Indicators and trends

Monitoring climate change adaptation

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Indicator name				Version
NB13 Condition of key habitats: Area of modified deep peat soils				**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

- Deep peat represent a very significant carbon store- even small changes in this carbon store (a 1% loss) become comparable to other major carbon fluxes.
- Significant negative changes to peatland areas are currently due to management for agriculture and game, wildfire, commercial forestry, domestic and commercial peat harvesting and losses to wind farm construction.
- Projected changes in Scotland's climate are likely to create increased pressure on peatland, increasing the importance of limiting land management activities which act to decrease the condition of these soils
- Areas of drained and afforested peatland are being restored under the Peatland Action Plan and the Scottish Rural Development Programme, but the process of restoration will take time to bring about a permanent change, measured in anything from several years to several decades.

Latest Figure		**Trend**
Area		**Trend**
a) Cultivated	3.6 kha	Not known, but change unlikely
b) Intensive grassland	43.9 kha	Not known
c) Drained	732 kha	Some decrease as drain blocking is part of ongoing peatland restoration programmes
d) Regularly burnt	43.1 kha	Not known- though there are restrictions that apply to managed burning in deep peat areas
e) Afforested	235 kha	Some decrease as tree removal is part of ongoing peatland restoration programmes
f) Bare (no vegetation)	268 kha	Not known, some decrease as areas undergo restoration (though currently little bare peat restoration has occurred) but could be balanced

	by increasing erosion in others
g) Under extraction 3.0 kha	This figure is based on data from 1988 (Scottish Government, 1988); it will have decreased and may now be less than a third of this, though there has been resurgence in some areas
a), b), c), e) and f) from Chapman et al. (2012) but with a correction to e) (Artz, pers. comm.) d) and g) based on Artz et al. (2014). Note that areas are not mutually exclusive, e.g. areas may be both drained and burnt.	

Why is this indicator important?

Deep peat (soils having an organic layer >50 cm deep) represents a very significant carbon store, estimated at 1620 Mt C and 56% of the total soil C stock (Chapman et al., 2009). By comparison, there is about 48 Mt C in plants, including trees, while Scotland's yearly total carbon dioxide emissions are about 14 Mt C. Hence even small changes in this carbon store, say a 1% loss, become comparable to other major carbon fluxes. An additional 957 Mt C are found within organo-mineral soils (soils having an organic layer <50 cm deep). While these do not fall within the definition of 'deep peat', they often carry peatland vegetation or lie adjacent to, or intermixed with, areas of deep peat.

The main threat for release of carbon from peatlands arises from degradation of these soils due to factors like erosion, drainage, fire, afforestation, over-grazing, pollution and peat extraction. While land management is often at the root of these factors, this degradation can also be a 'natural 'process impacted to some extent by more recent shifts in climate.

Peatlands are likely to be negatively impacted by a warmer climate but more importantly by a climate in which drought conditions are more frequent.

Peatlands are under a number of pressures from various land uses, each of which may decrease the carbon stock, though some much more than others. None of the pressures identified specifically within this indicator will carry active peatland vegetation that is capable of sequestering carbon[1]. In addition, unmodified areas in poor condition may be either carbon neutral, or, as condition worsens, can be losing carbon at increasing rates through the direct oxidation of peat organic matter to the atmosphere, increased ecosystem respiration, increased methane emissions, or through the loss of peat material as both DOC (dissolved organic carbon) and POC (particulate organic carbon) carried away by streams and rivers. In dry conditions, peat as POC may be carried away by the wind. Once translocated by these means, the majority of this carbon will also oxidize to carbon dioxide.

The condition of Scotland's deep peat reserves is an indicator of whether changes in the total peat carbon stock may be occurring. Areas in good condition may be continuing to sequester carbon, as they have done for millennia, however, condition outwith designated areas is poorly known.

Projected changes in Scotland's climate are likely to create increased pressure on peatland, increasing the importance of limiting land management activities which act to decrease the condition of these soils. This indicator is therefore based on specific modifications to deep peat soils.

Related indicators:

[1] There might be some debate over peatlands subject to periodic light or 'cool' burning. Some authorities claim that such burning may be beneficial in some cases. However, the greater consensus is that it will tend to C loss, though this is based on few hard data.

NB11 Extent of key habitats: deep peat
NB18 Annual greenhouse gas (GHG) emissions from degraded peatlands
NB22a Peatland restoration area

What is happening now?

Currently, the most significant changes to peatland areas are the areas drained and lost to wind farm construction and the areas of drained and afforested peatland that are being restored under the Peatland Action Plan and under the new Scottish Rural Development Programme. Commercial peat harvesting operations are increasing in some areas under their licence agreements.

Attention is now being given to eroded peatland but this is a relatively new development, though it follows on from the considerable developments in restoration techniques over the last 10 years. It should be noted that the process of restoration will take time to bring about a permanent change, measured in anything from several years to several decades.

2015 sees the launch of Scotland's National Peatland Plan with the principle aim to 'manage, protect and restore peatlands to maintain their natural functions, biodiversity and benefits' (SNH, 2014).

What has happened in the past?

Clearly at one time peatlands were net accumulators of carbon, including those now under the pressures a) to g) listed above. Most of these pressures are relatively recent phenomena, given that peatland formation was initiated 5,000 to 10,000 years ago.

- Attempts to cultivate peatland were made in the eighteenth and nineteenth centuries but with little success; most of the areas now cultivated or used intensively were probably done so in the second half of the twentieth century. About this time an active programme of drainage began, funded by readily-available grants but these came to an abrupt end and there has been little further drainage (gripping) in the last thirty years.
- Management burning has probably always occurred to varying degrees in the past but took off intensively during the nineteenth century when grouse shooting became popular. This decreased considerably in the north and west of Scotland in the 1940s but continues in the south and east. Burning has also been used routinely to improve grazing, particularly for sheep, throughout the last 200 years.
- Wildfires, which can occur during drought periods and perhaps increase in frequency when drought periods coincide with the prescribed management burning period, can have significant impacts on peat condition and peatland vegetation with implications for ecosystem functionality and carbon balance.
- Afforestation of peatland began in earnest in the 1950s, particularly in south-west Scotland and continued until the 1980s, infamously in the Flow Country.
- While peat erosion is exacerbated by current land management, it may also be a 'natural' process, impacted to some extent by more recent shifts in climate. It is not really known when serious erosion began but there are sites that are over 400 years old. However, many contemporary actively eroding hagg and gully systems may have been instigated by draining and burning in the recent past.
- Commercial peat extraction only took off in the early twentieth century when suitable harvesting machines were invented; however, peat cutting by hand has long been practiced, dating back to at least Roman times.

What is projected to happen in the future?

Without intervention, peatlands will continue to deteriorate.

- Any cultivated deep peat is likely to remain so but areas under intensive grazing will possibly decrease through abandonment and reversion to rough grazing, though deer and goat impact could still remain very high in some areas.
- 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. The drainage of peatland will continue where infrastructure is installed. Drains can also instigate erosion and the direct loss of peat.
- Burning of blanket bog contravenes the Muirburn Code (Scottish Government, 2011) and should not occur unless heather constitutes more than 75% of the vegetation. However, some landowners are not fully aware of what may constitute moorland and what may be blanket bog vegetation. A better understanding of the processes involved during burning will help the development of the Muirburn Code to reduce the risk of severe damage. There is some debate regarding the concern that resulting fuel load (vegetation) build up may increase risk of severe wildfires.
- It is no longer practice to afforest deep peat but deep peat which is already afforested 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.
- Peat erosion, possibly instigated and exacerbated by various other factors, is likely to continue and expand. Additionally, climate change may accelerate the loss processes.
- 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.

Notwithstanding the above, we would expect to see a continued reduction in the areas suffering from drainage, erosion and afforestation through ongoing programmes of peatland restoration and the Peatland Plan.

Patterns of change

Patterns of change are difficult to delineate across the country as sufficient detailed information is currently unavailable. Some data may exist, e.g. in IACS or other sources, that could be mined but this would require further detailed examination.

Interpretation of indicator trends

Indicator trends are very much ‘trends’ and not known with any degree of precision. Changes in afforestation are likely to be best known as forest data is regularly compiled by the Forestry Commission. Other trends might be more properly described as a ‘best guess’ as accurate data is not available.

Limitations

None of the areas given above for categories a) to g) are known with any real certainty and some are based on assessments made over thirty years ago.

- The area of cultivated peat is quite minor and much less than that found in England. This is because, while most of the English cultivated peatlands are fertile fens, fens are quite rare in Scotland and bogs, either blanket or valley, are naturally nutrient-poor and acidic, and much more difficult to cultivate.
- The area under intensive grazing, though larger, for similar reasons is not that extensive due to the effort required in raising the nutrient status. However, although upland livestock stocking densities may be lower they are often in combination with high deer and or goat numbers so grazing impact can be significant.
- The area under drainage is not known with any certainty as the drainage intensity across Scotland has never been systematically appraised. Even where the presence of drains has been identified, their impact, which will depend upon distance between drains, drain depth, maintenance and the nature of the peat, will not be known.
- The area regularly burnt is known to be very much under-estimated. The estimate is made from observation (LCS88) of recently burnt areas. Hence much depends on the definition of 'regularly' (every 5, 10, 20 years?) and on how long visible burns remain after burning. There is also a suggestion that 'strip' burning for grouse (seen predominantly in the centre and east of Scotland) is more visible than more widespread burning for sheep (practiced more in the west of Scotland).
- The area of peatland that is under afforestation is probably the most accurately known, being based on Forestry Commission records.
- The area of bare peat is estimated from extent of erosion (presence of erosion features) as determined during the Scottish Soil Survey, published in 1982 at 1:250,000. While some follow-up estimates do agree approximately (see Cummins et al., 2011), again a systematic country-wide determination of the intensity of erosion has not been made. The figure given is very much an over-estimate as it actually refers to the area affected by erosion; not all this will be bare as such.
- The area under extraction refers only to commercial extraction. There is a largely unknown area of domestic cutting, the intensity of which varies from year to year; the LCS88 gave the area affected as 53.8 kha but this is not the area cut in any one year. Such areas are difficult to assess as usually they are rapidly revegetated if best practice is followed during the hand cutting process.

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Acknowledgements

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Appendix One: Indicator metadata and methodology

Table 1: Indicator metadata

	Metadata
Title of the indicator	Condition of key habitats: Area of modified deep peat soils
Indicator contact: Organisation or individual/s responsible for the indicator	Anna Moss (CXC/ University of Dundee)
Indicator data source	(Chapman et al., 2012) (Artz et al., 2014)
Data link: URL for retrieving the indicator primary indicator data.	http://www.climatexchange.org.uk/files/1513/7339/0076/Carbon_savings_from_peat_restoration.pdf http://www.snh.org.uk/pdfs/publications/commissioned_reports/562.pdf

Table 2: Indicator data

	Indicator data
Temporal coverage: Start and end dates, identifying any significant data gaps.	Dates are variable, going from the present back to data based upon the LCS88 (Scottish Government, 1988).
Frequency of updates: Planned or potential updates	None specifically planned. However, we would hope ongoing work, particularly that using remote sensing, would enable better estimates.
Spatial coverage: Maximum area for which data is available	Scotland
Uncertainties: Uncertainty issues arising from e.g. data collection, aggregation of data, data gaps	National peat mapping, which delineates where peatland occurs, has low resolution.
Spatial resolution: Scale/unit for which data is collected	1:250,000 for peatland occurrence. Resolution for various pressures varies, depending upon data collection.
Categorical resolution: Potential for disaggregation of data into categories	Disaggregation into blanket vs valley bog should be possible. Potentially afforestation could be disaggregated into tree species though the benefit is unclear. Erosion could potentially be

	disaggregated into erosion types but data for this is currently not available. Peat extraction may be disaggregated into commercial and domestic though good data for the latter is lacking.
Data accessibility: Restrictions on usage, relevant terms & conditions	Publicly available, free of charge

Table 3 Contributing data sources

Contributing data sources Data sets used to create the indicator data, the organisation responsible for them and any URLs which provide access to the data.
None

Table 4 Indicator methodology

Indicator methodology The methodology used to create the indicator data
• Peatland extent was determined by interrogating the National Soils Data within a GSI environment. • Peatland under the various pressures 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, presence of burning, etc.