
7. Cropland	4.5

This score means that individual indices can then be summed using weights based on these and broad habitat area to give an overall Natural Capital Asset (NCA) index. This analysis is for the years 2000 (base year) to 2009, see figure 11 below.

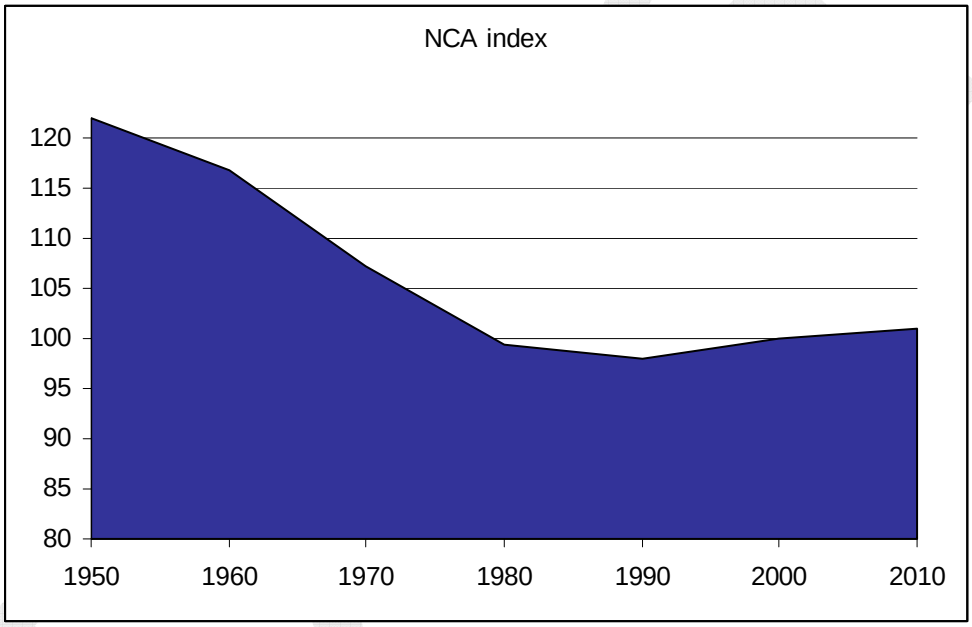
Figure 11: Changes in Scotland's natural capital in the 21st century



From the figure above it can be seen that Scotland's natural capital as remained fairly flat over the last decade. The NCA index shows a slowly rising trend from 2002 to 2008, but as with the individual indices less confidence can be placed in changes <5% (the change between 2002 and 2008 was 3.5%). Holding natural capital flat can be seen as an achievement if over the same time period the economy has grown (so long as it is not achieved through an increase in substitution of resource use from outwith Scotland, displacing environmental harm on to others). However, looking at the current level of natural capital over only the last decade does not indicate whether this is a sustainable level.

Once again by using back-casting the NCA index can be placed in historical context to have a better understanding of the current situation. This is shown in figure 12, below.

Figure 12: Changes in Scotland's natural capital 1950-2009



As can clearly been seen, Scotland's natural capital fell significantly from circa 1950 to circa 1990, with the greatest rate of decline through the 1960s and 70s. Most ecosystems were in decline during this period, and the fall is heavily driven by the change in moorland and grassland broad habitats (which cover a large area of Scotland). However, although the decline in moorland and grassland broad habitats has continued, the improvement in natural capital of the other broad habitats after 1990 has outweighed this. This has resulted in a slow recovery in natural capital since 1990.

However, if we had held on to progress across ecosystem services this recovery could have been much greater. For example, if we had met the following conditions then the NCA index would have stood at 108:

- maintained the agri-environment and set-aside area at the decade peak, along with livestock numbers and fodder cropping at year 2000 levels;
- held upland bird numbers and bracken cover to year 2000 levels, bird of prey poisonings to 2005 levels and the condition of heath and bogs to 2000 levels;
- kept species richness of woodland at year 2000 levels and woodland birds at 2008 levels;

- kept urban bird numbers at 2003 levels;
- maintained coastal bathing water quality at the peak levels of the last decade, controlled coastal non-native invasive species by holding them at year 2000 levels,
- maintained freshwater quality, and fen/freshwater marsh species richness at year 2000 levels; and
- maintained species richness of grasslands and the area of hay meadow at year 2000 levels.

This potential increase in the NCA index would be a significant increase over the actual 2009 levels. It illustrates how over the coming years, even reaching conditions previously achieved over the last decade, Scotland's natural capital could be markedly improved.

3. NEXT STEPS

This index is being released as a pilot, and SNH wishes to develop it further over the coming year. Therefore, we are seeking feedback on this work by 20th May 2011. We shall then refine the data sources, methodology, and assumptions adopted for estimation of the index, using any relevant comments received. We plan to republish a finalised index (updated to include 2010 data) in December 2011.

A key factor in the calculations are the weightings. Firstly, the weighting given to each of the broad habitat quality indicators (i.e. measuring ecosystem services), which must take into consideration how representative the indicator is, the reliability of the data, and the relative importance of a percentage change in the indicator. Secondly, the weighting given to the different broad habitats (in terms of their importance per unit area in delivering ecosystem services), for the summing of separate indices into the overall NCA index. For both of these judgement is required based on knowledge. In this pilot this has been conducted using specialists within SNH. We are keen to extend this survey to a panel of external experts, however, for many cultural services we also need to take more account of the preferences of the general public, and this will also be explored. There is a need to update weightings regularly (5 to 10 years minimum) in order to take into account changes in both the natural capital stocks of the different ecosystems as well as preferences.

The main questions that we are seeking feedback on are:

1). What improvements can be made to the NCA index methodology?

2). How should the weightings be made more robust?

3). Have you any suggestions for available indicators/data that could be used to fill gaps?

4). How could a target level for future natural capital be determined?

We would also be very pleased to receive comments on other ideas for how the index could be improved.

Please send comments to:

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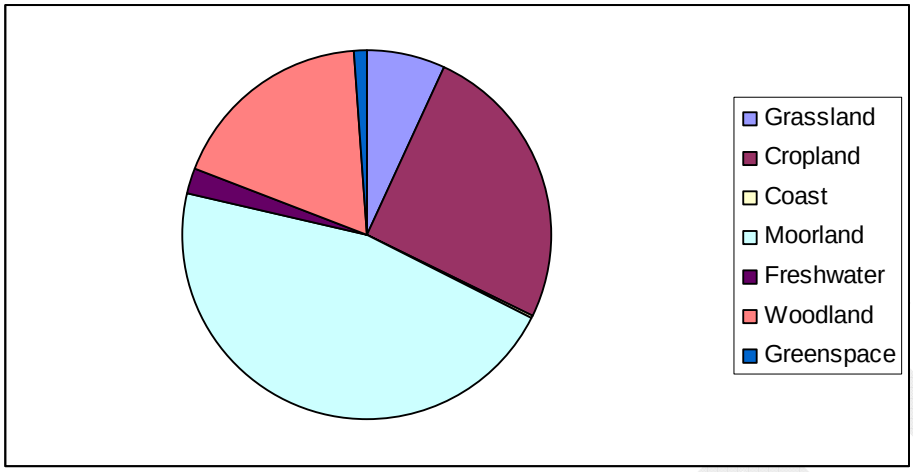
APPENDIX 1

This diagram shows the relative area of the broad habitats in Scotland (2009):



The table below provides corresponding figures for the area in hectares:

Grassland	511,232
Cropland	1,876,838
Coast	28,100
Moorland	3,424,940
Freshwater	165,990
Woodland	1,341,000
Greenspace	85,000

APPENDIX 2

Ecosystems and ecosystem services:

The most widely used definition of an ecosystem is that adopted by the Convention on Biological Diversity (CBD) and the Millennium Ecosystem Assessment (MA):
"*A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit*".

The main identifying feature of an ecosystem is that it is indeed a system, with interactions between its living elements and their environment. Ecosystems are often defined in terms of their dominant vegetation or environmental features. In reality, the concept of an ecosystem is a human construct to describe the natural world and we define ecosystems according to the scale of our interests.

For analysis and assessment purposes it is necessary to adopt a pragmatic view of the definition of an ecosystem and its boundaries, depending on the questions being asked. In one sense, the entire biosphere of planet Earth is an ecosystem since all its elements interact. The CBD definition of an ecosystem as a functional unit may be a reflection more of human scale of interest, rather than definition of a distinct entity such as an individual animal.

In the UK and much of Europe the classification of ecosystems can be considered as significantly overlapping with that of habitats. A definition of a habitat is an ecological or environmental area that is inhabited by a particular animal or plant species. However, whilst the classification and management of habitats has centred on the populations of species of interest, the concept of an ecosystem is based on the interactions between its components and its properties as a system. This systems perspective logically extends to including people as part of ecosystems. We simultaneously depend upon and influence ecosystems. Ecosystem services are the benefits provided by ecosystems that contribute to making human life both possible and worth living.

Ecosystem services (based on UN Millennium Assessment):

Provisioning services
For example – food and water.

Regulating services
For example - climate regulation and flood protection.

Cultural services
For example – recreation and spiritual value.

APPENDIX 3

The following pages contain the worksheets for calculating each broad habitat index.

Cropland

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	*WEIGHTING*
Provisioning											
Total no. Livestock Units (cattle & sheep) in non-LFA	100	89	91	93	95	95	95	95	90	89	*0.144*
Yeilds of representative crops	100	106	98	118	108	106	98	116	116	116	*0.096*
Regulating/supporting											
Lowland grazing (total no. cattle in non-LFA)	100	91	94	97	97	98	98	97	93	92	*0.025*
Cropping in the west of Scotland	100	108	101	97	96	96	91	91	97	98	*0.035*
Bare fallow/set-aside area	100	114	110	111	94	100	96	87	36	25	*0.040*
Fertiliser use (inverse)	100	100	98	97	88	77	94	113	118	124	*0.045*
Pesticide use (inverse)	100	112	99	105	87	98	97	91	70	100	*0.048*
Area of fodder crops grown	100	91	81	78	76	72	74	68	62	56	*0.019*
Farm pollution incidents (inverse)	100	102	103	105	119	99	122	93	125	120	*0.015*
Hedges species richness (Countryside Survey)	100	97	95	92	89	87	84	82	79	76	*0.036*
Farmland bird index	100	98	95	102	100	104	100	107	112	106	*0.047*
Species richness arable land (Countryside Survey)	100	100	101	101	102	102	103	103	104	104	*0.033*
Species richness improved grass (Countryside Survey)	100	99	98	97	96	95	94	93	92	92	*0.033*
Agri-environment area	100	110	131	141	136	164	158	141	121	104	*0.058*
Butterflies - generalists	100	101	101	102	103	103	104	104	105	106	*0.026*
Mixed farming	100	95	94	94	102	100	98	96	95	92	*0.025*
Invasive non-native species (inverse)	100	99	98	97	96	95	94	93	92	91	*0.015*
Cultural											
Amount of landscape covered in polytunnels (inverse)	100	102	98	97	93	92	90	83	93	70	*0.001*
Hedges in the landscape (total length of hedgrows)	100	100	99	98	98	97	97	96	95	95	*0.105*
Butterflies - generalists	100	101	101	102	103	103	104	104	105	106	*0.049*
Farmland bird index	100	98	95	102	100	104	100	107	112	106	*0.065*
Lowland boundary walls in landscape (total length)	100	100	100	100	100	100	100	100	100	100	*0.020*
No. livestock in non-LFA (cattle & sheep)	100	89	91	93	95	95	95	95	90	89	*0.020*
Total	100	100	99	103	100	101	100	101	97	96	*1.000*
Area	100	101	102	103	103	102	101	101	100	103	
NCA index	**100**	**101**	**101**	**106**	**102**	**103**	**102**	**102**	**98**	**99**	

Moorland

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	*WEIGHTING*
Provisioning											
Venison production	100	109	118	109	132	100	173	150	164	164	*0.004*
Peat production (large-scale extraction only)	100	96	93	89	85	81	78	74	70	66	*0.001*
Red grouse numbers (for shooting rights)	100	93	83	70	63	57	50	52	59	58	*0.005*
Regulating/supporting											
Bracken encroachment (inverse)	100	99	97	96	95	93	92	91	89	88	*0.100*
Upland bird index	100	96	92	98	101	93	94	98	96	95	*0.150*
Mountain hare distribution	100	100	100	100	100	100	100	100	100	99	*0.070*
Heath species richness (Countryside Survey)	100	99	99	98	97	97	96	95	95	94	*0.100*
Bog moisture score (Countryside Survey)	100	100	100	100	100	100	100	100	100	100	*0.150*
Heath bird food (Countryside Survey)	100	99	99	98	97	96	96	95	94	93	*0.010*
Bog grass:forb ratio (inverse) (Countryside Survey)	100	97	94	91	89	86	83	80	77	74	*0.120*
Heath butterfly food (Countryside Survey)	100	99	98	98	97	96	95	95	94	93	*0.050*
Soil carbon concentration in bogs (Countryside Survey)	100	100	99	99	98	98	98	97	97	97	*0.050*
Carbon release from peat extraction (inverse)	100	104	107	111	115	119	122	126	130	134	*0.010*
Heath Site Condition Monitoring (favourable condition)	100	104	109	113	118	122	127	131	135	140	*0.050*
Bog Site Condition Monitoring (favourable condition)	100	99	99	98	97	96	96	95	94	94	*0.050*
Cultural											
Upland bird index	100	96	92	98	101	93	94	98	96	95	*0.020*
Red grouse numbers	100	93	83	70	63	57	50	52	59	58	*0.010*
Birds of prey poisoning (inverse)	100	75	106	63	94	125	38	50	125	63	*0.020*
Landscape bracken encroachment (inverse)	100	99	97	96	95	93	92	91	89	88	*0.010*
Landscape impact of windfarms	100	99	99	98	97	96	95	95	94	93	*0.020*
Total	100	98	98	97	98	97	95	95	96	94	*1.000*
Area	100	100	100	100	100	100	100	100	100	100	
NCA index	**100**	**98**	**98**	**97**	**98**	**97**	**95**	**95**	**96**	**94**	

Woodland

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	*WEIGHTING*
Provisioning											
Amount of timber harvested	100	98	103	115	122	123	124	132	122	116	*0.070*
Regulating/supporting											
Woodland bird index	100	101	100	103	113	115	103	114	121	114	*0.200*
Area of certified forest	100	105	111	116	121	124	125	132	132	133	*0.200*
Woodland Site Condition Monitoring (favourable cond.)	100	104	109	113	117	121	126	130	134	138	*0.200*
Species richness in broadleaf woods (Countryside Surv.)	100	98	96	94	92	90	88	86	83	81	*0.060*
Species richness in conifer woods (Countryside Survey)	100	99	97	96	94	93	92	90	89	87	*0.060*
No. butterfly food species broadleaf target plots (CS)	100	98	96	94	91	89	87	85	83	81	*0.050*
Cultural											
Landscape (timber harvesting (inverse))	100	102	97	85	78	77	76	68	78	84	*0.040*
Woodland bird index	100	101	100	103	113	115	103	114	121	114	*0.040*
Proportion of broadleaved woodland	100	102	104	106	108	110	112	114	116	118	*0.040*
Area of certified forest	100	105	111	116	121	124	125	132	132	133	*0.040*
Total	100	102	104	107	111	113	111	116	118	117	*1.000*
Area	100	100	101	101	101	102	102	102	102	102	
NCA index	**100**	**102**	**105**	**108**	**113**	**115**	**113**	**119**	**121**	**120**	

Greenspace

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	*WEIGHTING*
Provisioning											
Area of garden/allotment/urban orchard	100	100	100	100	100	100	100	100	100	100	*0.010*
Regulating/supporting											
Urban background NO2 levels	100	113	110	103	121	126	131	131	128	138	*0.100*
Green network policy area	100	105	109	114	118	123	128	132	137	142	*0.050*
Urban birds (garden birds)	100	101	102	102	99	98	97	97	98	92	*0.150*
Cultural											
Proportion of greenspace meeting people's needs	100	102	103	105	107	108	110	112	113	115	*0.300*
School playing fields avilability	100	100	100	100	100	100	100	99	99	99	*0.050*
Urban birds (garden birds)	100	101	102	102	99	98	97	97	98	92	*0.200*
Amount of derelict urban landscape	100	100	100	100	100	100	93	94	94	94	*0.050*
Visits to urban parks (Scottish Recreation Survey)	100	100	100	100	100	100	100	100	100	100	*0.090*
Total	100	102	103	103	104	106	106	107	108	107	*1.000*
Area	100	100	100	100	100	100	100	100	100	100	
NCA index	**100**	**102**	**103**	**103**	**104**	**106**	**106**	**107**	**108**	**107**	

Coast

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	*WEIGHTING*
Provisioning											
Number of areas designated shellfish waters	100	227	327	327	327	327	327	315	339	236	*0.005*
Cockle biomass (harvest)	100	58	118	280	285	158	68	105	146	146	*0.015*
Regulating/supporting											
Pollution - imposex in dogwhelks	100	104	104	104	104	108	112	117	128	139	*0.040*
Bathing water quality (guideline)	100	100	100	163	134	139	137	120	120	139	*0.080*
Wintering waterbird index	100	100	99	98	97	95	94	94	94	94	*0.110*
Coastal non-native invasive species	100	86	72	58	44	30	16	2	-13	-27	*0.020*
Coastal Site Condition Monitoring (favourable condition)	100	106	112	118	124	130	136	142	148	154	*0.110*
Cultural											
Bathing water quality (mandatory)	100	100	108	113	111	113	119	105	108	112	*0.250*
Coastal birds	100	102	99	100	93	92	94	95	95	96	*0.150*
Beach litter count	100	122	120	132	133	134	129	116	107	102	*0.200*
MCS beach quality measure	100	105	137	174	295	263	263	258	232	216	*0.020*
Total	100	105	109	121	120	119	119	112	112	114	*1.000*
Area	100	100	100	100	100	100	100	100	100	100	
NCA index	**100**	**105**	**109**	**121**	**120**	**119**	**119**	**112**	**112**	**114**	

Freshwater

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	*WEIGHTING*
Provisioning											
Water provision (use/precipitation)	100	88	87	84	85	95	93	89	96	100	*0.250*
Water quality - nitrates in rivers at safe level	100	104	108	112	115	119	127	135	135	139	*0.250*
Water quality - orthophosphate at safe level	100	106	111	117	123	128	134	139	124	130	*0.180*
Regulating/supporting											
Pollution: nitrates in rivers at safe level	100	104	108	112	115	119	127	135	135	139	*0.005*
Pollution: orthophosphate at safe level	100	106	111	117	123	128	134	139	124	130	*0.005*
Fen, marsh, swamp species richness (Countryside Srv.)	100	97	95	92	89	87	84	81	79	76	*0.024*
Streamside species richness (Countryside Survey)	100	99	97	96	95	93	92	91	89	88	*0.010*
Pooled headwater plant species richness (CS)	100	102	103	105	106	108	110	111	113	115	*0.024*
Non-native invasive species (inverse)	100	100	100	100	100	100	100	100	100	100	*0.035*
Freshwater macroinvertebrate diversity	100	91	100	100	87	113	100	126	130	130	*0.035*
Rivers & streams Site Condition Monitoring (favourable)	100	100	100	100	100	100	100	100	100	100	*0.024*
Standing water Site Condition Monitoring (favourable)	100	101	103	104	106	107	108	110	111	113	*0.024*
Freshwater fauna Site Condition Monitoring (favourable)	100	101	103	104	105	106	108	109	110	112	*0.024*
Cultural											
Otter population	100	100	101	101	101	101	102	102	102	102	*0.020*
Number of ponds	100	101	101	102	103	103	104	105	105	106	*0.020*
Mean headwater plant richness (Countryside Survey)	100	104	108	113	117	121	125	129	134	138	*0.010*
HQA of headwater streams (Countryside Survey)	100	101	101	102	102	103	103	104	104	105	*0.010*
Salmon catch	100	106	85	78	137	124	126	134	128	107	*0.050*
Total	100	99	100	101	106	111	113	117	116	118	*1.000*
Area	100	100	100	100	100	100	100	100	100	100	
NCA index	**100**	**99**	**100**	**101**	**106**	**111**	**113**	**117**	**116**	**118**	

Grassland

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	*WEIGHTING*
Provisioning											
Total no. Livestock Units (cattle & sheep) in the LFA	100	92	93	93	93	93	89	87	85	82	*0.040*
Regulating/supporting											
Level of cattle grazing (total no. in the LFA)	100	95	96	96	97	97	94	92	91	88	*0.100*
Farmland & Upland birds (combined index)	100	97	94	100	100	99	97	102	104	101	*0.060*
Butterflies (specialists)	100	99	99	100	100	101	103	104	105	107	*0.060*
Area of hay meadow	100	97	87	82	80	97	61	82	74	74	*0.060*
Level of sheep grazing in north west (no. ewes)	100	97	91	90	87	86	78	74	69	67	*0.160*
Neutral grassland species richness (Countryside Surv.)	100	98	96	94	92	90	88	86	84	82	*0.160*
Grassland Site Condition Monitoring (favourable cond.)	100	114	129	143	157	171	186	200	214	229	*0.060*
Festuca ovina in acid grassland (Countryside Survey)	100	99	98	96	95	94	93	91	90	89	*0.080*
Galium saxatile in acid grassland (Countryside Survey)	100	99	98	98	97	96	95	94	94	93	*0.080*
Cultural											
Number of working occupiers in the LFA	100	99	98	98	93	98	97	94	90	93	*0.050*
Neutral grassland species richness target plots (CS)	100	98	97	95	94	92	91	89	88	86	*0.050*
Corncrake population	100	101	112	139	181	187	194	216	197	192	*0.020*
Area of hay meadow	100	97	87	82	80	97	61	82	74	74	*0.020*
Total	100	98	97	98	98	100	96	98	96	95	*1.000*
Area	100	95	91	87	85	86	93	96	100	87	
NCA index	**100**	**94**	**89**	**85**	**84**	**86**	**89**	**94**	**95**	**83**	