

Indicator name			Version
NF16 Proportion of coniferous woodland on the National Forest Estate with a high/medium-high risk of wind throw			27/03/16
Indicator type:	Risk/opportunity	Impact	Action
	X		
SCCAP Theme	SCCAP Objective	CCRA risk/opportunity	
Natural Environment	N3: Sustain and enhance the benefits, goods and services that the natural environment provides	FO3: Windthrow and storm damage	
At a glance			
<ul style="list-style-type: none"> • Forests in the UK are already significantly impacted by wind damage • Scotland has the highest percentage of forest cover in the UK and contains some of the windiest areas • The impact of climate change on future wind risk is uncertain but is likely to increase due to more frequent severe storms and wetter soils in winter • This indicator uses knowledge about current levels of windiness and the latest information on the National Forest Estate to show the extent of forest with a significant risk from wind throw • Wind risk is calculated using Forest Research's decision support tool ForestGALES 			
Latest Figure		Trend	
In 2010, 8.7% of the planted conifer forest on the National Forest Estate was at medium-high to high risk of wind throw. The area of forest at risk is low considering Scotland's high wind risk.			
Why is this indicator important?			
<p>Wind throw can cause significant damage to woodland through uprooting and snapping of stems. Scotland contains some of the windiest areas of the UK (Quine <i>et al.</i>, 2005) and the highest percentage of forest cover (Forestry Commission, 2014). Wind throw is an important factor for forest management, and the UK already experiences significant impacts from wind damage. It influences the tree species planted and management practices, including felling age and thinning regimes (Mason <i>et al.</i>, 2013).</p> <p>This indicator was chosen as it uses current knowledge about the level of windiness across Scotland and latest information on the extent and composition of the National Forest Estate in Scotland to show the extent of coniferous woodland which has a significant risk from wind throw. The indicator will be used to show how wind throw risk is changing in response to changing woodland cover, species composition, and management practices.</p> <p>Wind risk is calculated using ForestGALES, Forest Research's decision support tool (Gardiner <i>et al.</i>, 2004). ForestGALES calculates wind risk using measured windiness values (Detailed Aspect Method of</p>			

Scoring, DAMS), soil type, tree species, age, management type, modelled growth rate (calculated from temperature and moisture regime, and standard yield class models). ForestGALES requires detailed information about forest management and site conditions, therefore this indicator can only be applied to public sector forests at the national scale, where such information is available.

Wind risk and storm frequency, like other extreme events, are hard to predict and to model, therefore wind risk projections need to be interpreted with caution.

Related indicators:

NF21 Number of uses and users of the ForestGALES decision support tool

What is happening now?

In 2010, 8.7% of the planted conifer forest on the National Forest Estate was at medium-high to high risk of wind throw, categorised as class 5 or 6 as assessed by the ForestGALES model (Table 1). The area of forest at risk is low considering Scotland’s high wind risk.

Wind risk is taken into account when the felling age of a forest stand is determined, typically around 50 years of age. Wind risk also impacts stand management, such as thinning practices. In the West of Scotland where wind risk is the highest, stands are either not thinned, or planted in self-thinning mixtures. As strong winds impact the growth rate, form and timber value of a forest, productive stands aren’t typically planted in very windy areas.

Current wind risk models are thought to over-estimate wind risk, and revised models are likely to further reduce the forest area at medium-high to high risk.

Table 1. Wind Risk on the National Forest Estate (data from 2010)

Wind Risk for Scotland’s National Forest Estate (2010)	
Data	Area/Percentage
Area of Planted Conifer Forest (Hectares)	399,982
Area of Planted Conifer Forest at Medium-High to High Wind Risk (Hectares)	34,790
Percentage of Conifer Forest at Medium-High to High Wind Risk	8.7%

What has happened in the past?

What is projected to happen in the future?

The impact of climate change on future wind risk is uncertain, and projections are not included in all future climate datasets (such as UKCP09). Wind risk is likely to increase as a result of climate change, as the frequency of severe storms is projected to increase globally, however regional trends are unclear (UKCP, 2010).

Forest stands in wetter soils have a higher wind risk, and projected changes in rainfall distribution may increase wind risk in wetter winter months (Gardiner *et al.*, 2013).

Wind risk increases with tree height, and an increased growth rate as a result of the higher temperatures associated with climate change may mean forest stands reach an unacceptable level of risk at a younger age. Tree slenderness (height to diameter ratio) also changes the degree of wind risk, although the impact of a changing climate on tree form is uncertain.

Patterns of change

Figure 1 shows the variation in wind risk on the National Forest Estate across Scotland as determined by the ForestGALES model (version 3). Regions in the east of Scotland are showing as having a higher proportion of forest area under medium-high or high wind risk. This trend is different to expected, as the west of Scotland experiences windier conditions than the east (Quine *et al.*, 2005). This difference may be due to the higher proportion of mature stands in the east of Scotland; there is some evidence that the wind risk to very mature stands is lower than predicted by current models. Management practices also differ between the regions, and forests in the west of Scotland are typically managed under no –thin regimes and are harvested earlier in order to reduce the wind risk.

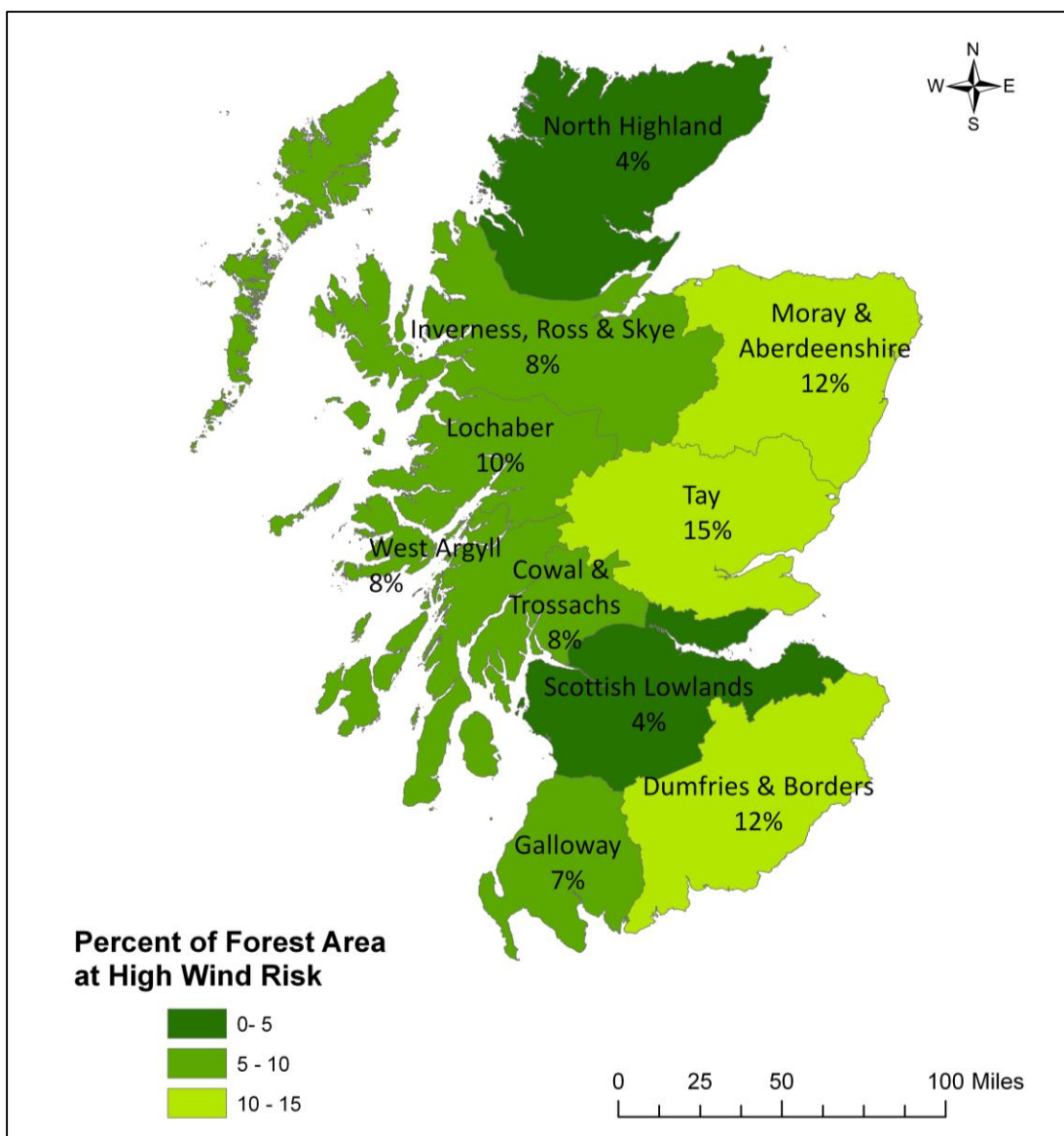


Figure 1. Percentage of conifer forest on the National Forest Estate at medium-high to high wind risk. Forestry Commission Scotland Districts. Data from 2010 using ForestGALES version 3.0.

Interpretation of indicator trends

The proportion of forest area at medium-high to high wind risk on the National Forest Estate in Scotland is quite low, as forest stands are actively managed for wind risk. It is also thought that current models over-estimate wind risk, and that the overall wind risk is lower. There is some evidence that wind risk management in the east of Scotland may need to increase, however it is not clear if the higher proportions of forest area at risk in the east of Scotland are due to the presence of mature stands where the wind risk is over predicted.

Changes to wind risk as a result of climate change can't be accurately predicted using future climate models, but the risk is likely to increase with wetter soil conditions and faster growing stands.

Limitations

The dataset is from 2010, which is the most recent data for wind risk calculations for the whole of Scotland. An updated data set will be available in 2015. It is thought that the updated ForestGALES model will provide less pessimistic estimates of wind risk.

District boundaries have changed since 2010, and the data have been presented according to current management boundaries.

ForestGALES calculates wind risk using modelled growth rate (calculated from temperature and moisture regime and standard yield class models) rather than measured values which introduces a source of error to the data. The national soil maps are at a lower resolution than recommended for individual stand management, which also may result in inaccuracies, especially in regions where maps are less detailed.

No models are available for broadleaf species or less common conifer species. Where models are not available for a conifer, parameters for a similar species are used. There is a known error for lodgepole pine, where models are over predicting wind risk.

References

Forestry Commission (2014) *Forestry Facts and Figures*. Available at:

www.forestry.gov.uk/forestry/infd-7aqf6j

Gardiner B, A., Suarez. J., Achim, A., Hale, S.E., and Nicoll B.C., (2004) *ForestGALES 2 – A PC-based wind risk model for British forests. User Guide*. Forestry Commission, Edinburgh.

Gardiner, B., Schuck, A., Schelhaas, M-J., Orazio, C., Blennow, K. and Nicoll, B. (Eds.), (2013) *Living with Storm Damage to Forests: What Science Can Tell Us 3*. European Forest Institute.

Mason, W., and Vallinger, E., (2013) Managing forests to reduce storm damage. In: Gardiner B, Schuck, A., Schelhaas, M-J., Orazio, C., Blennow, K. and Nicoll, B. (Eds.), *Living with Storm Damage to Forests: What Science Can Tell Us 3*. European Forest Institute.

Quine, C. P., Coutts, M., Gardiner, B. and Pyatt, G. (1995) *Forests and wind: Management to minimise damage*. Forestry Commission Bulletin 114. HMSO, London.

UKCP (2010) *UKCP09: Probabilistic projections of wind speed*. Available at:
<http://ukclimateprojections.metoffice.gov.uk/media.jsp?mediaid=87845&filetype=pdf>

Further information

Forest Research:

ForestGALES <http://www.forestry.gov.uk/fr/INFD-5V8JC8>

Acknowledgements

Forest Research (Kate Beauchamp, Stephen Bathgate and Bruce Nicoll, Sophie Hale, Stefania Pizzirani).

Appendix One: Indicator metadata and methodology

Table 1: Indicator metadata

	Metadata
Title of the indicator	Proportion of coniferous woodland on the national forest estate with a high or medium-high risk of wind throw
Indicator contact: Organisation or individual/s responsible for the indicator	Ruth Monfries, RBGE
Indicator data source	Forest Research
Data link: URL for retrieving the indicator primary indicator data.	Contact Forest Research

Table 2: Indicator data

	Indicator data
Temporal coverage: Start and end dates, identifying any significant data gaps.	2010
Frequency of updates: Planned or potential updates	Updated data sets are likely to be available at approximately 5 yearly intervals
Spatial coverage: Maximum area for which data is available	Scotland
Uncertainties: Uncertainty issues arising from e.g. data collection, aggregation of data, data gaps	The SCDB is regularly updated, however there may be some discrepancies due to its large size. The dataset is from 2010. Models for Lodgepole pine are over predicting wind risk. No models are available for broadleaf species. Where models are not available for a conifer, parameters for a similar species are used.
Spatial resolution: Scale/unit for which data is collected	Forest compartment
Categorical resolution: Potential for disaggregation of data into categories	Tree species, Forestry Commission Scotland District
Data accessibility: Restrictions on usage, relevant terms & conditions	

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.
Forestry Commission Sub-Compartment Database (SCDB) http://www.forestry.gov.uk/datadownload For methodology see http://www.forestry.gov.uk/pdf/FCOASSCDB.pdf/\$file/FCOASSCDB.pdf Forest Research model: Forest Gales http://www.eforestry.gov.uk/forestdss

Table 4 Indicator methodology

Indicator methodology
The methodology used to create the indicator data
Data for tree species, age, management type and location for each sub compartment are taken from the forestry Commission Sub Compartment Database and entered into ForestGales, along with height, slenderness and yield class estimations calculated from moisture deficit and accumulated temperature based on a grid reference through the Forestry Commission's Ecological Site Classification (ESC) and Forestry Commission growth models.
ForestGALES calculates a current probabilistic wind risk for each sub compartment. Wind risk scores range from 0-6, with 0 low risk and 6 the highest risk. Stands with scores of 5 and 6 can be considered high risk. These are summed for Scotland and grouped for each district.
Compartments for which wind risk data are not available were excluded.
Stefania Pizzirani, Forest Research, collated the Sub Compartment database. Stephen Bathgate, Forest Research, processed the data through the ESC and ForestGALES models, and holds copies of the data. Kate Beauchamp, Forest Research, carried out the data analysis.