Indicators and trends

Monitoring climate change adaptation

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Indicator name			
NF9 Forest extent affected by *Dothistroma* needle blight (DNB)			
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**	**FO1a Forest extent affected by *Dothistroma* needle blight (DNB)**

At a glance
• *Dothistroma* needle blight (DNB) has become the most significant disease affecting coniferous trees in the UK. • Climatic changes may optimise conditions for spore dispersal and infection. • The majority of DNB infected forestry is in the north and north east of Scotland, with over half of infected pine in the North Highland district.

Latest Figure	Trend
13722 ha/ 1661 sub-compartments[1] (National Forest Estate only) This represents approximately 15% of the total high forest pine area in the NFE.	Increasing Average annual increase of positive DNB sub-compartments of around 1% of total number surveyed (2006-13)

Why is this indicator important?

Forest pests and pathogens can cause extensive and catastrophic damage to productive forestry stocks. Affected woodlands may experience sufficiently severe outbreaks to reduce productivity, timber quality and/or to require changing forest management. The majority of insect pests that currently affect UK forestry are likely to benefit from climate change as a result of increased activity and reduced winter mortality. If climatic conditions influence the success of a pest or pathogen establishing, breeding and spreading, then a change in climatic conditions is likely to influence their prevalence and severity (Moffat et al., 2012). Other effects may be more indirect and result from increased susceptibility to infection due to damage or stress to the trees as a result of storms, drought or temperature extremes.

The fungal disease *Dothistroma* needle blight (DNB), often referred to as 'Red Band Needle Blight', has become the most significant disease affecting coniferous trees in the UK. The fungus affects the needles of the infected tree, which eventually shed. As this continues, year on year, gradually the tree will weaken, significantly reducing timber yields. It can also eventually lead to mortality. Whilst it was first recorded in the UK in the 1950s, it was not known in Scotland until 2002 and has now been identified in Corsican, Lodgepole and Scots pine stands (though primarily a disease of pines,

[1] Includes compartments which have been surveyed as positive for DNB either in the latest year or in an earlier year. Data provided by FCS Dec2013.

five spruce species, European larch and Douglas fir are also known to host the disease) (Forestry Commission, 2010).

This indicator monitors the abundance of DNB in the Forestry Commission Scotland National Forest Estate (NFE) which holds over 35% of Scotland's woodland. The indicator is based on DNB surveys which have taken place annually since 2006 to monitor the distribution and spread of the disease. Although the data covers the NFE only, changes in the abundance of DNB in these areas is likely to be indicative of DNB abundance across forestry in Scotland as a whole.

Related indicators:
NB36 Proportion/area of Caledonian pine woodland exposed to *Dothistroma* needle blight (DNB)
NF7 Proportion/area of pine woodland exposed to *Dothistroma* needle blight (DNB)

What is happening now?

The current extent of pine woodland in the NFE that is known to have been infected with DNB is 13722 ha. from 1661 infected sub-compartments (see Figure 1).

The impacts on timber yields are currently most severe on Corsican and Lodgepole pine (particularly those of 'Inland' origin), with trees infected by DNB becoming unmarketable over time (Forestry Commission Scotland 2013).

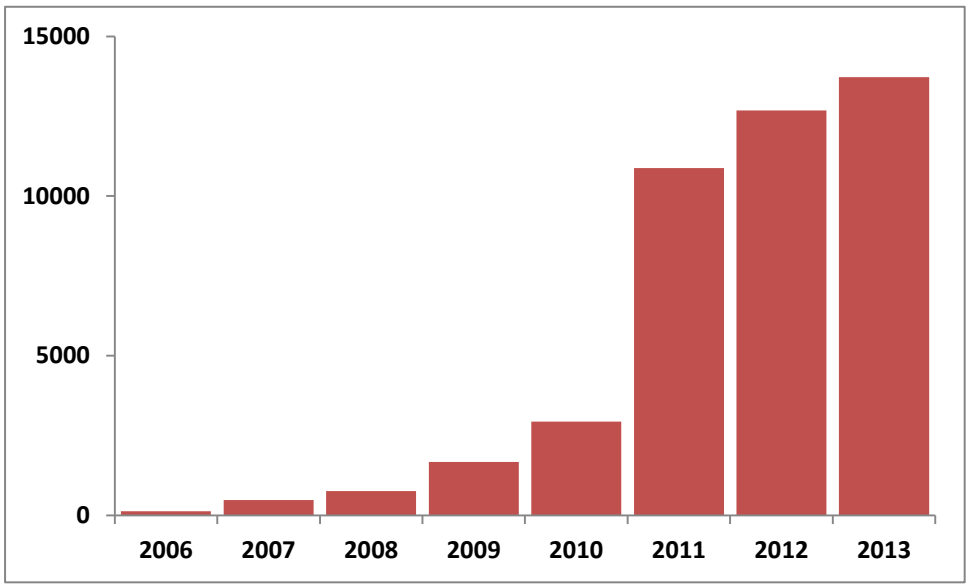

Figure 1 Total pine area (ha) in FCS sub-compartments with positive DNB survey results. Positive status is accumulative and therefore results include data for compartments which have been surveyed as positive for DNB either in the latest year or in an earlier. Data provided by FCS Dec 2013 (2013 data incomplete).

Due to changes in annual surveying effort over this period (most notably a significant increase in area surveyed between 2010-2011), it is important to consider the positive survey results as a proportion of *total* area surveyed. Figure 2 shows that over this period there has been an average annual increase of positive DNB sub-compartments of around 1% of total number surveyed, with the latest results showing that approximately 10% of all surveyed pine forestry in the NFE is positive for

DNB.

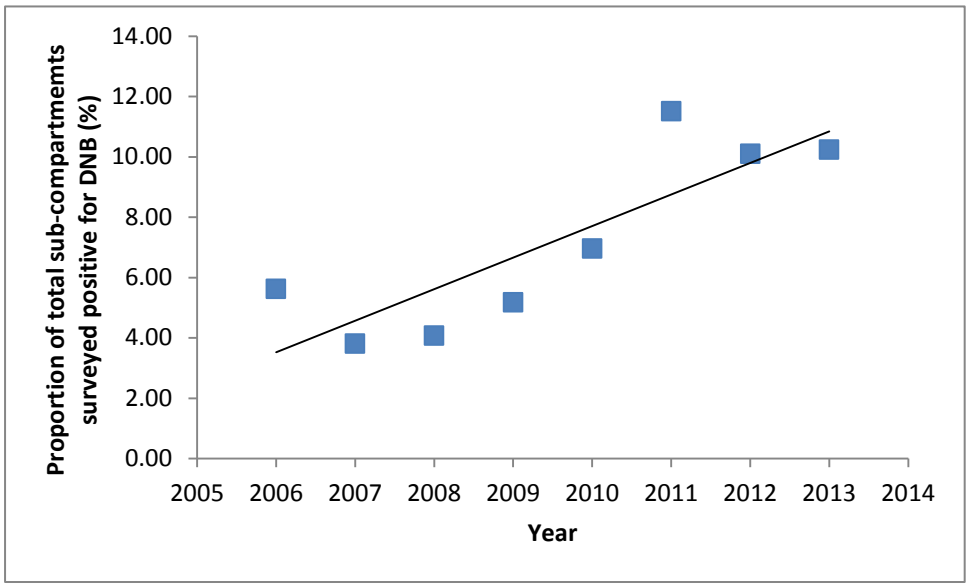

Figure 2 Proportion (%) of total (accumulative)sub-compartments surveyed which show a positive result for DNB (results for 2013 are incomplete).

What has happened in the past?

Whilst it was first recorded in the UK in the 1950s, it was not known in Scotland until 2002 and has now been identified in Corsican, Lodgepole and Scots pine stands (though primarily a disease of pines, five spruce species, European larch and Douglas fir are also known to host the disease) (Forestry Commission, 2010).

There has been a dramatic increase in identified infection since first detected in 2002, with the earliest available survey figures being from 2006 (see Figure 3 for comparison between 2007 and 2013).

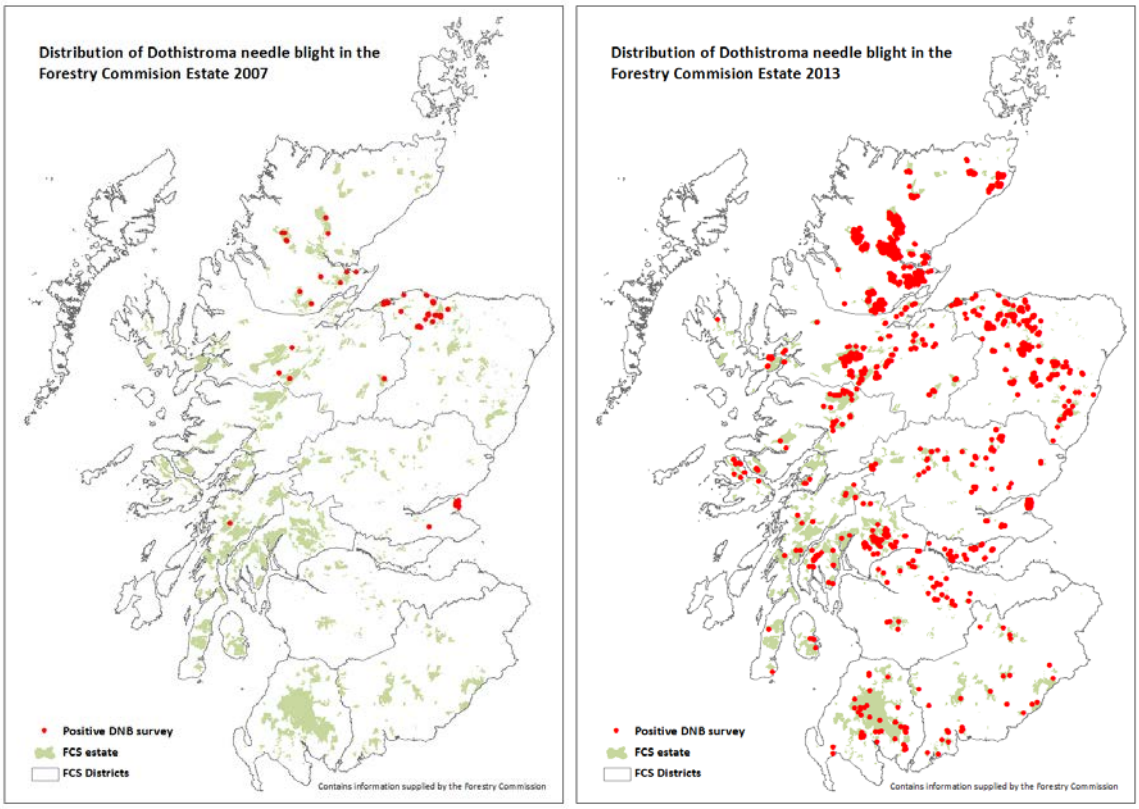

Figure 3 Distribution of *Dothistroma* needle blight in Forestry Commission Scotland National Forest Estate blocks, 2007 and 2013

What is projected to happen in the future?

Analysis for the Climate Change Risk Assessment for the Forestry Sector (Moffat *et al* 2012) indicated that potentially by the 2020s, between 12% to 25%[2] of pine forest area in the UK may be affected by DNB, with this figure rising to between 49% to 98%[3] in the 2050s and 100%[4] in the 2080s.

Projected increases in spring and summer rainfall, along with temperature increases are considered to be the key drivers for determining the prevalence of DNB (Brown and Webber, 2008). Regions with the highest mean summer temperatures, along with those areas with the greatest projected change in temperatures are likely to see the greatest change in the level of risk (Moffat *et al 2012*).

However, the basis of the response functions was associated with high uncertainty and further research is required to provide stronger evidence for future risk.

Limiting the spread and potential impact of DNB on Scottish forestry is being addressed by the FCS Dothistroma Needle Blight Action Plan, which is reviewed annually. As well as increasing awareness, research and detection effort, the action plan also covers preventative measures (e.g. destruction of infected plants in nurseries, buffer zones around Caledonian pinewoods), and the prioritisation of

[2] Estimated range of 11% to 98% for the p10 to p90 probability levels for the medium emissions scenario
[3] Estimated range of 11% to 100% for the p10 probability level low emissions scenario to the p90 probability level high emissions scenario
[4] Estimated range of 12% to 100% for the p10 probability level low emissions scenario to the p90 probability level high emissions scenario

felling infected stock (FCS, 2013). Increasing diversity in the forest stock is also believed to increase overall forest resilience to a wide number of potential risks as well as delaying or reducing the build-up of pests and diseases within a plantation (Brown & Claydon, 2012).

In 2011, the disease was found in Abernethy, an RSPB-owned native pinewood, bringing to the fore the threat to native pinewoods. Many of these areas have until recently had a poor regeneration record, and there is concern that impacts of DNB on young trees could further threaten the age class structure, and hence continuity of these woodland (Forestry Commission 2012). Mature pine in Caledonian pinewoods currently appear to be less susceptible to the disease but there is concern that this could change as there is considerable potential for genetic exchange due to the presence of two mating types, a high number of genotypes of *Dothistroma septosporum*, and the possible introduction of *D. pini*, which is responsible for DNB in North-Central America, Russia, Ukraine, France and Hungary (Forestry Commission Scotland 2013).

Patterns of change

The majority of DNB infected forestry is in the north and north east of Scotland, with over half of infected pine in the North Highland district (see Table 1 and Figure 4a). This distribution largely reflects the distribution of pine in general across Scotland.

Figure 4b highlights that over a third of all forestry surveyed in the North Highland district is now infected with DNB. However, the detected infection proportion does not show quite such a clear relationship with pine forestry distribution as Figure 4a, with the Scottish Lowlands having a relatively high proportion of infection (16.8%), though this district holds only approximately 2% of the National Forest Estate pine.

Table 1 Changing DNB distribution in FCS Forest Districts (area (ha) of surveyed FCS sub-compartments with positive DNB survey results). Table also provides 2013 figure for total pine area in each district. Positive status is accumulative and therefore results include data for compartments which have been surveyed as positive for DNB either in the latest year or in an earlier. Data provided by FCS Dec 2013, results for 2013 are incomplete.

	2013 total pine area (ha)*	DNB infected pine area (ha)							
		2006	2007	2008	2009	2010	2011	2012	2013
West Argyll	2964	0	0	2	5	46	50	107	168
Tay	10101	66	87	155	155	184	365	795	844
Moray & Aberdeenshire	16443	68	141	315	366	740	983	1090	1339
North Highland	23119	0	155	162	569	715	7715	8230	8365
Inverness, Ross & Skye	20156	0	98	111	434	984	1258	1588	1873
Lochaber	4634	0	0	14	14	87	124	225	247
Cowal & Trossachs	2628	0	0	0	129	154	213	274	291
Scottish Lowlands	1774	0	0	0	0	0	26	196	298
Galloway	5870	0	0	0	8	28	89	92	198
Dumfries & Borders	1914	0	0	0	0	3	48	83	97

* Total area of high forest pine (positive and negative for DNB)

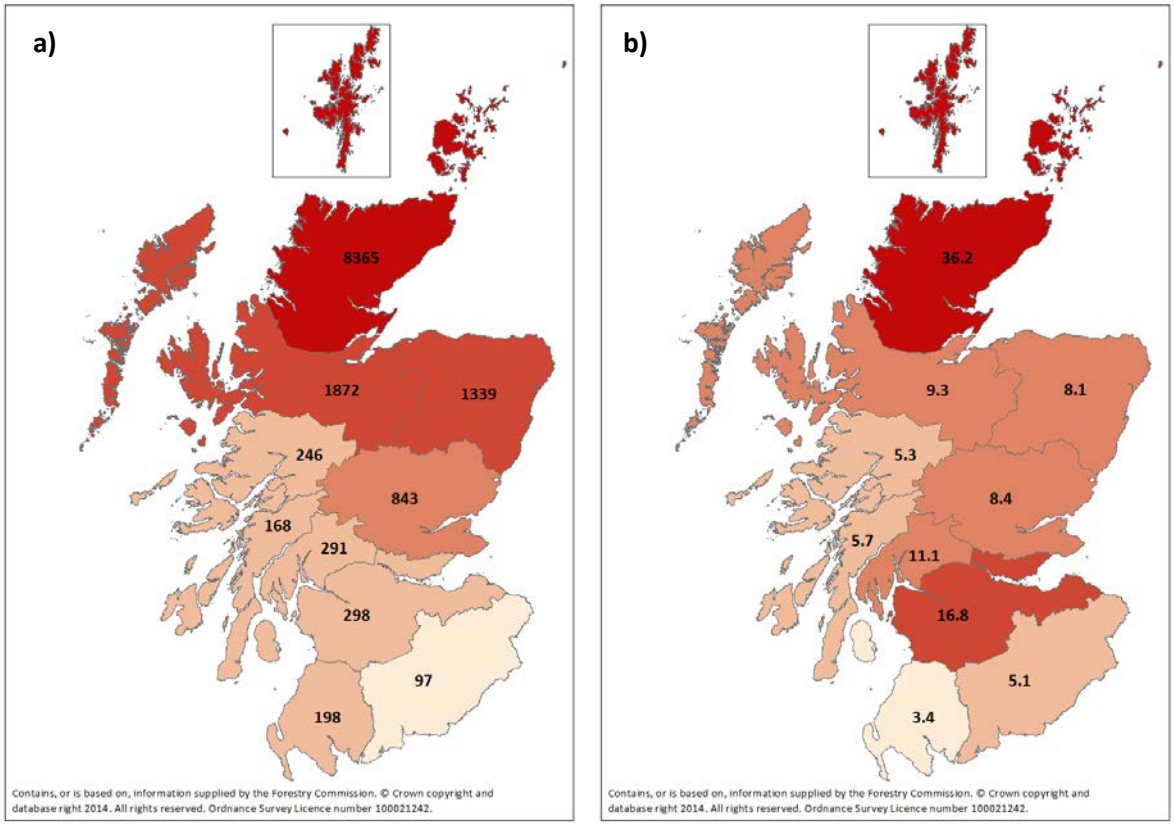

Figure 4 Comparison of extent of pine woodland containing DNB in Forestry Commission districts: a) Total pine area (ha) in FCS sub-compartments with positive DNB survey results (2006-13); b) Proportion (%) of total pine area surveyed with positive DNB survey results (2006-13)

Interpretation of indicator trends

Whilst reasons for the increase in the disease are presently unclear, there is some evidence to suggest that increased rainfall in spring and summer coupled with a trend towards warmer springs is optimising conditions for spore dispersal and infection (Brown and Webber, 2008).

The increase in geographic extent and intensity of the disease across the whole of Britain is probably due to a combination of factors including an increase in favourable climatic conditions, as well as availability of suitable hosts, a genetically diverse fungal population, and movement of the pathogen through the plant trade.

The survey methodology targets priority areas, and survey effort has varied considerably over the period (Figure 5). There was a significant increase in 2011 in the amount of forestry included in the annual survey, with 2012 also maintaining this extent (NB the data presented here for 2013 does not represent the full data for the year).

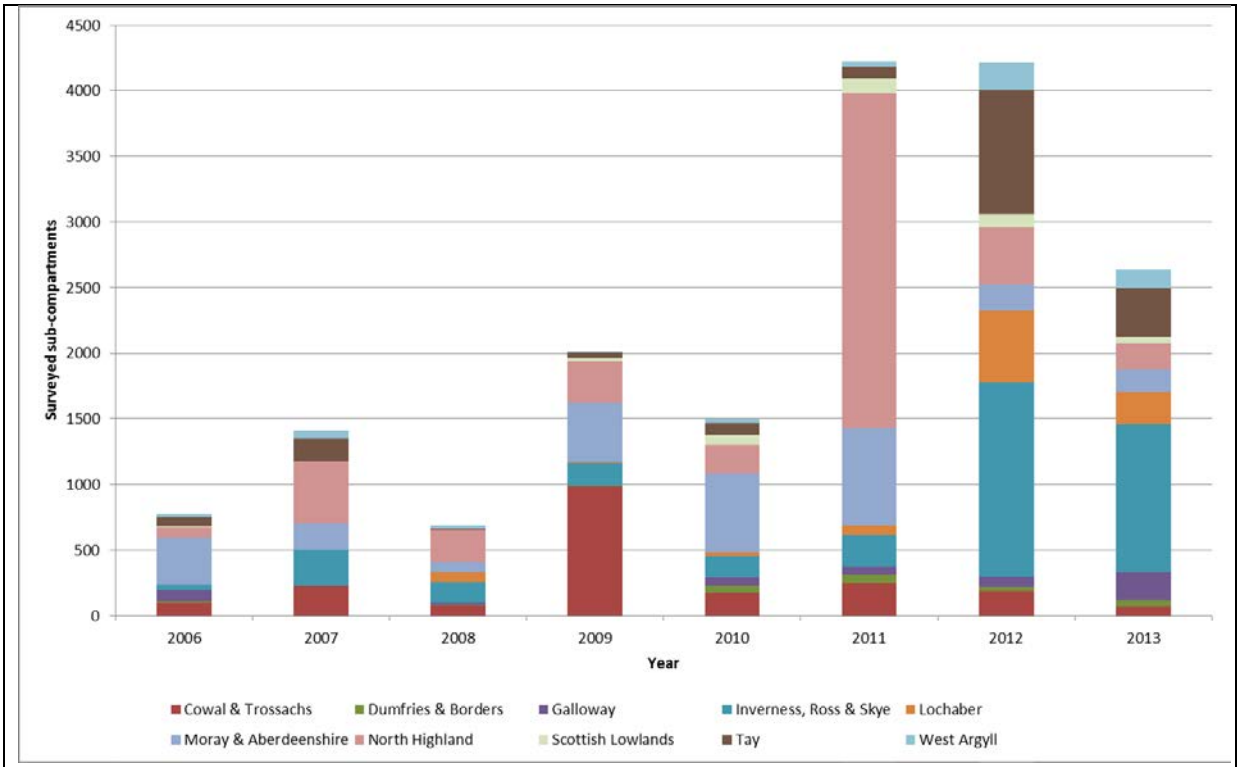

Figure 5 Annual DNB survey extent (number of sub-compartments surveyed) in the National Forest Estate forestry districts 2006-13.

Limitations

- Data covers FCS National Forest Estate only, however, changes in the abundance of DNB in this forestry is likely to be indicative of DNB abundance across Scotland.
- Survey effort has varied considerably over the period.
- The survey methodology targets priority areas, therefore positive results should not be seen as a random subset of the National Forest Estate.
- Positive survey results are applied to the whole sub-compartment, though detection may only have been at the edge of a sub-compartment.
- Positive status has been assumed to remain for a compartment for all subsequent years. Additional analysis could begin to establish re-surveying effort and what change is detected in these areas, though it is potentially difficult to infer complete change in a sub-compartment due to the issues with survey methodology mentioned above.

References

Brown, A. & Claydon, H. (2012) Dothistroma (red band) needle blight in Scotland. *Forestry Journal* 2/12. Available online at: http://www.forestryjournal.co.uk/newsitefiles/2012/0212Web/DNB.pdf

Brown, A. & Webber, J. (2008) *Red band needle blight of conifers in Great Britain*. Research Note

FCRN002. Forestry Commission, Edinburgh.

Forest Research (2013) *Status of Dothistroma needle blight in Britain*. Available online at: http://www.forestry.gov.uk/

Forestry Commission (2010) *Red band needle blight in Scottish tree nurseries*. Available online at: http://www.forestry.gov.uk/

Forestry Commission (2012). *Dothistroma Needle Blight GB Strategy*. Available online at: http://www.forestry.gov.uk/

Forestry Commission Scotland (2013). *Dothistroma needle blight action plan– Scotland (2013/14)*. Available online at: http://www.forestry.gov.uk/

Moffat, A.J., Morison, J.I.L., Nicoll, B., & Bain, V. (2012) *Climate Change Risk Assessment for the Forestry Sector*. DEFRA, available online at: http://www.defra.gov.uk/environment/climate/government/

Further information

Dothistroma needle blight:
http://www.forestry.gov.uk/forestry/infd-74jjfk

Dothistroma needle blight Action Plan:
http://scotland.forestry.gov.uk/images/corporate/pdf/dothistroma-needle-blight-action-plan-scotland.pdf

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Forestry Commission Scotland- Ben Griffin, Glenn Wilson for provision of FCS data and reviewing

Forest Research- Anna Brown, Kate Beauchamp for advice regarding indicator development

Appendix One: Indicator meta data and methodology

Table 1: Indicator meta data

Title of the indicator	Forest extent affected by Dothistroma needle blight (DNB)
Indicator contact: Organisation or individual/s responsible for the indicator	Anna Moss (CXC, University of Dundee)
Indicator data source	Forestry Commission Scotland
Data link: URL for retrieving the indicator primary indicator data.	Data supplied directly by FCS

Table 2: Indicator data

	Indicator data
Temporal coverage: Start and end dates, identifying any significant data gaps.	DNB sub-compartment data copied from FCS district servers Dec 2013. Data available from 2006
Frequency of updates: Planned or potential updates	Annual surveys
Spatial coverage: Maximum area for which data is available	FCS National Forest Estate
Uncertainties: Uncertainty issues arising from e.g. data collection, aggregation of data, data gaps.	Data covers FCS National Forest Estate only FC Metadata: The SCDB is constantly being edited. This caused problems when the spreadsheet data from 2006 and 2012 was used to derive a spatial dataset. Approximately 5% of records were unable to be linked over this period. In 2013 grid references were included for two thirds of the samples sent to FR. This has improved the ability to link samples to a location but

	it has highlighted the fact that most samples are collected very close to sub-compartment boundaries.
Spatial resolution: Scale/unit for which data is collected.	Data collected by FC National Forest Estate sub-compartments
Categorical resolution Potential for disaggregation of data into categories.	Disaggregation possible according to all fields of the sub-compartment data
Data accessibility: Restrictions on usage, relevant terms & conditions.	Any product derived from or incorporating the Data must include the following statement: *"Contains, or is based on, information supplied* by the Forestry Commission*."* If the Data is derived from or includes third party data supplied by the Forestry Commission additional third party statements may also be required For Scottish datasets: "Contains, or is derived from, information supplied by Ordnance Survey. © Crown copyright and database right [insert year of supply]. All rights reserved. Ordnance Survey Licence number 100021242." http://www.forestry.gov.uk/forestry/INFD-8G5BMY

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 Scotland http://www.forestry.gov.uk/datadownload: Forest Districts Forest Blocks DNB sub-compartment data

Table 4 Indicator methodology

Indicator methodology The methodology used to create the indicator data
• DNB data copied from district servers (Dec 2013) and supplied by FCS. • As not all sub-compartments are surveyed annually, combined data for all survey years (2006-13) was used to identify for each year a) the sub-compartments with a positive survey result in that year and b) sub-compartments previously identified as positive for which there has been no subsequent survey identifying otherwise. Duplicates for each sub-compartment were then removed to leave single entries for any one sub-compartment.

- The area of pine in each compartment was calculated, and only these areas (not overall sub-compartment area) used for the indicator.
- Positive DNB results in surveyed sub-compartments were summarised by forest block and forest districts, both by area (ha) and number. Indicator metric based on total pine area of sub-compartments with positive DNB result.