

# Generation of national clearfell area estimates through sampling of EO data – A Case Study in Scotland

National Forest Inventory

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## Summary

The National Forest Inventory (NFI) provides a record of the size and distribution of forests and woodlands in Britain and information on key forest attributes. This report explores whether rapid estimates of the amount of clearfell in Scotland can be generated through sampling of remote sensing data captured between June 2016 and June 2017.

Estimates of the amount of clearfelling in Scotland between 2016 and 2017 are scheduled for publication in 2019. In response to requests from the forest industry this paper sets out interim results based upon sampling 10% of the sites detected as potential clearfell through satellite images. The report also includes revised amounts of clearfelling observed between June 2014 and June 2016 for comparative purposes.

- The preliminary estimate of the amount of clearfell detected by earth observation techniques in Scotland between June 2016 and June 2017 was 24,157 hectares with a standard error of sampling of 30%.
- The estimate of the amount of clearfell detected by earth observation techniques in Scotland between June 2015 and June 2016 was 27,126 hectares.
- The results suggest that levels of clearfell may have decreased between the two periods. However, the standard error of 30% for the June 2016 to June 2017 estimates are greater than the estimated difference in area meaning that this difference cannot be regarded as statistically significant. The final estimates to be published in 2019 will confirm if this is the case or not.

## Introduction

The National Forest Inventory (NFI) of Great Britain (GB) provides a record of the area and distribution of forests and woodlands in Britain and information on key forest attributes. One of these key metrics is the level of clearfell each year. This report contains new estimates of the amount of clearfell over 0.5 hectare in extent<sup>1</sup> observed in Scotland's woodlands between 2015 and 2017. Previously published data on clearfell 2014 to 2015 has been included for comparative purposes; these earlier data were based on a full census of all detected sites. The new estimates for 2015-2017 were made using two sets of satellite imagery.

## Data and methods overview

### 2015/16 Estimates

The data used for identification of clearfelling consisted of a complete satellite imaging of Great British woodlands, from the Sentinel satellite systems with polygons classified by size and the likelihood of clearfelling, judged using vegetation indices, as high or low. All polygons detected as being over 0.5 hectare were then inspected by eye, using aerial photography (AP), to ensure they were a true hit.

### 2016/17 Estimates

The raw data for identification of clearfelling consists of a complete satellite image of Great British woodlands. For the most recent data two distinct satellite imaging systems were used, Sentinel and DMC (Disaster Monitoring Constellation). The former gave higher resolution images and was therefore used whenever possible and the latter was used to fill in areas where the Sentinel image was not practical, for example where there was too much cloud cover.

These images were classified by size of polygon and whether the likelihood of clearfelling, judged using vegetation indices, was high or low. An automated process was then used to class each polygon as clearfell or not. A 10% sample of these images were then visually inspected and marked as either a true or false hit. The true hits were classified by region and ownership, more specifically as either National Forest Estate or "private sector", although the latter includes some public and government bodies, such as local councils and the Ministry of Defence.

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<sup>1</sup> Or part of a clearfell over 0.5 hectare in extent

An adaptation of the methodology adopted in the National Forest Inventory for estimation of population totals from the field sample results was used and makes use of ratio estimators. Formulation of these estimates follows an approach outlined for sampling and estimation from clusters of unequal sizes<sup>2</sup>. In this context the clusters are the sampled polygons, which have unequal areas within them.

Additionally the previous monitoring period figures were updated after a sample of the 'weak' clearfell hits from the satellite images were inspected and scaled up in the same fashion. These were not classified by owner or region so the additional clearfell found from this approach was apportioned by size of the clearfell from the 'strong' hits.

## Results

In all tables amber is used to indicate a standard error of greater than 25% and red is used to indicate greater than 50%. NFI statisticians recommend that both amber and red statistics are useable, but care should be taken with their interpretation.

**Table 1: Estimates of clearfell for 2015/16 by strength of satellite signal**

Source	Signal strength	Area identified by satellite as clearfell (ha)	True new clearfell area (ha)
Sentinel	Low	36,013	3,214
	High	35,732	24,751
<b>Total clearfell</b>			<b>27,965</b>

**Table 2: Estimates of clearfell for 2016/17 by source of image and strength of satellite signal based on a 10% sample of the polygons detected**

Source	Signal strength	Area identified by satellite as clearfell (ha)	Sample area validated using AP (ha)	True new clearfell area in sample (ha)	Bulked up estimate of clearfell (ha)	% Standard error of estimate
DMC	High	15681	2174	525	4541	114
Sentinel	Low	35146	3603	185	1943	128
	High	37724	3986	1773	17673	25
<b>Total clearfell</b>					<b>24157</b>	<b>30</b>

<sup>2</sup> "Sampling Techniques", Cochran, W.G. 3<sup>rd</sup> edition, John Wiley and Sons, 1977.



Table 3: New clearfell observed between 2006 and 2017 in Scotland by ownership type and monitoring period

	National Forest Estate	Private Sector
	Total (ha)	Total (ha)
<b>Scotland</b>		
2014/15 <sup>1</sup>	10,351	15,060
2015/16 <sup>1</sup>	11,708	15,417
2016/17 <sup>2</sup>	10,267	13,889
<b>Total new clearfell observed</b>	<b>32,327</b>	<b>44,367</b>

Notes:

(1) Includes 1.2 years - rounded down to one whole year.

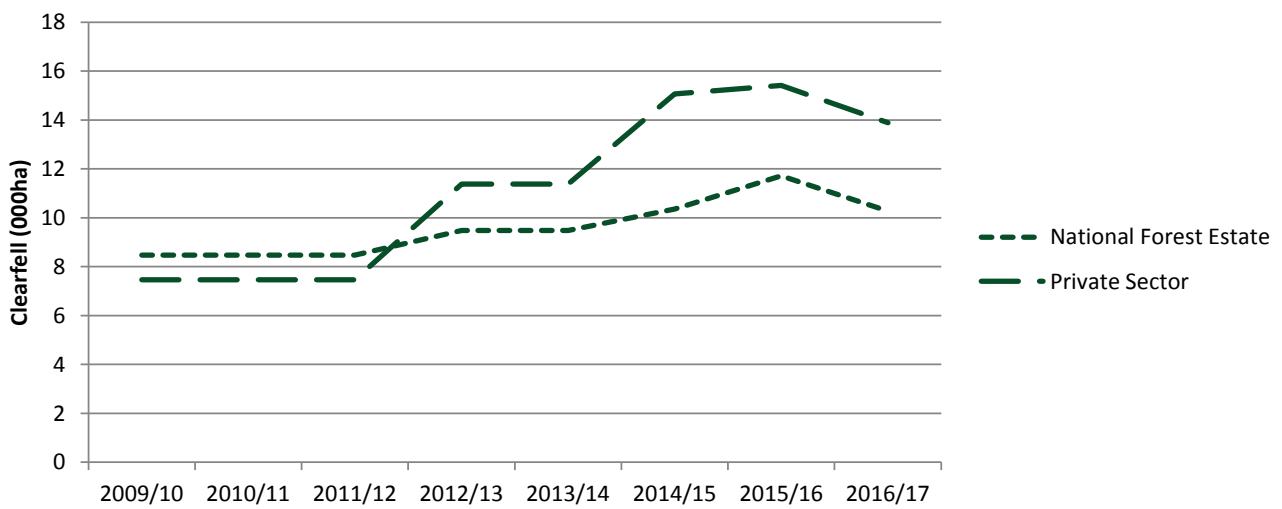
Clearfell estimates revised since publication in 'Preliminary estimates of the changes in canopy cover in British woodlands between 2006 and 2015'

(2) Results are derived from a 10% sample, see methodology for more details

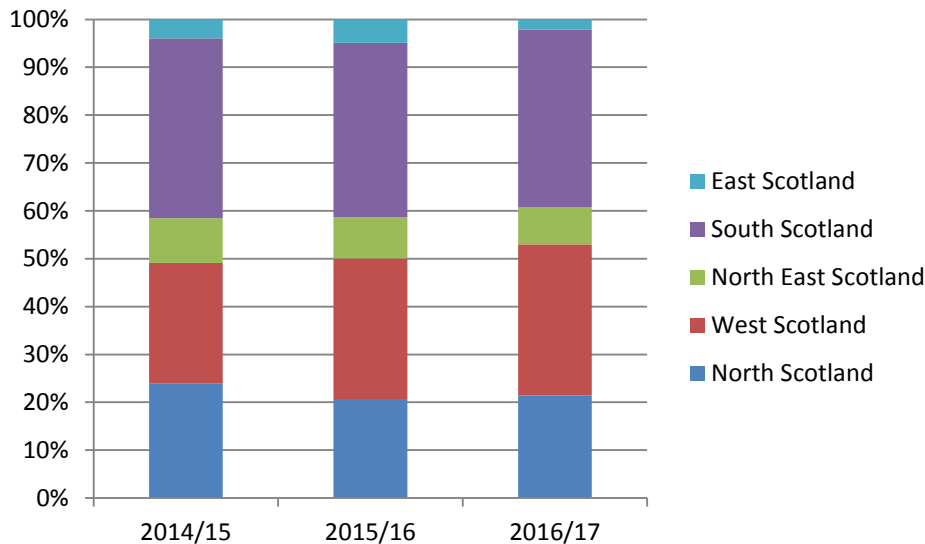
Estimates are derived from earth observation.

The ownership boundary used for this analysis was the Forestry Commission legal boundary at March 2016. In other words, the 2016 FC legal boundary was applied to the all data in the 2009-16 period

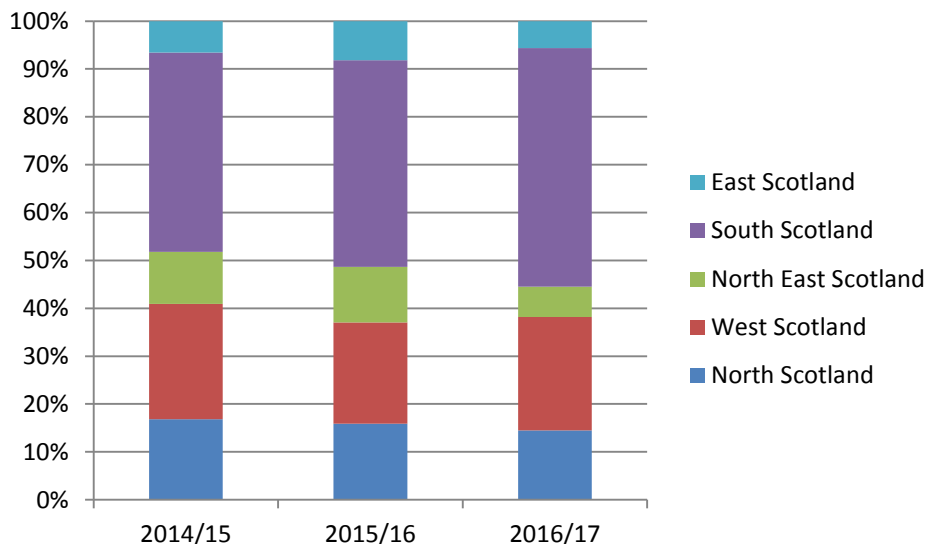
Figure 1: New clearfell observed between 2009 and 2017 in Scotland by ownership type



**Figure 2: Percentage of new clearfell observed between 2014 and 2017 in Scotland in National Forest Estate woodland by region**

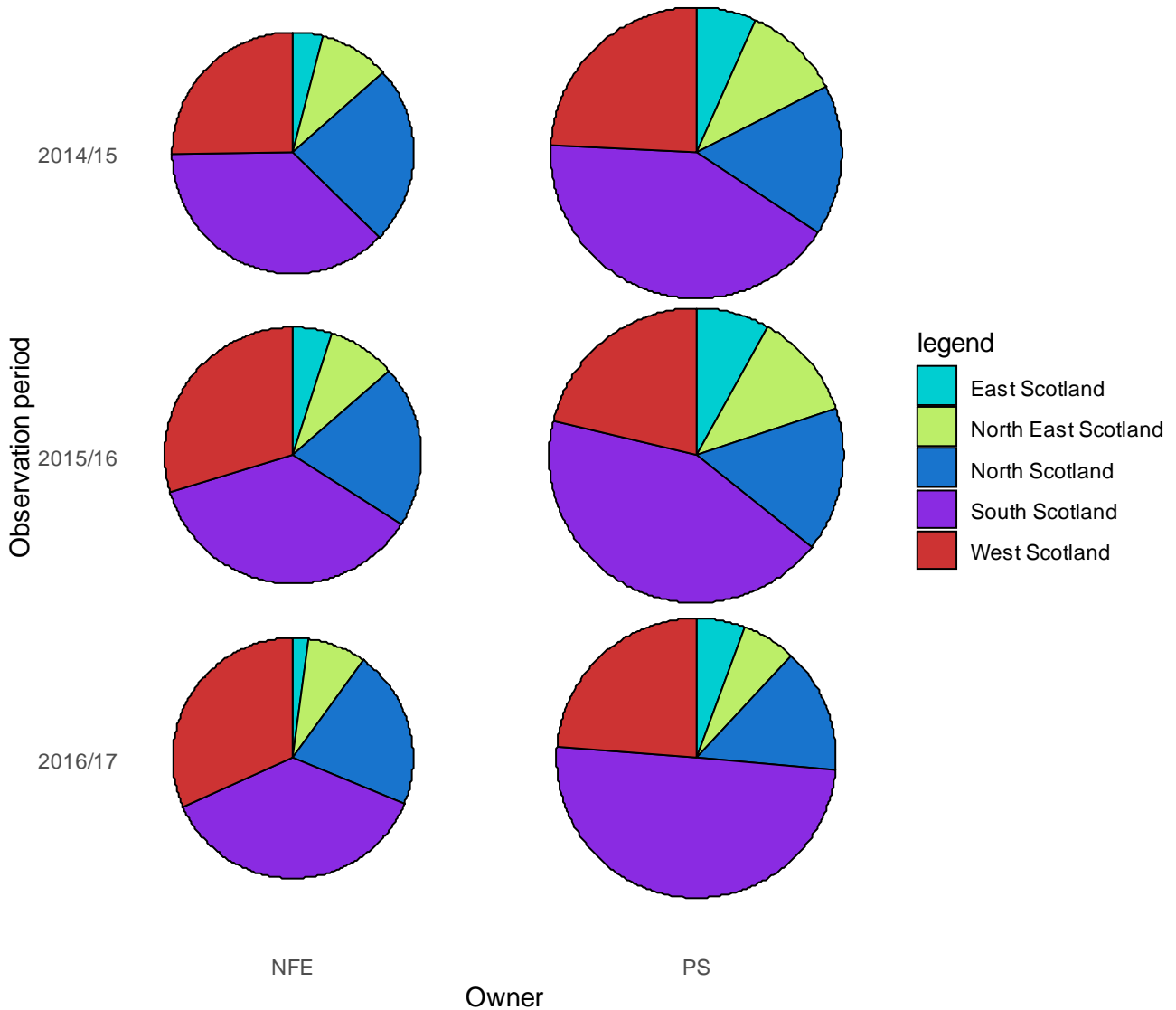


**Figure 3: Percentage of new clearfell observed between 2014 and 2017 in Scotland in private sector woodland by region**



**Note: The figures for 2016/17 have very high standard errors at a regional level therefore the data should only be considered indicative for 2016/17.**

**Figure 4: Proportion of observed new clearfell in woodland by year and owner with scale of plot representing total clearfell**



**Note: The figures for 2016/17 have very high standard errors at a regional level therefore the data should only be considered indicative for 2016/17.**

## Conclusion

Rapid generation of clearfell estimates from sampling of Sentinel optical data is possible. However, in this exercise, over a very cloudy year, the automated process of change detection was not good enough to enable precise estimates to be generated with a 10% sample. All that can really be concluded is that our expected value does not show a dramatic rise or fall in the rate of clearfell between 2016 and 2017.

When interpreting these estimates it is worth noting that whilst the levels of clearfell detected are broadly commensurate with the amount of timber production reported in Forestry Commission statistics, direct comparisons cannot be drawn. This is because timber production statistics are produced each calendar year, December to December, and the clearfell data June to June. In addition the clearfell estimates do not account for the amount of timber arising from thinning activity nor the variable amounts of timber volume produced per hectare site to site.

These estimates have not been classified as Official Statistics. Official statistics on rates of clearfell 2015 to 2017 will be published in future and may present a slightly different estimate to these.



## NFI national reports and papers

This report concerns aspects of the changing size, structure and composition of British forests. NFI reports that contain information relating to these areas are:

- NFI Woodland Area Statistics, Great Britain, England, Scotland, Wales (2011)
- 25-year forecast of softwood timber availability (2012)
- 50-year forecast of softwood timber availability (2014)
- 50-year forecast of hardwood timber availability (2014)
- 25-year forecast of softwood timber availability (2016)

Each theme has a series of associated reports, papers and data, tailored for different audiences and uses.

All these documents and data can be found on the NFI website [www.forestresearch.gov.uk/inventory](http://www.forestresearch.gov.uk/inventory).

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