

Indicator name			Version
NB11 Extent of key habitats: deep peat			29/03/16
Indicator type:	Risk/opportunity	Impact	Action
	X		
SCCAP Theme	SCCAP Objective	CCRA risk/opportunity	
Natural Environment	N2: Support a healthy and diverse natural environment with capacity to adapt	Cross-cutting	

At a glance
<ul style="list-style-type: none"> <li>Scotland has about 60% of UK peatlands, with around 20% of Scotland's land area covered by blanket bogs alone, which represent around 15% of the global total for this habitat.</li> <li>The extent of peatlands is important in terms of understanding their resilience to the pressures of climate change. More extensive areas, in better condition, are more likely to be able to cope with climate change than small fragmented areas.</li> <li>Many areas are now in poor condition - without intervention, peatlands will continue to deteriorate in both condition and extent.</li> <li>Climate projections indicate significant areas where active peat formation may no longer occur. Therefore, existing peat resources will need to be carefully protected and appropriate hydrological conditions created in order to maximise resilience.</li> </ul>

Latest Figure	Trend
<b>Blanket bog: 1653 kha</b> (Chapman et al., 2009)	Currently stable
<b>Raised bog: 34.9 kha</b> (Artz et al., 2012) though Lindsay et al. (1996) suggested only 27.8 kha	Decreasing
<b>Fen: 8.6 kha</b> (Bruneau and Johnson, 2014)	Not known

Why is this indicator important?
<p>Peatlands are important for their unique biodiversity, their contribution to water quality (important both for some potable water supplies and for freshwater fisheries), their contribution to flood control and mitigation, their preservation of archaeological and environmental records, the provision of the wilderness experience (important in tourism) and as a limited habitat for deer and grouse (important in the sporting industry) (Bain et al., 2011).</p> <p>Peatlands are likely to be negatively impacted by a warmer climate but more importantly by a climate</p>

in which drought conditions are more frequent. Warmer and drier conditions could increase the vulnerability of vegetation communities associated with peatlands as many species are reliant upon a very high water table. Peatland with a consistently low water table will result in the release of stored carbon, and colonisation by non-peat forming species (grasses, heather, etc.) which will themselves act to maintain a low water table. The extent, and particularly the condition, of peatlands is important in terms of understanding their resilience to the pressures of climate change, e.g. more extensive areas of peatland in better condition are more likely to be able to cope with climate change than small fragmented areas in poor condition.

Scotland holds about 60% of all UK peatlands, with around 20% of total land area covered by blanket bogs alone (Scotland is host to probably the largest single expanse of blanket bog in the world – the Flow Country), this represents around 15% of the global total for this habitat.

This indicator focuses on the extent of three key types of deep peat habitat: lowland raised bogs, blanket bogs and fens, which are identified as priority habitats within the UK Biodiversity Action Plan. Blanket bogs are upland peatlands which receive all their water from precipitation. In lowland areas, rain fed peatland is termed as ‘raised bog’ as the accumulation of peat elevates the bog surface above groundwater levels to form a dome. The source of moisture is the key distinction between lowland peatland types, with raised bogs receiving all water inputs from precipitation and not groundwater that supplies fens from below.

**Related indicators:**

NB13 Condition of key habitats: Area of modified deep peat soils

NB18 Annual greenhouse gas (GHG) emissions from degraded peatlands

NB22a Peatland restoration area

**What is happening now?**

The extent of blanket bog is currently stable. The Countryside Survey records no change 1998-2007 in bog habitat (Norton et al., 2009).

Historically there have been considerable losses in raised bog extent but variability in definition make current trends difficult to discern. The Countryside Survey records a slight decrease in lowland bog (not synonymous with raised bog) 1998-2007 (Norton et al., 2009).

The Countryside Survey for Scotland shows no significant change in the broad habitat category of ‘Fens, marsh and swamp’ between 1998 and 2007 (Bruneau and Johnson, 2014).

It is important to understand the extent of these critical habitats in conjunction with condition. However, while designated areas have been subject to routine site condition monitoring, peatland condition outwith these areas is poorly known. For blanket peat, for those soil mapping areas that are 100% blanket peat, 81% carry blanket bog habitat (vegetation) and 30% is estimated to be relatively undamaged (Artz et al., 2014). For raised bog, only 7% is in natural or near-natural condition with a further 15% moderately degraded. The remainder is under grassland, woodland, cultivated or cutover (Artz et al., 2012).

All categories of designated sites are recorded as ‘declining’ (slowing) in terms of the National Action Plan (Bruneau and Johnson, 2014). The Countryside Survey suggests some deterioration in the

condition of non-designated bog habitat 1998-2007 (Norton et al., 2009).

### What has happened in the past?

Clearly at one time peatlands were net accumulators of carbon. One hypothesis is that this was boosted by widespread deforestation but subtle changes in climate, wetting and drying, may also have played a role. What we now see as a major carbon stock has been built up slowly over the past 5,000 to 10,000 years, essentially since the retreat of the last ice age. In more recent times anthropogenic influences in many areas have changed net uptake to net loss. Our current estimate of blanket bog extent is based upon the 1:250,000 scale National Soil Data. This was based upon field survey 1978-1981 though it incorporated earlier surveys of the “lowlands and foothills”. However, for blanket peat areas they would be mainly covered in the latter period. It is not possible to say whether there might have been a material change in the intervening 30+ years.

The estimates of areal extent of raised bog and fen are more recent. Many areas are now in poor condition due to factors like erosion, drainage, afforestation, over-grazing, pollution and peat cutting. While peat erosion is exacerbated by land management, it may also be a ‘natural’ process, impacted to some extent by more recent shifts in climate. There are now areas where peat cover (particularly for raised bog and fen but also for blanket bog) has been lost completely though the full historical extent of this is unknown.

The trends in peatland extent are not easy to delineate. The extent of peatland, in terms of its soil definition, cannot be readily measured using current methodology without considerable on-the-ground effort and so, as mentioned, has only been determined once. Peatland, in terms of vegetation, can be more readily determined by remote means and changes can be picked up by aerial or satellite imagery if taken at time intervals. However, peatland vegetation does not map onto the peat resource as many areas of the latter do not now carry typical peatland vegetation and, conversely, as mentioned, some areas of peatland may occur on organo-mineral soils. While the Countryside Survey records no change in the extent of bog habitat, the fact that these are based on observations at a limited number of sites (<60) puts a restriction on what change might be detected.

### What is projected to happen in the future?

Without intervention, peatlands will continue to deteriorate in both extent and condition.

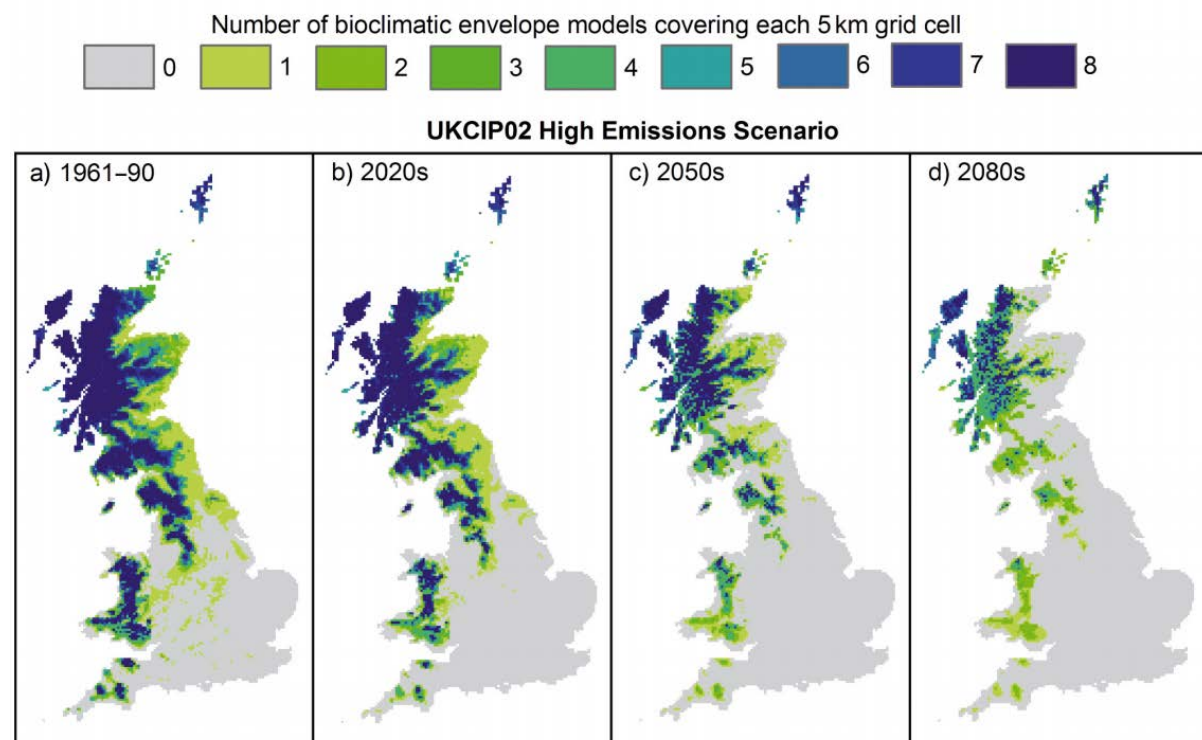
- Peat cutting on a commercial basis is now at a low level, except where it supports the whisky industry, and is continuing to decrease but domestic cutting is ongoing in some areas with the intensity varying with the price of other energy forms.
- Drainage of peatlands is no longer practiced but previously drained areas continue to suffer from low water tables. While in some areas drains may lose their effectiveness over time, there are some landowners who actively maintain existing drainage systems.
- Burning of blanket bog contravenes the muirburn code (which sets out best practice for land managers carrying out muirburn) and should not occur (Scottish Government, 2011). However, some landowners are not fully aware of what may constitute moorland and what may be blanket bog.
- It is no longer practice to afforest deep peat, but already afforested deep peat will continue to degrade during the current forest cycle. The situation at harvest and whether a second (or third) rotation may be instigated is currently unclear.
- Over-grazing has been recognised, sheep and cattle numbers are not what they used to be and efforts to reduce deer numbers have been made.
- Atmospheric pollution by sulphur has decreased dramatically but nitrogen inputs are continuing with little sign of much decrease in the future.

- A much more recent factor is that of renewable energy developments such as wind farms on peatland and this is set to continue. These developments typically result in pressure due to the requirement for construction of access roads and foundations for infrastructure, as well as associated drainage needs (Artz et al., 2014).
- Peat erosion, possibly instigated and exacerbated by these various other factors, is likely to continue and expand.

Additionally, climate change may accelerate the loss processes. Future bioclimatic envelope predictions shrink considerably the area within Scotland where active peat formation can occur (Clark et al., 2010).

### Patterns of change

Future predictions of where active blanket peat may occur under climate change show a dramatic shrinkage in area (Figure 1). Note that this figure indicates changes under the high emissions scenario; changes under the low emissions scenario lag about 30 years behind those shown. While Scotland fares somewhat better than England and Wales, the climate in large sections of the east of the country may become unfavourable for blanket peat formation and across much of the west of the country becomes rather patchy. Only the Western Isles and Shetland remain as they are now. Particularly worrying is the impact on much of the Flow Country by 2080. These maps do not necessarily indicate disappearance of the peat resource but show areas where active peat formation may no longer occur. Therefore, existing peat resources will need to be carefully protected and appropriate hydrological conditions created in order to maximise resilience and hence to avoid rapid carbon loss.



**Figure 1** Projected changes in bioclimatic space associated with the 1961–1990 baseline climate and mapped area of blanket peat using the UKCIP02 high emissions scenario. Number of models covering each space indicates increasing likelihood of active blanket peat survival. Taken from Clark et al. (2010).

## Interpretation of indicator trends

Whilst the available data indicates that the trend of blanket peat extent is stable, this needs careful interpretation as it is mainly based on a single estimation in time for the National Soils database, while the Countryside Survey is not sensitive enough to pick out any small changes. However, we can be confident that there is not a major change.

We can be more confident of the decreasing trend in raised bog extent as these land forms have been more regularly assessed. The decreasing trend in peatland condition is difficult to quantify precisely due to lack of consistent appraisal methods and detailed survey in non-designated areas. Nevertheless it is a consistent theme in numerous publications and has been positively indicated in the Countryside Survey.

## Limitations

At the broad scale, changes in peatland extent and condition are difficult to assess and will depend upon the methodology, including the scale of operation. Any change in methodology or definition, for either peatland extent or condition, is likely to result in a change in the parameter, which may be largely apparent and not real. At the local scale, changes can more easily be recognised, whether it is areas gained by restoration or areas lost, e.g., to development. The future bioclimatic envelope predictions are based on the assumption that current (UK) peatlands represent the extent of functional peat under the current climate; this may not be the case. Climate changes may have already impacted peat viability in some regions or conversely peatland extent should be greater but for anthropogenic impacts.

## References

Artz, R.R.E., Donnelly, D., Cuthbert, A., Evans, C., Smart, S., Reed, M., Kenter, J. & Clark, J. (2012) *Restoration of lowland raised bogs in Scotland: Emissions savings and implications of a changing climate on lowland raised bog condition*. Scottish Wildlife Trust.

Artz, R.R.E., Donnelly, D., Andersen, R., Mitchell, R., Chapman, S.J., Smith, J., Smith, P., Cummins, R., Balana, B. & Cuthbert, A. (2014) *Managing and restoring blanket bog to benefit biodiversity and carbon balance - a scoping study*. Scottish Natural Heritage Commissioned Report No.562. 2014. Scottish Natural Heritage.

Bain, C.G., Bonn, A., Stoneman, R., Chapman, S., Coupar, A., Evans, M., Gearey, B., Howat, M., Joosten, H., Keenleyside, C., Labadz, J., Lindsay, R., Littlewood, N., Lunt, P., Miller, C., Moxey, A., Orr, H., Reed, M., Smith, P., Swales, V., Thompson, D.B.A., Thompson, P.S., Van de Noort, R., Wilson, J.D. & Worrall, F. (2011) *IUCN UK Commission of Inquiry on Peatlands*. Edinburgh, IUCN UK Peatland Programme.

Bruneau, P. & Johnson, S.M. (2014) *Scotland's peatland - definitions & information resources*. Commissioned Report No. 701. Scottish Natural Heritage.

Chapman, S.J., Bell, J., Donnelly, D., Lilly, A. (2009) Carbon stocks in Scottish peatlands. *Soil Use and Management* 25, 105-112.

Chapman, S., Artz, R. & Donnelly, D. (2012) *Carbon Savings from Peat Restoration*. ClimateXChange

enquiry number 1205-02, 1-17. Edinburgh, ClimateXChange.

Clark, J., Gallego-Sala, A., V, Allott, T., Chapman, S., Farewell, T., Freeman, C., House, J., I, Orr, H., Prentice, I. & Smith, P. (2010) Assessing the vulnerability of blanket peat to climate change using an ensemble of statistical bioclimatic envelope models. *Climate Research* 45, 131-150.

Lindsay, R.A. & Immirzi, C.P. (1996) *An inventory of lowland raised bogs in Great Britain*. Scottish Natural Heritage Research, Survey and Monitoring Report No. 78. Edinburgh, Scottish Natural Heritage.

Norton, L.R., Murphy, J., Reynolds, B., Marks, S. & Mackey, E.C. (2009) *Countryside Survey: Scotland Results from 2007*. CEH Project Number: C03259, 1-83. NERC/Centre for Ecology & Hydrology, The Scottish Government, Scottish Natural Heritage.

### Further information

Case study: Lowland raised bog at Blawhorn Moss National Nature Reserve, Central Scotland  
<https://weadapt.org/placemarks/maps/view/920>

Lindsay, R. (2010) *Peatlands and carbon: A critical synthesis*. RSPB Scotland.  
[http://www.rspb.org.uk/Images/Peatbogs\\_and\\_carbon\\_tcm9-255200.pdf](http://www.rspb.org.uk/Images/Peatbogs_and_carbon_tcm9-255200.pdf)

Strack, M. (2008) *Peatlands and Climate Change*. International Peat Society, Jyväskylä.  
<http://www.peatsociety.org/sites/default/files/files/PeatlandsandClimateChangeBookIPS2008.pdf>

### Acknowledgements

Primary author of this document: Steve Chapman (James Hutton Institute)

Rebekka Artz (James Hutton Institute)

Scottish Natural Heritage

## Appendix One: Indicator metadata and methodology

**Table 1: Indicator metadata**

	Metadata
<b>Title of the indicator</b>	Extent of key habitats: deep peat
<b>Indicator contact:</b> Organisation or individual/s responsible for the indicator	Anna Moss (CXC/ University of Dundee)
<b>Indicator data source</b>	Extent: Hutton Institute 1:250,000 scale National Soils Data Condition: Artz et al. (2014)
<b>Data link:</b> URL for retrieving the indicator primary indicator data.	<a href="http://www.macaulayscientific.com/gis2_dataset_1a.php">www.macaulayscientific.com/gis2_dataset_1a.php</a> <a href="http://www.snh.org.uk/pdfs/publications/commissioned_reports/562.pdf">www.snh.org.uk/pdfs/publications/commissioned_reports/562.pdf</a>

**Table 2: Indicator data**

	Indicator data
<b>Temporal coverage:</b> Start and end dates, identifying any significant data gaps.	Soil maps showing peat are at a single time point (1982) though data was gathered prior to that. Condition is as at 2014 but based on various prior assessments.
<b>Frequency of updates:</b> Planned or potential updates	None planned for peatland extent but condition mapping is ongoing project.
<b>Spatial coverage:</b> Maximum area for which data is available	Scotland
<b>Uncertainties:</b> Uncertainty issues arising from e.g. data collection, aggregation of data, data gaps	National peat mapping has low resolution; some finer scale mapping exists for some areas. Condition assessments have been largely confined to designated areas and extrapolations made to the national extent.
<b>Spatial resolution:</b> Scale/unit for which data is collected	1:250,000 for peat extent
<b>Categorical resolution:</b> Potential for disaggregation of data into categories	Difficult to go beyond blanket bog vs raised (valley) bog though potential exists for categorisation based upon vegetation classes.

<b>Data accessibility:</b> Restrictions on usage, relevant terms & conditions	Publicly available, free of charge
---	------------------------------------

**Table 3 Contributing data sources**

<b>Contributing data sources</b>
Data sets used to create the indicator data, the organisation responsible for them and any URLs which provide access to the data.
<p>Future active peatland maps (Clark et al. 2010) use projected climate data from UKCIP02. Countryside Survey results (Norton et al. 2009) were obtained from: <a href="http://www.countrysidesurvey.org.uk/sites/default/files/pdfs/reports2007/scotland2007/CS-Scotland-Results2007-Chapter07.pdf">www.countrysidesurvey.org.uk/sites/default/files/pdfs/reports2007/scotland2007/CS-Scotland-Results2007-Chapter07.pdf</a></p>

**Table 4 Indicator methodology**

<b>Indicator methodology</b>
The methodology used to create the indicator data
<ul style="list-style-type: none"> <li>• Peatland extent was determined by interrogating the National Soils Data within a GSI environment</li> <li>• Trends in extent were gauged from the Countryside Survey Report (Norton et al., 2007)</li> <li>• Peatland condition could only be assessed semi-quantitatively from a synthesis of information based upon vegetative cover (LCS88), erosion extent as indicated within the National Soils Data, extrapolation from site condition monitoring within designated areas, GIS overlays of forestry, improved grazing, arable land, peat cuttings, renewal energy developments, etc.</li> </ul>