



OGB 4

# Plant density: surveys and monitoring

A guide for FC staff

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- The guidance in the booklets is specific to FC operations.
- Our booklets refer to other internal guidance which is designed solely for FC use.
- We revise our booklets regularly. Please make sure you have the latest version.

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# 1. Foreword

This Guidance Booklet is one of a series covering various subjects in the Forestry Commission (FC). We, the Forest Management Officers (FMOs) have reviewed and revised this one entitled, *Plant Density: surveys and monitoring* to help you through the policy, planning, fieldwork and paperwork involved. We will also cover elements of restocking that are essential to making this work.

We have designed the booklet to be:

- a reference work;
- a supporting and instructional document; and
- the basis for follow up support visits and audits.

We hope you find it useful. You may also see:

## **P** Policy.



**Mandatory elements.** These are auditable actions necessary to meet legal requirements or to deliver or report on corporate policy.



**Timebound mandatory elements.** As above, but to a deadline.



**Recommendations:** these are auditable actions that you should practise for efficiency and effectiveness. Any variation must be defined and authorised by unit managers.



**Cautions** against certain actions, or things to avoid.

Examples, best practice and important reader information are in light blue boxes like this.

If you have any comments on this booklet, its procedures, or any new ways of presenting this subject please contact [Mark Lawrence](#).

We will publish updates on the Inventory, Forecasting and Operational Support Intranet site in the Operational Guidance folder and tell you in the Connect Bulletin.

## 1.1 Moving around in this booklet

We have designed this document for you to read on screen using Adobe Acrobat Reader. If you need help with the various versions of Adobe Reader, please click on [this link](#).

## 2. Some terms explained

In the Forestry Commission we use many terms and abbreviations and we explain them here before you read them.

Term	Explanation
<b>Beat up</b>	Replacing lost trees after planting.
<b>Clinometer</b>	Device for measuring slope.
<b>FDM or FMD</b>	The Forest District Manager or Forest Management Director is responsible for managing forest districts in the Forestry Commission. We will refer to them as Forest District Managers in this OGB for simplicity. This term may also cover Area Operations Managers (AOM) in some cases.
<b>Forest District</b>	We have used the term Forests Districts throughout this OGB which also covers Wales Silvicultural Operations (WSO) who are responsible for OGB 4 surveys in Wales and equivalent job titles.
<b>GIS</b>	Geographical Information System – Forester.
<b>GPS</b>	Global Positioning System.
<b>SCDB</b>	Sub-compartment Database.
<b>Shapefile</b>	Map-based file in GIS.
<b>sph</b>	Stems per hectare.

### 3. What's mandatory and recommended in OGB 4?

Here we summarise for you the mandatory and recommended elements that are in this booklet, with the relevant section for you to refer to.

**Please note that staff must follow their countries' policies for the planting densities of variable density crops.**

Each mandatory element is mapped to the [UK Forest Standard](#) (UKFS) with the reference and a category for compliance with Section 5 of the standard. Our legend is:

1. **Legal (L)** as in UKFS/Guidelines.
2. **Best Practice (BP)** as in UKFS/Guidelines.
3. **FC Policy (P)**.
4. **Internal Business Process (IBP)**.

The UKFS uses the following legends which we have used here.

	General Forestry Practice		Forests and Landscape
	Forests and Biodiversity		Forests and People
	Forests and Climate Change		Forests and Soil
	Forests and Historic Environment		Forests and Water

#### 3.1 What's timebound and mandatory?

No.	 Timebound mandatory requirement	OGB Section	UKFS Ref	Category
1.	As an absolute minimum, FDs must ensure their SCDB is updated to cover all planting and felling changes within the preceding year at the 31st of March each year.	6 <a href="#">(6)</a>		IBP
2.	Initial and Final assessments will be carried out according to the timescales described in Section 8.1. The assessment details will be recorded using the approved stocking density assessments forms in Section 14.	8 <a href="#">(8)</a>		IBP
3.	All forest districts will complete a stocking density return – see Section 14 <a href="#">(14)</a> – each year which will give a summary of the initial and final assessment results. You will submit this to your country office to arrive there no later than 15th April. England will acquire these results by querying the sub-compartment database and will therefore not use the density return forms.	8 <a href="#">(8)</a>		P

### 3.2 What's mandatory?

No.	 Mandatory requirement	OGB Section	UKFS Ref	Category
1.	<p>Non-commercial crop sites generally become live monitoring sites 1-2 years after felling operations are completed. At this stage a restocking coupe record or work plan should be activated and the establishment and monitoring of other components of the coupe should start. When regeneration reaches 1.5 metres high and can be classed as established, assess the planting year and input an estimate to the SCDB based on tree health and height.</p>	7.5.2 <a href="#">(7)</a>		P
2.	<p>Each district will keep a record for each stocking density assessment which must be kept for seven years. These records will include:</p> <ul style="list-style-type: none"> <li>• maps showing all sample plot locations, each plot numbered for easy cross-reference with stocking density assessment forms;</li> <li>• stocking density assessment forms;</li> <li>• stocking density returns; and</li> <li>• audit assessment forms - if done.</li> </ul> <p>Forest district stocking density assessments will be independently audited as determined by country Forest Management Officers.</p> <p>The country office will be responsible for summarising and analysing the data before publishing the results internally.</p>	8 <a href="#">(8)</a>		P

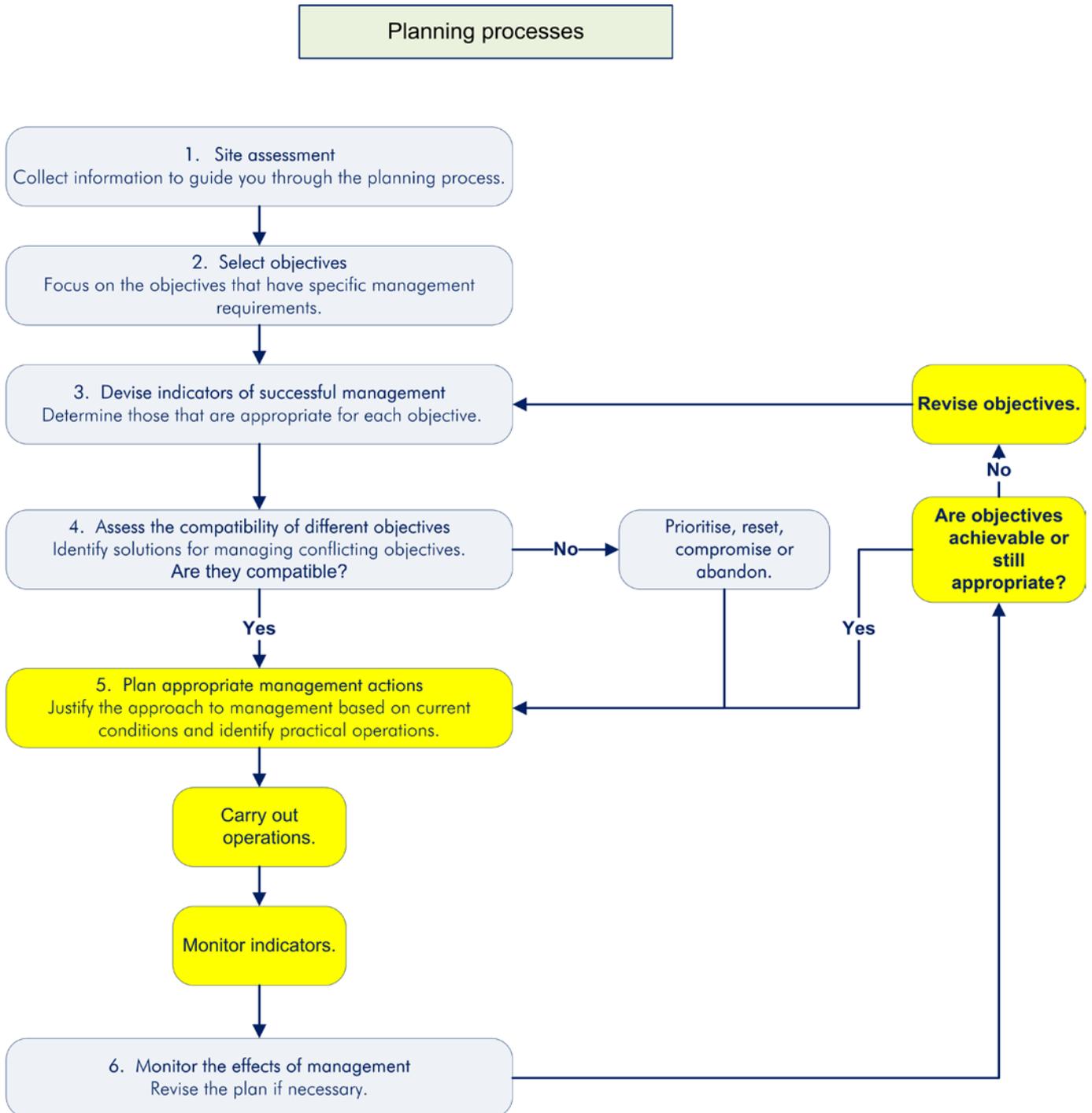
### 3.3 What's recommended?

No.	Recommendation	OGB Section
1.	If you decide to beat up, we recommend you discuss the importance of selecting the right planting spot with your planting team or contractors before you begin. Remember that a tree can only be counted as a live location if it is over 1.5 m from its nearest neighbour – see Section 10.2.9.	7.4 <a href="#">(Z)</a>
2.	We recommend that ten years should be the maximum monitoring period if you are not achieving your objectives. This ten year 'cut off' point should start at either site intervention or a reassessment of the objectives, and justify any change of management prescription for the area.	7.5.2 <a href="#">(Z)</a>
3.	We recommend that routine site inspections by staff should include a very basic stocking density or survival assessment at least once every five years, ideally in the late summer.	7.5.2 <a href="#">(Z)</a>

## 4. Introduction

Before establishment or re-establishment of a tree crop, you must set and understand the objectives for the site. The objectives may already have been set as part of the Forest Design Plan – see [OGB 36 – Forest Design Planning](#). Figure 1 defines the planning process with six main stages (adapted from Harmer *et al*, 2010) and continues in Figure 2.

Figure 1 Planning the process (Harmer *et al*, 2010)



## 4.1 Objectives

The Surveys Handbook states that for forest design plans:

**'It is essential that the long-term objectives of crops are clearly defined and recorded in the right planning documents. Generally, this will be the district strategic plan, the forest design plan and the individual coupe planning document or record.'**

When planning the establishment of crop areas, managers need to determine the range of outcomes which would satisfy their objectives. Specifically, managers should consider the tolerances which would be associated with the parameters and terms used to specify the woodland. For example:

- the target number of trees or restocking density;
- the range of species, including conifer regeneration within broadleaved areas;
- the spatial distribution of trees; and
- the balance with open space.

In most circumstances a wide range of outcomes for total tree numbers, species distribution and range may be equally acceptable. For example, you might judge a site to have achieved its objectives if between 200 and 800 trees per hectare were established, including at least three native species suited to the site, and with between 25% and 75% of the area likely to be under tree cover by maturity.

Tolerances should generally be tighter at the FDP level, covering the whole FDP unit with some flexibility at the coupe level. At all stages it is important to bear in mind the need to demonstrate success or failure through appropriate monitoring via surveys. You can find guidance on agreeing the use of tolerance tables between conservancies and forest districts in OGB 36 – [Forest Design Planning](#).

In addition, you may need to include some broader targets for the type of woodland area you want. For example, 'ensure spruce does not dominate' or 'establish open woodland W1 1 with some W4 woodland NVC classification'.

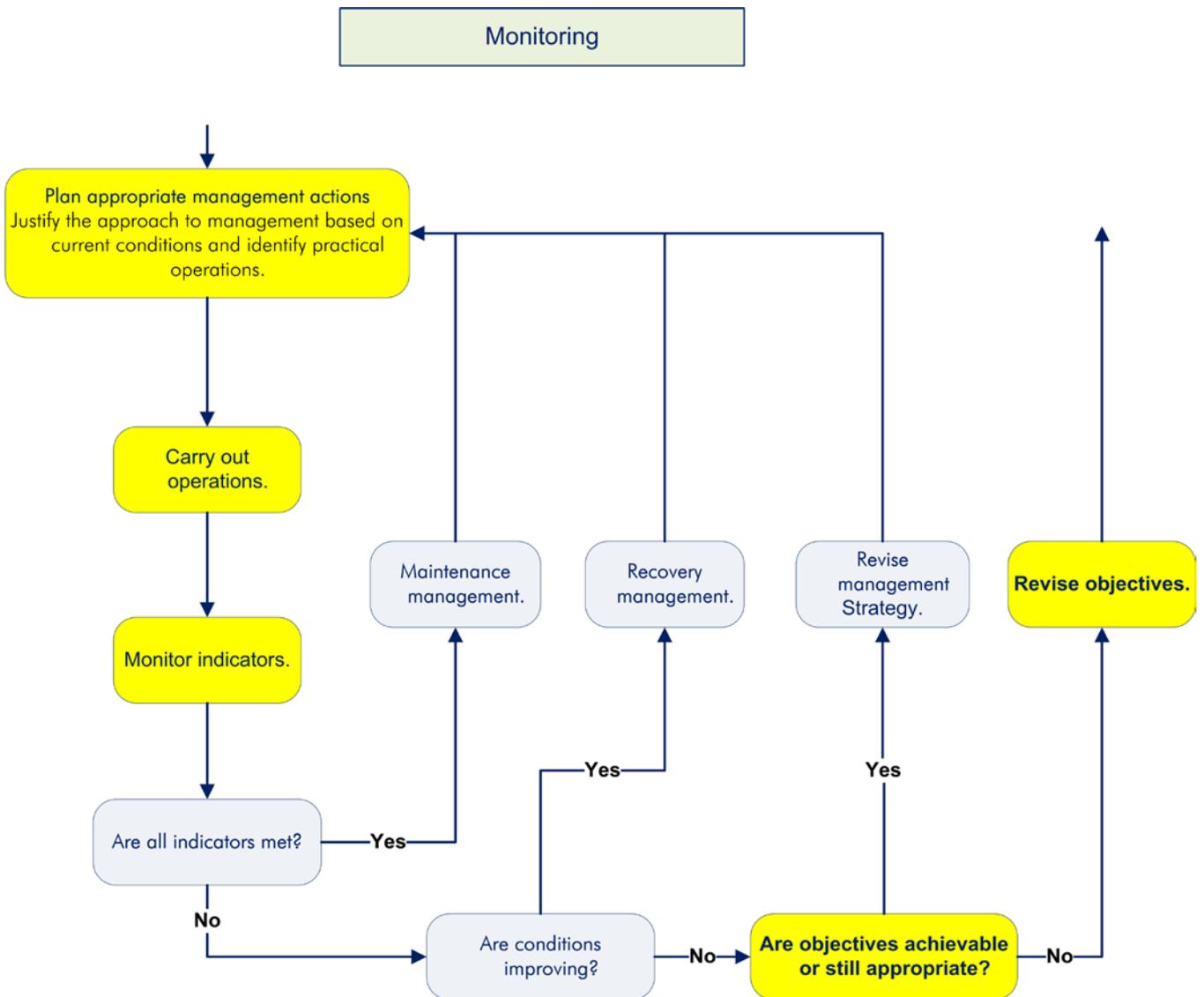
OGB 36 also gives you guidance on setting appropriate objectives at the design planning stage.

## 4.3 Monitoring objectives

Monitoring is essential to ensure that you are meeting your management objectives. Figure 2 illustrates the process for revising management plans and objectives based upon the analyses of any monitoring results. It follows on directly from Figure 1.

Figure 2 Monitoring process (adapted from Harmer *et al*, 2010)

This chart follows on from Figure 1.



## 5. Stocking densities

### 5.1 Uniform stocking density

The initial density and uniformity of trees have important implications for their growth and subsequent timber quality.

Studies on Sitka spruce (our main timber species) growing in the UK, have shown that at wider spacings there is an increase in the percentage of juvenile core which is normally associated with lower timber strength properties. Research has also shown us that the yield of quality timber falls below acceptable levels when Sitka spruce is planted at spacings wider than two metres (2m). There is less information available for other conifer species in the UK, and, in the absence of clear scientific studies, it is considered best to assume that the strength properties of all conifers will deteriorate at spacings greater than two metres.

The situation for the principal broadleaved species is similar to conifers. We know that stem form in most broadleaved species deteriorates rapidly with increased spacing. The countries' policies therefore are:

**P** England – Plantations of uniformly spaced timber crops on Forestry Commission land, (except East Anglia); will have at least 2,500 evenly spaced stems of acceptable species per net hectare by the final assessment.

**P** Scotland: – Conifers: all plantations of uniformly spaced commercial crops on Forestry Commission land will have *at least* 2,700 live locations plus plantable gaps per net hectare by the end of the first growing season to give at least 2,500 live locations of acceptable species per net hectare by the end of the 5<sup>th</sup> growing season.

Broadleaves: plantations of uniformly spaced commercial crops on Forestry Commission land will have *at least* 2,700 live locations plus plantable gaps per net hectare by the end of the first growing season to give at least 2,500 live locations of acceptable species per net hectare by the end of the 5<sup>th</sup> growing season.

Some planting sites, especially woodland creation projects, may have targets of establishing 3,500 – 5,000 live plants and plantable gaps by the end of the first growing season. The same final target density of evenly spaced stems of acceptable species per net hectare is to be achieved by the final assessment at the end of the 5<sup>th</sup> growing season.

**P** Wales – Plantations of uniformly spaced timber crops on Forestry Commission land will have at least 2,500 evenly spaced stems of acceptable species per net hectare by the final assessment.

Restocking is a significant investment, and we must be able to show that we have acted responsibly in setting and achieving appropriate standards. The uniform planting monitoring allows us to regularly and formally review what we are doing and see what progress we are making with evidence. We can then decide on what action is necessary if we are not achieving that standard.

In certain parts of GB, there are rare occasions when the terrain and or soil type mean that it is physically not possible to achieve desired targets. In these circumstances the country FMO will issue supporting guidance which should be used with this OGB.

### 5.2 Variable density stocking

With the increase in variable density stocking sites, for a variety of management objectives, it is important to ensure that stocking meets the planning and design criteria for a site. The individual forest districts need to assign the required stocking densities in line with country policies, site objectives and design planning. Management objectives need to be clear, known and understood for each site so that the

correct stocking density is reached and to help decide whether monitoring is needed and, if so, what intensity of monitoring.

Refer to [OGB 36](#) – Section 4 for information on setting and reviewing objectives for forest design plans. These objectives will be carried through to operational planning documents, such as:

- Coupe Plans;
- Ops 1's;
- Operational Site Assessments (OSA); and
- Work Plans.

Variable stocking can be a result of deliberate planting, natural regeneration and re-spacing or a combination of both.

## 6. Responsibilities

**P** Forest districts will plan and budget for all the associated costs of stocking density monitoring in their business plans.

Table 1 describes the tasks involved with survey management and who is responsible.

Table 1 Responsibilities

Phase	Task	Responsibility
<b>Budgeting.</b>	Plan and budget all survey costs and include in business plan.	Forest district manager.
<b>Training.</b>	Identify training needs within the forest district.	Forest district manager.
<b>Assessments.</b>	Decide on survey or monitoring method. Carry out monitoring.	Planning or Operations staff. (In Scotland it is the Operations staff with support from Planners).  Discretion of the individual countries. However, selected individuals should be well-trained and have an objective approach to the assessment.  Generally, we expect it to be done by competent survey contractors, Forest Research staff or our own teams.
<b>Independent audit of assessments.</b>	Determine the frequency of audits. Carry out audit of assessments.	Country FMO. Research.
<b>Recording.</b>	Record relevant survey outputs in the SCDB.	Planning staff.



As an absolute minimum FDs must ensure their SCDB is updated to cover all planting and felling changes within the preceding year at the 31st of March each year.

## 7. Establishment – for Uniform Planting sites

It is important that we consider successful establishment throughout the restocking process. In this section, we aim to highlight some of the important issues that you will need to consider during this phase.

### 7.1 Restocking area

Our monitoring procedures use methods that calculate a figure for plant density per net hectare.

The total area of a sub-compartment or felling coupe is described as the '**Gross Area**'. This area represents all the ground within the boundary and includes unmapped open areas and rides within the site.

The term '**Net Area**' describes the actual area that you are going to plant. Net area excludes **all** the following:

- roads;
- rides;
- permanent watercourses;
- main drains; and
- unplantable areas like rock outcrops or other features that are not woodland.

### 7.2 Site preparation



If after cultivation, there are less than 2,500 planting positions per net hectare (England and Wales), you will not be able to achieve the minimum stocking standard. Note, that in Scotland, policy requires a minimum of 2,700 planting positions per net hectare for conifer species and 3,500 to 5,000 for broadleaf species.

Growing good quality timber begins with ground preparation. You must make sure that the technique and pattern of cultivation provides the correct density of planting positions (density), evenly distributed (uniformity) across the site. There will inevitably be variations across a site and we encourage you to specify a planting positions target density greater than that of the plant density required. For example for a plant density of 2,500 stems per hectare, we recommend you that you need *at least* 2,700 planting positions per net hectare (1.9 m x 1.9 m spacing). This should make sure you achieve the minimum standards without excessive expenditure on beating up.

You should make sure your contractor or machine operator monitors stocking density and uniformity regularly by writing it in the contract schedule. You should monitor these results by carrying out your own sample plots during the operation – we must get stocking density and uniformity right from the start!

You can find more information on ground preparation in Information Note [Forest Ground Preparation](#).

### 7.3 Planting

It is more important to select the right planting spot than to maintain exact spacing between the seedlings, and you may vary the spacing of individual trees within the row to do this, for a density of 2,500 stems per hectare spacing should be **no closer than 1.5 m**. In Scotland the minimum 1.5m spacing is also a requirement for a density of 2,700 stems per hectare.

### Best practice for 2,500 (and 2,700 in Scotland) stems per hectare

Planting should be as 'square' as possible where applicable. When planting trees in rows, the spacing between adjacent rows should not exceed 2.2 m and the average spacing within the row should not exceed 2 m. Where trees are not planted in rows, such as on mounded sites, the site preparation must provide a planting position on every 2 m x 2 m square of plantable ground (2,500 sph).

For higher stocking levels spacing will need to be much closer. For broadleaf stocking in Scotland for example, with 3,500 – 5,000 stems per hectare, you will need to reduce the spacing. For example to achieve a uniform spacing for 4,000 stems per hectare the spacing you need is 1.58m x 1.58m. However, in order to get quad bike in-between rows, you need a between-row spacing of 1.8-1.9m reducing the within-row spacing to  $\approx$ 1.4m, and down to  $\approx$ 1.1m for 5,000 stems per hectare with the result that 'square' planting is not possible. Note that in the SCDB, the Spacing field requires spacing assuming square spacing.

## 7.4 Beating up

Even with the best planting and management, some trees will not survive the first season. In commercial forestry, where it's important to maximise timber production on a site, replacement is necessary where trees have died, and we call this 'beating up'.

Your decision on whether to beat up will need to take account of the distribution of the losses over the site, and whether there is acceptable natural regeneration – see Sections 7.5.1 and 11 ([11](#)).



If you decide to beat up, we recommend you discuss the importance of selecting the right planting spot with your planting team or contractors before you begin. Remember that a tree can only be counted as a live location if it is over 1.5 m from its nearest neighbour – see Section 10.2.9 ([10](#)).



Successful beating up is normally undertaken within the first three years of planting. If you wait longer than this you risk failure and will have an uneven crop height at establishment.

## 7.5 Other considerations

### 7.5.1 Natural regeneration

Natural regeneration may occur, and you will need to define acceptable natural regeneration based on your site objectives. These objectives can be defined locally or nationally. Where timber production is a primary aim of management:

**P** Regeneration will only be accepted as a live location where the presence of that species is consistent with the agreed site objectives and the tree is at least 1.5 m from surrounding live locations. Acceptable species should be clearly stated on the site plan and the Uniform Planting assessment form.

You can find more detail on timing your assessments for natural regeneration in Section 8.1 ([8](#)) and a guide on effective counting of regeneration is in Supporting Documents – Section 14 ([14](#)).

Naturally regenerated crops, enriched if necessary by supplementary planting, **do not** require a formal Uniform Spacing initial assessment, but do need to conform to the same stocking criteria as planted uniform crops at the time of establishment.

Where natural regeneration clearly falls within the range of 'acceptable' and meets the objectives of the site, other than mapping, you would not normally need a detailed site assessment.

We recommend that where ongoing site inspections show that natural regeneration is producing a density and distribution of trees which will be within site tolerances, allow the site to develop and continue monitoring it into the next FDP period.

- When trees reach 1.5 metres high and are easily visible, it should be possible to map the extent of the regeneration using GPS or similar technology. Then update the SCDB and input the Planting Year based on an estimate which takes account of tree health and height.
- Where natural regeneration is used to establish a timber crop, you can use the standard uniform 5 year assessment once it reaches 1.5m in height and live location acceptance falls within the criteria noted previously.

### 7.5.2 Non-commercial stands

The decision on when to intervene and more proactively manage a non-commercial area will depend on the site objectives and conditions. However, you might need to monitor some sites for up to ten years before intervention.



We recommend that ten years should be the maximum monitoring period if you are not achieving your objectives. This ten year 'cut off' point should start either site intervention or a reassessment of the objectives, and justify any change of management prescription for the area.



**Non-commercial crop sites generally become live monitoring sites 1-2 years after felling operations are completed. At this stage a restocking coupe record or work plan should be activated and the establishment and monitoring of other components of the coupe should start. When the trees reach 1.5 metres high and can be classed as established, assess the planting year and input an estimate to the SCDB based on tree health and height.**

Highly accurate stocking density data (as is required for all plantations on FC land where timber production is a primary aim under Uniform Planting) is generally not required for non-commercial crops. The survival information collected during routine site inspections should be adequate to enable monitoring against the targets and tolerances determined at the planning stage.



We recommended that routine site inspections by staff should include a very basic stocking density or survival assessment at least once every five years, ideally in the late summer.

## 8. Timing

### 8.1 Timing your assessments

To check that everyone is meeting the standards set in this OGB, there will be two assessments of stocking density.

1. **Initial Assessment.** You can carry out the initial assessment at any time between the 1 September and the end of March, before the beginning of the second growing season. Your timing needs to make sure you gain the best quality management information from the site. For example.

Planting year	Initial assessment period
November 2010 – March 2011 (Pyear 2011)	Anytime between 1 September 2011 and 31 March 2012.

Naturally regenerated crops (enriched if necessary by planting) may not require a formal initial assessment. These crops, including those that do require an initial assessment, will still require monitoring to ensure professional management of the crop and to make sure that stocking density standards are met by establishment.

2. **Final Assessment: Uniform Planting** – You can carry out the final assessment at any time between the end of the 4<sup>th</sup> growing season and the end of March at the start of the 6<sup>th</sup> growing season or when the crop reaches a height of 1.5 m (whichever comes first). For example:

Planting year	Final assessment period
November 2010 – March 2011 (Pyear 2011)	Any time between Nov 2014 and 31 <sup>st</sup> March 2016. If however, the crop reaches a height of 1.5 m at year 3 (2013), you can carry out your final assessment any time between November 2013 and 31 March 2015 during the dormant season only.

**Naturally regenerated crops with timber as a main objective (enriched if necessary by planting) will have a final assessment carried out when the crop reaches an average height of 1.5m.**

**Key** Each district will keep a record for each stocking density assessment which must be kept for seven years. These records will include:

- maps showing all sample plot locations, each plot numbered for easy cross-reference with stocking density assessment forms;
- stocking density assessment forms;
- stocking density returns; and
- audit assessment forms - if done.



Initial and Final assessments will be carried out according to the timescales described in Section 8.1 (8). The assessment details will be recorded using the approved stocking density assessments forms.

**Key** Forest district stocking density assessments will be independently audited as determined by country Forest Management Officers.

## 8.2 Timing your stocking density returns?

In order to monitor country success in achieving the standards set in this OGB:



All forest districts will complete a stocking density return – see Section 14 ([14](#)) – each year which will give a summary of the initial and final assessment results. You will submit this to your country office to arrive there no later than 15th April. England will acquire these results by querying the sub-compartment database and will therefore not use the density return forms.

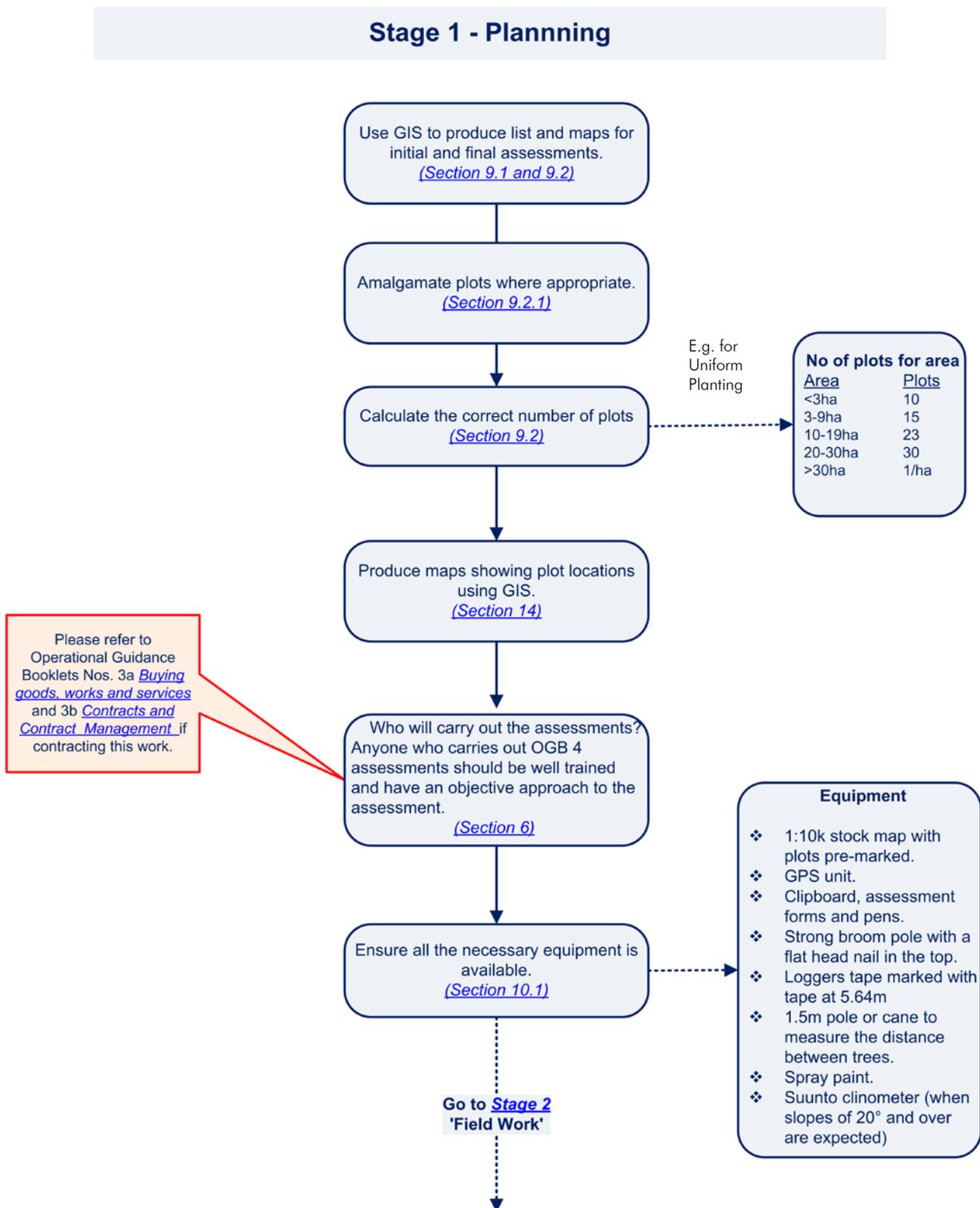


The country office will be responsible for summarising and analysing the data before publishing the results internally.

# 9. Planning

Please click the underlined blue links if you want to read that section.

Figure 3 The planning – stage 1



## 9.1 Planning the checks – which areas?

Your planning team can produce a list and maps identifying plot locations within all the coupes planted for specific years.

If you are not familiar with using Forester Geographical Information System (GIS) to produce maps and identify plot locations (gridding), we have given you a link to a complete guide as a supporting document – see Section 14 ([14](#)).



Plot locations on the map should be numbered in sequence and correspond with the numbering on your stocking density assessment form.

You may wish to export the plot locations and numbers into your GPS utility software or use [Mobile GIS](#). This will provide easier navigation to plots in the field and will save you time entering the plot location co-ordinates to the GPS by hand. The output from the GPS utility can also be converted to a 'shapefile' which allows for plots to be numbered in sequence and displayed within GIS.



If you are not familiar with hand-held GPS units, we recommend you contact Learning and Development for a course.

## 9.2 How many plots and where?

Having 'gridded' your maps in GIS, you will need to check you have enough plots for the area. GIS will tell you the area of each sub-compartment and you should then check against Table 2 to make sure you are using the correct number of plots.

Table 2 Number of plots you need – Uniform Planting

Assessment area – ha	No of plots required
<3	10
3 to 9	15
10 to 19	23
20 to 30	30
>30	1 per ha

If you reduce the number of plots per hectare (initial assessment only), you will need the approval of your FMO. In these circumstances your FMO will issue guidance to use with this OGB.

### 9.2.1 Amalgamating plots

There may be times when a number of adjacent sub-compartment have been planted during the same planting season with the same species. If these sites are suitable and similar in soil type, aspect, exposure and weed growth, then you can amalgamate them into one large survey area allowing you to carry out your assessment across boundaries.

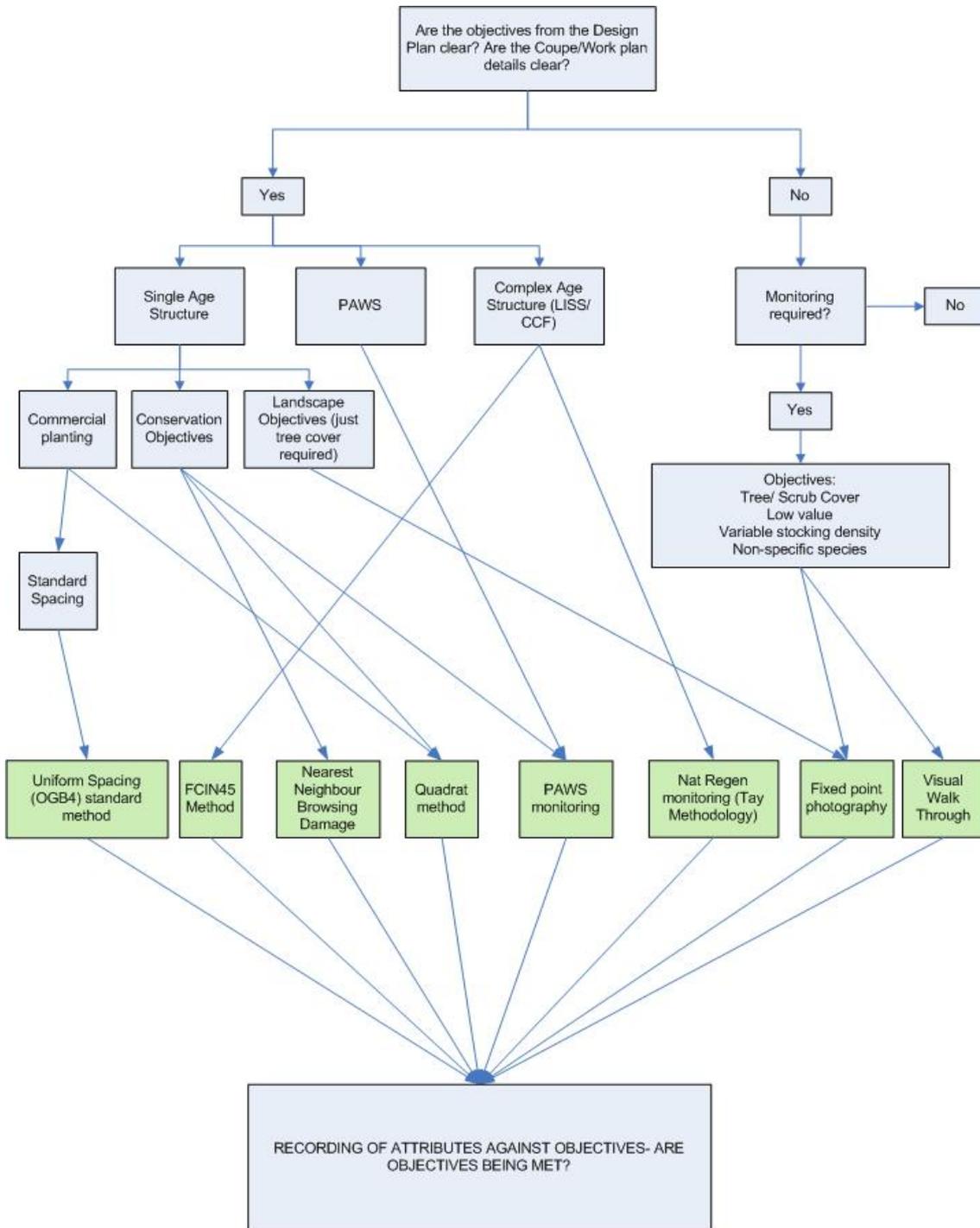
Where you amalgamate two or more distinct areas into one survey area, you cannot later separate them as the results are only valid for the total area. You must bear this in mind when interpreting the results (Section 12) or entering data to the SCDB (Section 11 ([11](#))).



If you alter the size of the survey area after you have identified the plot locations – Section 9.1 and the initial number of plots – Section 9.2 ([9](#)), you must recalculate them for the new survey.

# 10. Assessment methods

There are a number of survey methods available to help monitor stocking densities effectively to ensure that the objectives set for the site are being met. The decision tree below will help you decide which survey method is most suitable for you, taking into account your objectives for the site and cost.

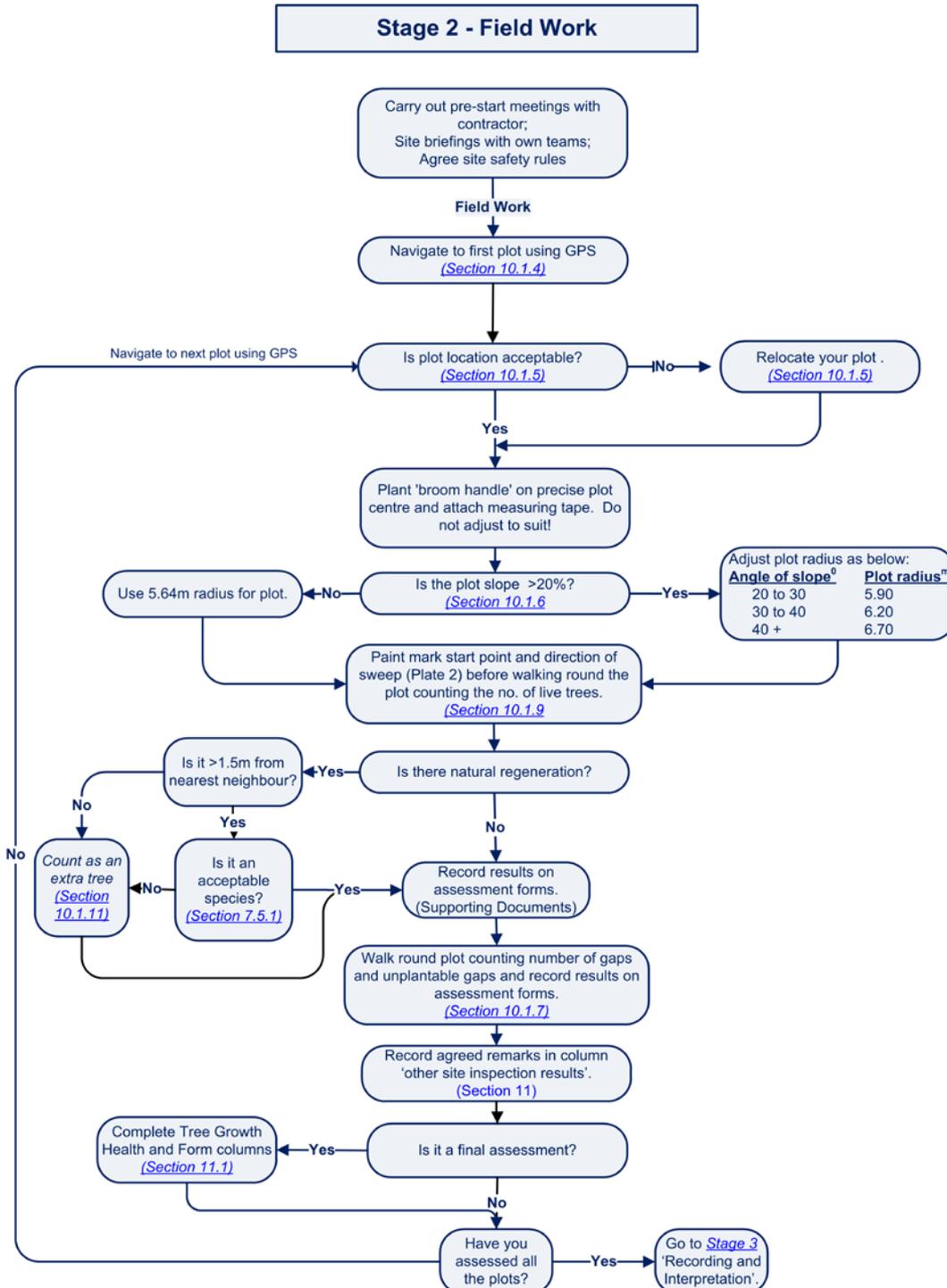


## 10.1 Uniform Planting Assessment (original OGB4 assessment)

You can find data collection sheets on the Operational Guidance intranet page for OGB4 – [click here](#).

Figure 4 shows you the steps required to carry out your Uniform Planting Assessment (original OGB 4) field work effectively. This process is the same for all the counts you will be making (Section 10.2.7 (10)) and we have used counting 'live locations' in this example. Please click the underlined blue links if you want to read that section.

Figure 4 The field work – stage 2



### 10.1.1 When?

Two surveys are normally carried out for Uniform Planting;

1. Initial assessment carried out at anytime between the 1<sup>st</sup> of September and the end of March, before the beginning of the second growing season. In FCE this can be via the Uniform Planting (previously OGB4) assessment or from another survey e.g. beat up survey.
2. A final assessment is carried out any time between the end of the 4<sup>th</sup> growing season and the end of March and the start of the 6<sup>th</sup> growing season or when the crop reaches a height of 1.5m (whichever comes first).

### 10.1.2 Purpose

The initial density and uniformity of trees have important implications for their growth and subsequent timber quality. The initial assessment provides information on how uniform and stocked your sub-compartments are and allows you to plan your management action (i.e. weeding, beat-up etc) to resolve any early identified issues. The final assessment allows us to monitor whether we have achieved our stocking standards and learn from any mistakes. The data gathered from the final assessment is also fed back into the sub-compartment database to help provide an accurate production forecast.

### 10.1.3 Materials and equipment required

- Stock map with plots pre-marked
- Handheld GPS
- Strong broom pole with a flat head nail in the top
- Loggers tape
- 1.5m pole or cane
- Spray paint
- Clinometer or Hypsometer: Suunto or Vertex

Data collection forms: these can be found in Section 14 [\(14\)](#). *You must ensure you have the correct forms for your country.*

### 10.1.4 Navigating to the plots – GPS

Only use GPS units with high sensitivity or quad helix antennas suitable for receiving a satellite signal under the canopy for Uniform Planting plot location and navigation.

GPS is accurate, helps reduce errors and provides a uniform approach for you, the assessor and any auditors.

Plot locations can be digitized and numbered within your GPS utility for easier navigation – see Section 9.1 [\(9\)](#).

### 10.1.5 What is an unacceptable plot?

If it is necessary to move your plot, you must move the plot to a location half way between two existing plots to ensure a plot is located systematically and is representative of the stand. You must make a note on the assessment form by the entry for the plot you are relocating.

Relocating plots should be rare; however there are occasions when a plot location is unacceptable and you will need to move it. Table 3 below provides examples of when you should and shouldn't relocate your plot.

Table 3 Examples of when to move or not to move a plot

Relocate for	Don't relocate for
<ul style="list-style-type: none"> <li>• Main drains.</li> <li>• Unplanted rides / watercourses.</li> <li>• Rocky crags.</li> <li>• If there are more than 3 unplantable gaps due to rocky terrain</li> </ul>	<ul style="list-style-type: none"> <li>• Spoil drains or trenches (mounding).</li> <li>• Brash - regardless of density.</li> <li>• Single rocks obstructing up to three locations.</li> <li>• Areas mistakenly missed by the planters.</li> </ul>

### 10.1.6 Plot size

We always use circular plots with a radius on flat ground (less than 20° slope) of 5.64 m (0.01 ha).

Slopes greater than 20° will however affect your plot area, and you will need to adjust the radius to compensate. Measure the slope using a clinometer and use Table 4 to adjust the radius.

Table 4 Correction factors for slope

Slope (degrees)	Correct plot radius (m)
20 to 30	5.90
30 to 40	6.20
40+	6.70

### 10.1.7 What to count

During the assessment you will be recording three different items.

1. Gaps – Section 10.2.8 ([10](#)).
2. Live Locations – Section 10.2.9.
3. Extra trees – Section 10.2.11.

### 10.1.8 Gaps

What is a Gap? *'A gap is a space where a tree has been missed, or lost, or where the spacing is considerably wider than that used for the rest of the crop.'*

So, would it be sensible and worthwhile to plant another tree in the space? Gaps also refer to dead or dying trees – plants that are unlikely to survive.

During your assessment you will be recording two types of gaps:

1. **Plantable gaps** – these are gaps where you could sensibly plant a beat up tree.
2. **Unplantable gaps** – these are gaps that you couldn't physically plant, for example impenetrable brash, a spoil drain or on a rock or boulder.

#### Counting gaps

When counting gaps you will be carrying out two counts in your head at once – one for the **Plantable** gaps and one for **Unplantable** gaps. To keep count, it is usually best to count aloud. You may prefer to use a tally counter or gate tally, but this may slow you down.

If you can't decide whether a gap is in or out of the plot, only count every other borderline case.

### 10.1.9 Live locations

What is a Live Location? *'A live location is a planting position filled by a live tree of an acceptable species that is likely to survive and is at least 1.5 m from surrounding live locations.'*

You need to discuss with the assessor what is a dead or dying tree so you have agreed clear criteria for accepting a tree as live.

#### Counting live locations

When counting 'Live Locations' the tree's location is taken as the position of the **base of the tree** regardless of the location of the leader. If you can't decide whether it is in or out of the plot, only count every other borderline case.

If the plot includes some natural regeneration, you can only count a regen tree as a live location if it is an acceptable species over 1.5 m from surrounding live locations – see Section 7.5.1 [\(7\)](#).

You can consider all trees which are likely to contribute to the final crop in your final assessment as established. Do not record any trees which are suppressed or checked or are highly likely to be killed from insects and browsing, as live locations. If a high proportion of trees fall into this category, then record this on the form using the remarks column – see Section 10 [\(10\)](#), so that this type of site can be resurveyed and the database updated to reflect the change.

### 10.1.10 Mixtures

**Initial assessment** – counting each species separately during your initial assessment is time-consuming, and at this stage the sub-compartment database (SCDB) is not updated with the species mix – see Section 8.

We therefore suggest you use one of the remarks columns to note the species in each plot and enter a percentage estimate of each species. This information will help you with your management of sites.

**Final assessment** – during your final assessment, it is important that you record the species mix accurately as this information will be used to update the area percentage of the components within the SCDB – see Section 6 (6).

During this assessment, you must therefore:

1. Enter the species code under the species column; and
2. Enter an accurate count of the species mixture in the plot.

The final assessment form will then automatically calculate the area percentage of the components to enter to the SCDB – see Section 8 (8). You will see an example in Figure 5.

During your final assessment you must count and record an accurate percentage breakdown of the species present within a mixed crop.

Figure 5 Extract from completed final assessment form

Plot No.	Unplantable gaps	Extra Trees	Live Locations				Leader Growth
			SS	LP	N/A	N/A	
1	0	0	10	15			
2	0	0	16	9			
		0	9	16			
		0	6	19			
		0	14	11			
		0	10	15			
			5	20			
<b>Totals</b>	0	0	50	105			
<b>Percentages</b>			40	60	0	0	

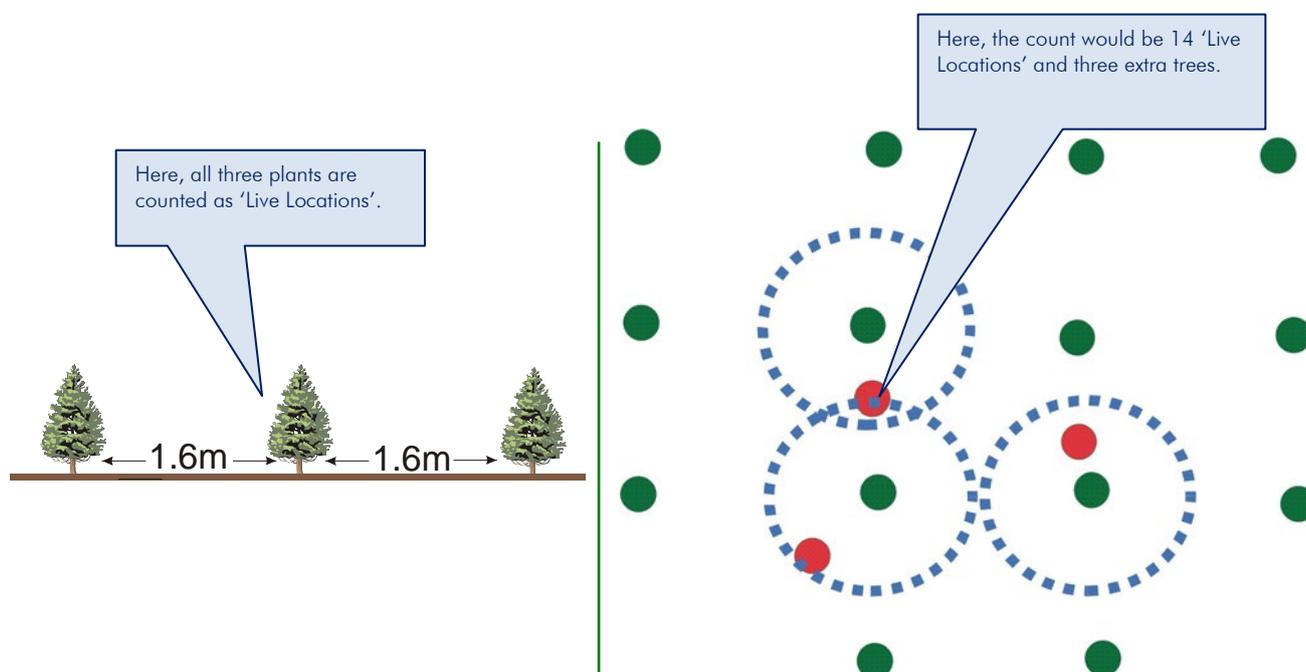
Area percentage for each component calculated here. This will be the figure to enter to the SCDB.

Enter species code here.

Total 'live locations' for species calculated here.

### 10.1.11 Extra trees

What is an extra tree? *'Extra trees are a count of all live trees that are not counted as live locations. This could be due to spacing or the natural regeneration of an unacceptable species'.*



#### Counting extra trees

When counting extra trees you should record the total number of extra trees within each plot. You should take a note of the extra tree species you see in each plot in the Remarks column. Once you have completed all the plots for the area, you should note the **estimated** species breakdown (%) of all the extra tree species you have noted. This will allow the extra trees to be recorded properly within the SCDB – see Section 8 [\(8\)](#).

### 10.1.12 Mapping errors

When accurately navigating around a forest block, you'll be in a good position to judge whether there are any significant errors on the stock map. If you notice an obvious map error, such as an incorrect species boundary then, draw on your map what you think the correction should look like. This can then be verified and updated by your planning team. When re-mapping a site you may wish to re-locate plots that would have otherwise fallen outside the planting boundary.

### 10.1.13 Tree health

You must complete the appropriate columns relating to tree health.

#### For England and Wales

During your 'final' Uniform Planting assessment, it is important that you record as much information about the crop's growth and health as possible. You must give this information to your operations team, so that they know which crops require more input if they are to produce a potential sawlog crop.

The columns within the final assessment form are designed to be quick and straightforward to complete and we recommend that you enter % values to the nearest 10%. The percentage recorded should be based on a visual assessment once you have completed your stocking assessment and are back at the plot centre. You do not need to carry out any more measurements.

The final assessment form requires you to record:

1. **(%) Poor Leader Growth** – the % of live locations within the plot, where leader increment in the growing season before assessment, is less than the mean increment achieved during the previous growing seasons.
2. **(%) Poor Foliage Colour or needle length** – the % of live locations (evergreen conifers) within the plot where the current or previous season's needles are showing yellowing or a reduction in the average length of the needles achieved during the previous and current growing seasons.
3. **(%) Multi-stems** – the % of live locations within the plot where there is more than one stem displaying apical dominance.

#### The remarks columns

Both initial and final assessment forms contain remarks columns, and you can add more columns if you need to collect more information. Use this information to help other management programmes, for example weeding or chemical spraying.

Table 5 provides some useful examples of column headings that you may wish to add to your assessment form. You can then add a tick, text or percentage estimate to record the presence of a problem within the plot.

Table 5 Example column headings and information

Column heading	Information to collect
Weed-growth	How significant is the weed-growth on the site – will it require weeding?
Weevil	Is there weevil damage? If so what percentage?
Browsing	Is there browsing? If so what percentage?
Check	Is there any check?
Dead	Are there any dead trees? If so, what percentage?



Discuss the 'remarks' column headings with the assessor before you begin, so that information that you, the forester, require on any particular site is included. Remember that your requirements may vary from site to site.

### For Scotland

More detailed information is required with respect to tree health and competition. You **must** fill out the Year 1 Management Sheet or the Year 5 Management Sheet fully when carrying out the OGB4 assessment. See the FES forms for more details.

You can find data collection sheets on the Operational Guidance intranet page for OGB4 – [click here](#).

## 10.2 Continuous Cover Forestry: FC Information Note 45

### 10.2.1 Overview

This [Information Note](#) describes a system for monitoring the development of a stand being transformed from an even-aged structure to continuous cover management. Monitoring is essential because it produces the stand-level information on species composition, diameter distribution and natural regeneration that is required to plan silvicultural interventions. The method uses fixed-area plots, either temporary or permanent, located on a systematic grid over the whole area being transformed. The main assessments are species, numbers and diameter of trees ( $\geq 7$ cm diameter at breast height), and the species and numbers of saplings (trees  $< 7$ cm dbh and  $\geq 130$ cm tall). Interpretation of the results of the monitoring depends on whether transformation is aiming for a simple structure (1 or 2 canopy strata) or a complex structure (3 or more canopy strata).

### 10.2.2 When?

This survey should be carried out before transformation work begins and repeated after a minimum of 5 years and a maximum of 10 years depending on stand reactions to transformation and the requirement for management information.

### 10.2.3 Purpose

This system of monitoring produces information so you can judge how a stand has developed over time. It is therefore important to use the system before starting, and during the process of transformation, to obtain information to control a sequence of interventions. You should include the information from the monitoring in a written plan describing management objectives, site conditions, current and desired stand structure and species composition, planned interventions and a transformation period. The plan should be revised after each cycle of intervention and monitoring.

### 10.2.4 Materials and equipment required

- Handheld GPS
- DBH tape
- Loggers tape
- Suunto or Vertex
- Spray paint
- Digital camera
- Blank survey form
- Permanent plot markers (if required).

*Appendix 2 of the Information Note contains a worked example plus a blank data collection form.*

## 10.3 Nearest Neighbour Method for quantifying wildlife damage to trees in woodlands

Please also read FC Practice Note [http://www.forestry.gov.uk/pdf/fcpn1.pdf/\\$FILE/fcpn1.pdf](http://www.forestry.gov.uk/pdf/fcpn1.pdf/$FILE/fcpn1.pdf)

### 10.3.1 Overview

To assess the exact scale of tree damage within a site you would have to examine every tree. Since this is rarely feasible, the Nearest Neighbour method uses a number of systematically located points throughout the site to assess a pre-determined number of trees (a cluster) for damage. In this way, you can make an assessment to a known level of statistical precision,  $\pm x\%$  at 95% confidence level. The greater the number of trees you assess; the greater the accuracy. Hence, depending upon the value of the site and the required accuracy, you can tailor your survey to give a defined *desired* level of accuracy. Note that you may not reach your desired level of accuracy if there is a large variation in the level of damage found between clusters, unless you resort to assessing more trees. You can also assess stocking using this method.

### 10.3.2 When?

Carry out as part of the year 1 and year 5 assessments or as required.

### 10.3.3 Purpose

To ascertain the level of tree damage across a site for a set level of accuracy.

### 10.3.4 Materials and equipment required

- A map of the area to be assessed, preferably 1:10,000 scale or larger.
- Compass.

If stocking is required:

- 30 m tape to measure 10 m x 10 m 0.01 ha plots.
- Posts to mark corners of 10 m x 10 m plots.
- DBH tape and hypsometer - if stand top height required.
- Record forms, clipboard and pencils.

You can find data collection sheets on the Operational Guidance intranet page for OGB4 – [click here](#).

## 10.4 Quadrat (square plots) assessment for stocking density<sup>1</sup>

### 10.4.1 Overview

This method uses a variable number (based upon the *desired* % of stocking required – 70%, 80% or 90%) of 2 x 2 m to 4 x 4 m quadrats. Quadrats are assessed in terms of whether they are stocked or not, and must be distributed across the site, systematic sampling is often used to achieve this. Whether you assess a quadrat as stocked or not depends upon a number of criteria, for example quadrat size, site, species and objectives, and it is important to record the criteria you use to determine whether you consider a quadrat stocked or not. [Click here](#) to see the full details.

### 10.4.2 When?

This survey should be carried out before any work begins to ascertain current stocking of the site against management objectives and you should repeat it after a minimum of 5 years and a maximum of 10 years depending on the requirement for management information.

### 10.4.3 Purpose

To assess the proportion of the site stocked with seedlings and saplings and to compare against management objectives.

### 10.4.4 Materials and equipment required

- Compass
- Survey sheet
- Linear tape and/or walktax
- GPS
- Map
- Aerial Photos
- DBH tape.

<sup>1</sup>from Harmer, R., Beauchamp, K. and Morgan, G. (December 2011) Research Note: Natural regeneration in western hemlock plantations on ancient woodland sites.

You can find data collection sheets on the Operational Guidance intranet page for OGB4 – [click here](#).

## 10.5 Planted Ancient Woodland Site (PAWS) Monitoring

You can find complete information on this link – [click here](#), including monitoring forms and methods.

### 10.5.1 Overview

A simple map-based and walk-through method of monitoring which allows you to use survey data as a baseline for future monitoring.

The method is based on a simple walk through, mapping and making target notes of specific features of interest. The form provides a structured layout to record information on ancient woodland remnants and components of native woodland development. For each stratum, you record a summary threat level and trend in conditions since the last monitoring round. You can use the “results last monitoring round” to record summarised information from other monitoring methods (for example the FES PAWS monitoring method developed in 2005). An action plan specifies which actions are necessary, justification for actions, timing and date for the completion of work plans.

### 10.5.2 When?

Table 6 identifies when to set the next monitoring round after the initial survey. Note that the cycle is based on silvicultural requirements as well as threat levels. For gradual restoration sites and pre-clearfell treatments, the cycle would change as the threat level changes.

Table 6 Setting the next round of monitoring

Restoration method and stage	Threat level		
	Critical	Threatened	Secure
Where work has not yet started	Assumption is that work will start here as soon as possible (i.e. within 2 years of initial survey).	5 to 10 years after initial survey or last monitoring round.	Does not apply.
Works before clearfelling (e.g. halo thinning) or gradual restoration using ATC	Every 2 years.	Every 5 years.	Every 10 years to ensure remnants are still secure.
Post clearfell (moist fertile sites)	Years 2, 5 and 10 then review.	Years 2, 5 and 10 then review.	Years 2, 5 and 10 then review.
Post clearfell (dry acidic sites)	Years 2, 5 and 10 then review.	Years 5 and 10 then review.	Years 5 and 10 then review.

### 10.5.3 Purpose

To monitor the restoration of PAWS sites and the threats associated with them.

### 10.5.4 Materials and equipment required

- Maps aerial photographs
- WeatherWriter clipboard
- Monitoring forms (preferably on waterproof paper) – one for each stratum
- Pencils
- Camera
- GPS.

You can find data collection sheets from Appendix 3 onwards of the PAWS Guidance – [click here](#).

## 10.6 Natural Regeneration Monitoring

### 10.6.1 Overview

This method assesses and maps, down to 0.25ha, the area and level of natural regeneration occurring within a coupe. Mapping is based upon the evenness and similarity of the regeneration in terms of species and size.

### 10.6.2 When

Dependent upon objectives, but initial assessment once a reasonable number of saplings are  $\geq 1.5$ m tall and therefore established. Use your site objectives to help define what is 'reasonable'. Data from this survey is viewed as an aid to management, and the survey is descriptive rather than prescriptive.

Surveys should be carried out winter to late spring when other ground vegetation is least likely to obscure the smaller regeneration.

### 10.6.3 Purpose

To spatially locate natural regeneration and record the number, species, height ( $> 1.5$ m or not), planting year (for plants  $> 1.5$ m tall), type of regeneration, stocking level, mammal damage and dominant ground vegetation.

### 10.6.4 Material and equipment required using:

- A Toughbook with:
  - Aerial Photos (current and ortho-rectified);
  - FC boundary;
  - FC roads;
  - Compartment boundaries and numbers;
  - Sub-compartment shape file with crop attributes;
  - PGDB providing one layer to record any mappable natural regeneration and a second 'point' layer to record any points of interest; and
  - OS maps.
- Paper:
  - WeatherWriter clip board;
  - Monitoring forms (preferably on waterproof paper) – one for each stratum;
  - Pencil(s);
  - Maps and APs;
- Additional Equipment:
  - GPS; and
  - Compass.

This method is not available elsewhere on the web so we have explained it in full in [Appendix 1](#).

You can find data collection sheets and the database file on the Operational Guidance intranet page for OGB4 – [click here](#).

## 10.7 Fixed point photography

Please also look at the FC(S) Woodland Grazing Toolbox – <http://www.forestry.gov.uk/forestry/infd-838mbm> and Section 17.10.10 of the Surveys Handbook.

### 10.7.1 Overview

Fixed-point photography is an ideal and cost-effective way of recording the status of non-commercial crop sites, and will provide evidence of the effectiveness of management.

Areas of special importance to consider when analysing photos for change are:

- an increase in tree seedling or sapling density;
- an increase in woodland indicator plant species (either an increase in clump size or increase in individual plants or an increase in the diversity of associated woodland vascular plants that could indicate changes in the woodland succession status); and
- an increase in undesirable plants or tree regeneration that would indicate a need for further management.

### 10.7.2 When?

Select an area that has the potential for native tree regeneration and, if possible, also has examples of native woodland vascular plant indicator species. Aim to revisit the points after about 5 years, sooner if you expect rapid change.

### 10.7.3 Purpose

An inexpensive method to subjectively assess natural regeneration across an area.

### 10.7.4 Materials and equipment required

- Digital camera;
- GPS;
- Post to mark photo point;
- Marker paint (for post);
- Hammer;
- Note paper and pen – comments to help find the post in the future and to note the direction of photo, time and date; and
- Canes to mark out a square 1.3 m x 1.3 m – use this area as a guide to the ‘field of view’ for the camera shot.

## 10.8 Visual walk-through

This method is taken from Section 17.10.12 of the Surveys Handbook.

### 10.8.1 Overview

On important sites, systematic sampling schemes or random transects will generally be much quicker than traditional stocking density surveys. This will provide you with enough precision as long as you have adequate records of tree numbers and distribution from when it was planted.

On the rare occasion, where the tolerance on the objective target is very narrow, or the site assessor has difficulty visually assessing the stocking density, then use the following method:

- the easiest transect method, is to walk using a compass bearing from a fixed point and visually assess or count (depending on density of regeneration) any plants which fall 50cm either side of the route you take;
- split the transect into sections by length, and record the number of plants (species proportion and average height, if desired) in each section;
- mark on the transect the length of open space with no plants using a compass, walktax and one metre long cane; and
- then apply the results of the transect proportionally to the area that the transect represents.

Use common sense when deciding how much of the site to walk. If there is a watercourse, then use a transect up one side and one down the other. If the site consists of a hollow and a slope, then one transect in the hollow and one diagonally across the slope should be fine. The transects must represent any variations on that site.

Consider permanently marking the start point of the transects so that the same transect can be used at the next five-year assessment.

### 10.8.2 When?

Dependent upon objectives, but at initial assessment once a reasonable number of saplings are  $\geq 1.5$ m tall and therefore considered to be established. Use your site objectives to help define what is 'reasonable'.

### 10.8.3 Purpose

Quick and cost effective assessment of species and abundance of saplings across a site.

### 10.8.4 Materials and equipment required

- GPS
- Post to mark transect lines if required
- Marker paint (for post)
- Hammer
- Note paper and pen – comments to help relocate the post or transects in the future.

## 10.9 Monitoring other attributes using the example of large herbivores

As well as assessing stocking density, you may want to assess other attributes on the site, for example deer damage or woodland structure. The number, and type, of other attributes you assess will depend upon the management objectives of the site and the available survey funding. Where possible it is often desirable to carry out surveys at the same time to reduce the cost of repeat visits and to aid logistics.

As an example we have used the method for assessing the impact of large herbivores on woodland which we have taken from the Woodland Grazing Toolbox <http://www.forestry.gov.uk/fr/inf-d-6chc9h>.

### 10.9.1 Overview

Impact assessments are a key element of deer and domestic stock management in woodlands. Earlier work, carried out in the 1980s focussed on deer damage assessment methods that were suited to plantation woodlands. However, with the increased focus on natural regeneration and woodland biodiversity, new methods are required.

Two methods are being developed and tested which are intended to address this need:

- A 'qualitative' method that involves subjectively categorising woodland structure into one of eight classes, then assessing the impact of current browsing and grazing on seven indicators – the method is documented in [The Woodland Grazing Toolbox](#). The indicators are:
  1. basal shoots;
  2. epicormic or lower shoots;
  3. seedlings or saplings;
  4. bark stripping;
  5. preferentially browsed plant species;
  6. ground layer sward; and
  7. ground disturbance.
- A quantitative method based on 10 m x 2 m plots, divided into 1 m long sub-plots. Indicators of woodland structure and current herbivore impact similar to those assessed in the qualitative methods are assessed quantitatively. The method has been developed to be practical, easy to implement and to interpret and can be statistically analysed. Further testing of the method, and of a database to receive and summarize data, continue.

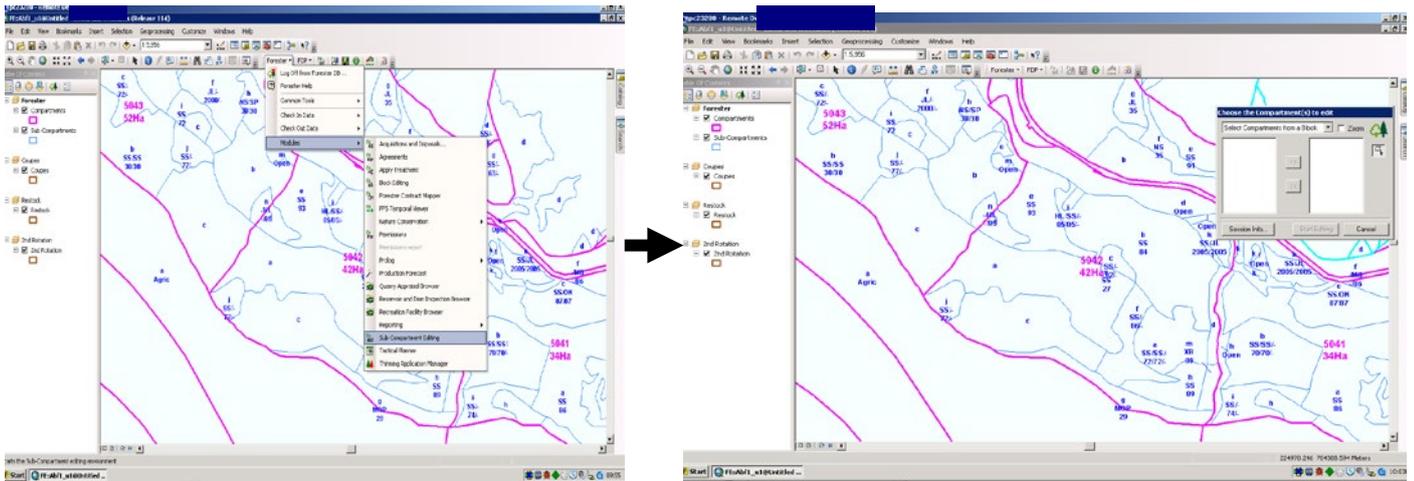
Data collection sheets can be found here: [The Woodland Grazing Toolbox](#).

# 11. Recording

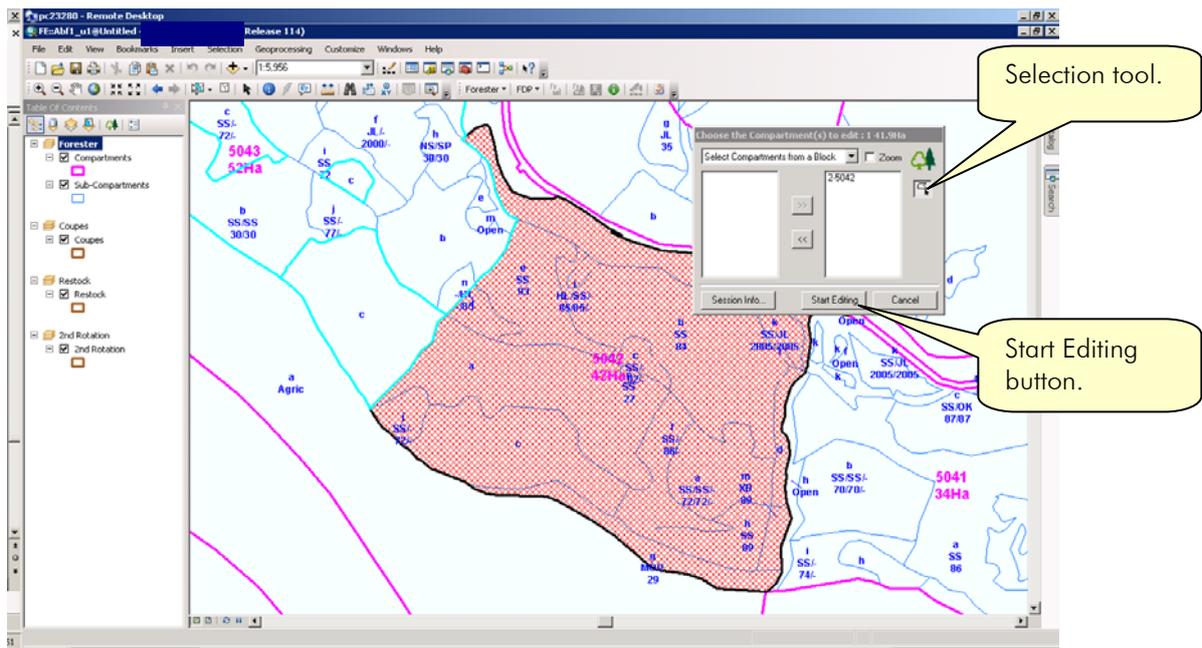
The data gathered from your assessments is valuable to the future management of the crops and may help to inform the Production Forecast across GB. It is therefore important that as much of this data as possible is fed back into the sub-compartment database.

The following sections tell you what you need to record, where to record it and how it informs the Production Forecast. (Note, the data shown in the screen displays is from the IFOS test database).

When entering data from the assessments we recommend you use a separate edit session for each survey.



- Open an edit session (see above) **Select the Area** to be edited using 
- then **Click** 



In the 'Edit session information' box which opens on the screen **Fill In** the required fields:

- Survey ID: The identification tag for the survey which should relate to any information held elsewhere about the survey, e.g. paper maps, photos...
- Survey Date: enter the **Edit Session** date here, the date of assessment is filled in later.
- Surveyor: filled in by software.
- Survey Type: Choose appropriate **Survey Type**.
- Method: Choose appropriate **Method**.
- Accuracy: Choose appropriate **Level Of Accuracy**.
- Comment: Fill in any other details required.

Note that you must complete all fields before you **Click**  to get the **Inventory Editing** dialogue box.

Data may or may not already exist. Where you see orange fields, these are mandatory elements which **must be filled in**.

Fill in the data fields as appropriate for the survey you have carried out:

- **% Area** – % of the area allocated to the Component.
- **Land Use** – Land Use allocated to the Component.
- **Habitat** – Habitat allocated to the Component.
- **Rotation** – rotation allocated to the Component.
- **Species** – species of the Component.
- **Planting Year** – P year allocated to the Component.
- **Storey** – storey allocated to the Component.
- **Mixture** – mixture type across the area allocated to the Component.
- **Yield Class** – estimated or measured yield class of the Component.
- **Spacing** – spacing, assuming square spacing, of the Component for Components < 1.3m tall, if  $\geq 1.3$ m tall use the Stems per hectare field further down.
- **OGB4 Survey Year** – Survey date allocated to Uniform Spacing assessments (original OGB4 assessment) or for variable density surveys where the trees are < 1.3m tall.
- **OGB4 Stems p/ha** – Stems per hectare allocated to Uniform Spacing assessments (original OGB4 assessment) or for variable density surveys where the trees are < 1.3m tall.
- **Assessment Date** – Assessment date for surveys of trees  $\geq 1.3$ m tall.
- **Assessment Pre/Post Thin** – If a thinning is due the year of the survey, it is important to know whether the survey has taken place pre or post thinning (not needed for OGB4 surveys but entered here for completeness).
- The remaining fields to be filled out as appropriate to the survey carried out.

Field	Value
Forecastable	Yes
Area	4.9 Ha
% Area	85
Land Use	High Forest
Habitat	CONIFEROUS WOODLANDS
Habitat Condition	<null>
Rotation	2nd and subsequent rotations
Species	Sitka spruce
Origin	<null>
Propagation	<null>
Seed Identity	<null>
Planting year	1992
Planting month	<null>
Storey	Single Storey
Mixture	Pure Crops
Yield class	10
Wind hazard	5
Spacing	2
OGB4 Survey Year	1998
OGB4 Stems p/ha	
Assessment Date	
Assessment Pre/Post Thin	<null>
Top Height (m)	
Basal Area per hectare (m2)	
Stems per hectare	
Quadratic Mean DBH (cm)	
Standing Volume per hectare (m3)	
Previously Thinned	
Last Thinned	

Area covered by components = 100%

## 11.1 Uniform Planting Recording

Table 7 Uniform Planting: What to record and where

Stage	Field	Required updates to SCDB	What contributes to the forecast
For each Component record:			
<b>Planting</b>	Planting year	Input planting year	For each component the forecast uses the planting year, estimated yield class and the spacing. From this initial spacing it calculates a number of trees per hectare based on the average spacing conversion table <a href="#">Surveys Handbook</a> (Table 4.3-21).
	Propagation	The 'Propagation' field should be set to either 'Null' or 'Vegetative propagation'.	
	Yield Class	Input estimated yield class to the 'Yield Class' field.	
	Spacing	Input <b>target</b> spacing.	At this stage the forecast is using the target number of trees for the site. As management is aimed at achieving this target for each component, you do not need to enter anything in the stocking fields.
	Mixture	If the site contains a mixture of species create a component for each species and enter the area percentage for each component based on the planting ratio.	
You should review and record a component for each species identified and for each Component review/record:			
<b>Initial Uniform Planting (OGB 4) Assessment</b>	Propagation	The 'Propagation' field should be set to either 'Null' or 'Vegetative propagation' for live locations and 'Natural regeneration' for extra trees.  NB: Extra trees that are of the same species as the live locations need to be entered as separate components with a propagation of 'Natural regeneration'.	As above.  At this stage the forecast is using the <b>target</b> number of trees for the site, as management is aimed at achieving this target number of stems for each component. However, the values in the OGB4 stocking fields are used for OGB4 reporting.  N.B. At this stage, the total stems per hectare assessed across the sub-compartment may differ from the stems per hectare derived from the target spacing.
	OGB4 Stems p/ ha	Input the number of stems per hectare relevant to each component.	
	OGB4 Survey Year	Input the survey year	
	Mixture	If the site contains a species mixture you must update the area percentage of each component based on the relevant proportion of trees counted.	

Stage	Field	Required updates to SCDB	What contributes to the forecast
You should review and record a component for each species identified and for each Component review/record:			
Final Uniform Planting (OGB 4) Assessment	Propagation	<p>The 'Propagation' field should be set to either 'Null' or 'Vegetative propagation' for live locations and 'natural regeneration' for extra trees.</p> <p>NB1: Extra trees that are of the same species as the live locations need to be entered as separate components with a propagation of 'Natural regeneration'.</p> <p>NB2: The number of components may change due to the removal of an extra tree component or seeing additional natural regeneration.</p>	<p>As above, bearing in mind that the spacing is now based on the total stems per hectare of all components.</p> <p>At this stage the forecast assumes that all establishment operations are complete and all the trees on the site are established regardless of whether they are planted or arise from natural regeneration.</p>
	OGB4 Stems p/ ha	Input the number of stems per hectare relevant to each component.	
	OGB4 Survey Year	Input the survey year.	
	Spacing	<p>Update the 'spacing field' based on the <b>total number of trees on site for all components</b> using the following formula:</p> $\text{Spacing} = 100 / \sqrt{\sum \text{sph}}$ <p>(stems per hectare)</p> <p><i>This will give you an estimate of the spacing as if the trees had been planted according to a perfectly square pattern.</i></p> <p><i>N.B. Each component is allocated the same spacing.</i></p>	
	Mixture	If your site contains a species mixture, you must update the area percentage of each component based on the relevant proportion of trees counted during the final assessment.	

## 11.2 Variable Density assessments

Table 8 What to record and where

Stage	Field	Required updates to SCDB	What contributes to the forecast
You should review and record a component for each species identified and for each Component review/record:			
Assessment of Components <1.3m height	Propagation	Set to either 'Null', 'Vegetative propagation' or 'Natural regeneration'.	For each component the forecast uses the planting year, estimated yield class and the spacing. From this initial spacing it calculates a number of trees per hectare based on the average spacing conversion table <a href="#">Surveys Handbook</a> (Table 4.3-21).
	Planting year	Input estimated planting/regeneration year per component.	
	OGB4 Stems p/ha	Input the number of stems per hectare relevant to each component.	
	Yield Class	Input estimated yield class for each component.	
	Spacing	Input spacing per component. Remember to convert estimated stems per hectare to a square spacing.	
	OGB4 Survey Year	Input the survey year for each component.	
	Mixture	If your site contains a species mixture you must update the area percentage of each component based on the relevant proportion of trees counted.	
You should review and record a component for each species identified and for each Component review/record:			
Assessment of trees ≥1.3m tall.	Propagation	The 'Propagation' field should be set to either 'Null', 'Vegetative propagation' or 'Natural regeneration'.  NB: The number of components may change due to the removal of a tree component or seeing additional natural regeneration.	For each component the forecast uses the planting year, estimated yield class and the spacing. From this initial spacing it calculates a number of trees per hectare based on the average spacing conversion table <a href="#">Surveys Handbook</a> (Table 4.3-21).  Where additional mensuration parameters
	Stems per hectare	Input/Update with the number of stems relevant to each component.	
	Assessment Date	Input/Update with the year of the assessment for each component.	

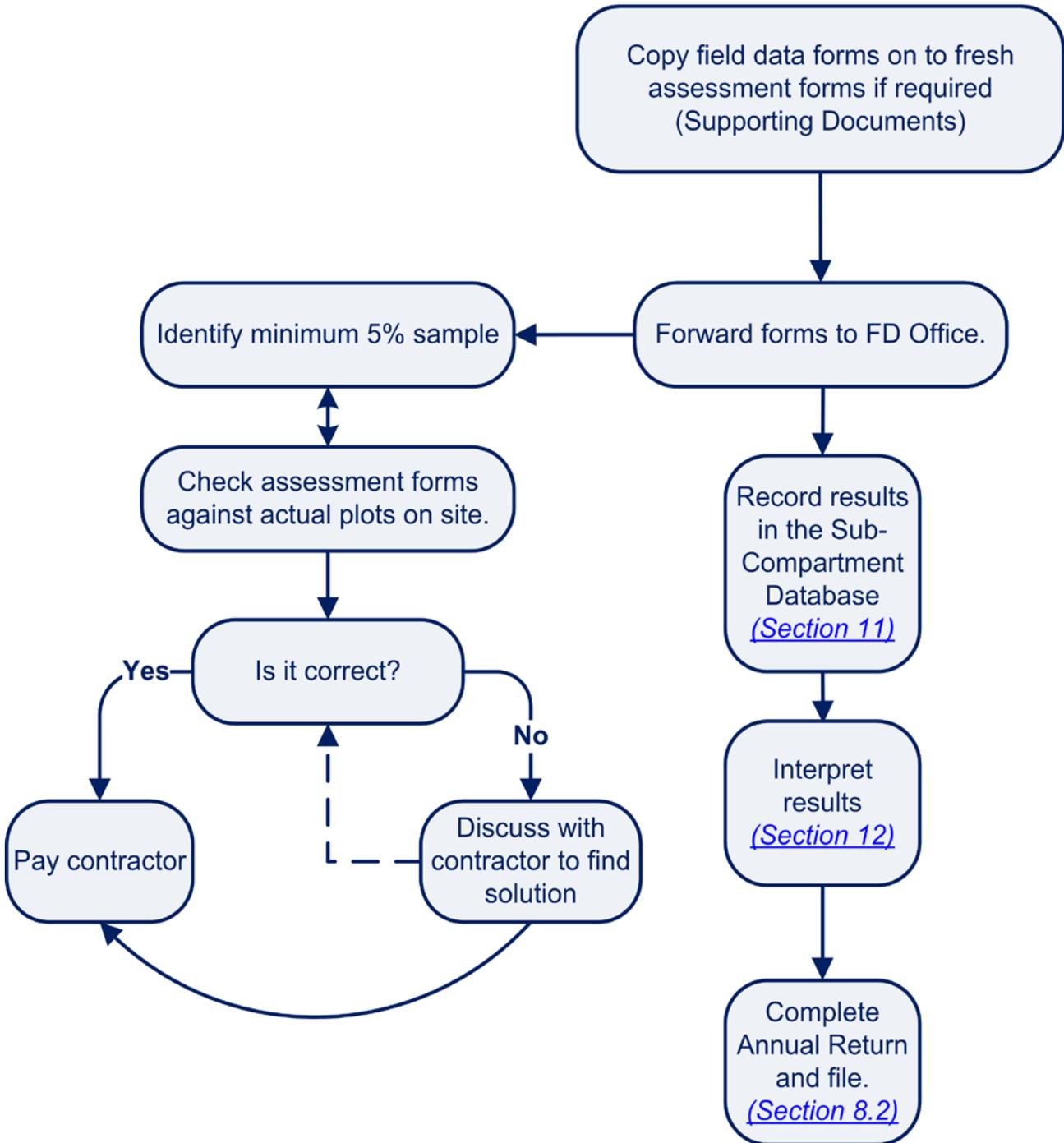
Stage	Field	Required updates to SCDB	What contributes to the forecast
		<p>Update the 'spacing field' based on the <b>total number of trees on site for all components</b> using the following formula:</p> $\text{Spacing} = 100 / \sqrt{\sum \text{sph}}$ (stems per hectare) <p><i>This will give you an estimate of the spacing as if the trees had been planted according to a perfectly square pattern.</i></p> <p><i>N.B. Each component is allocated the same spacing.</i></p>	<p>such as Top Height and Basal Area are known the forecast will use these data in preference to estimated Yield Class and stocking.</p>
	Mixture	<p>If your site contains a species mixture, you must update the area percentage of each component based on the relevant proportion of trees counted during the final assessment.</p>	
	Assessment Pre/Post Thin	<p>Input whether the assessment is pre or post thinning if a thinning is due that year.</p>	
	Top Height (m)	<p>Input if data collected.</p>	
	Basal Area per Hectare (m <sup>2</sup> )	<p>Input if data collected.</p>	
	Quadratic Mean DBH (cm)	<p>Input if data collected.</p>	
	Previously Thinned	<p>Input if known.</p>	
	Last Thinned	<p>Input if known.</p>	

## 12. Review and interpretation

Please click the underlined blue links if you want to read that section.

Figure 6 Recording and interpretation chart for Uniform Planting – Stage 3

### Stage 3 'Recording and Interpretation'



To keep improving your stocking density and uniformity, it is important that you review the information collected during your assessments, passing this information on to your operations teams to help management programmes and learn from mistakes. Table 9 provides some useful questions that may help.

Table 9 Some questions to help you

No	Question
1	Was the ground preparation method correct?
2	Was the initial ground prep density correct?
3	Were enough trees planted in the first place or have trees been lost after planting?
4	Does the site require beating up?
5	Was there significant browsing or weevil damage to the trees?
6	Does the site require pesticide application?
7	Does the site require weeding?
8	Was there a significant number of unplantable gaps? What were the reasons for this?

Don't just look at the overall figure for live locations and ignore the rest, even if this figure indicates a stocking of over 2500 stems per hectare (sph), you may still have problems that you need to address.

At the ideal 1.9 x 1.9 m spacing, we would expect 27 live locations per plot with no gaps. Remember that because the plot is quite small, the exact location of the plot centre in relation to the rows can mean that even in a perfect plot, the count may vary by +/- 2 locations. This is why you assess a reasonably large number of plots per site. Depending on the variability of the crop, you can expect a sample error of +/- 10% using this method, although +/-15% is not unusual.

Providing that you have <7% evenly distributed losses, you will usually not intervene as this is an acceptable minimum for beating up, but remember that the distribution of these losses is just as important.

We have provided some examples on how to interpret your results as a supporting document in Section 14.

## 13. Training

Learning and Development (L&D) run a training course entitled *Measuring Restock Planting Density (OGB4)* – Reference 2.08 – which you can apply for through [Yourself](#).

## 14. Supporting Documents

Table 10 Supporting documents

No	Title with link
1.	FES Uniform Planting <i>Data collection sheets can be found on the Operational Guidance intranet page for OGB4</i> – <a href="#">click here</a> .
2.	<a href="#">Initial or final assessment forms, and stocking density returns</a> .
3.	Uniform Planting <a href="#">Interpreting your results</a> .
4.	Uniform Planting <a href="#">How to generate plot locations and produce maps</a> . Due to be updated for Arc10.
5.	Uniform Planting <a href="#">Effective counting of natural regeneration in a sample plot</a> .
6.	Uniform Planting <a href="#">Plot grid spreadsheet</a> .
7.	Harmer, R., Kerr, G. and Thompson, R. (2010) <i>Managing Native Broadleaved Woodland</i> , The Stationary Office, Edinburgh.
8.	Kerr, G., Mason, B., Boswell, R. and Pommerening, A. (2002) <a href="#">Monitoring the Transformation of Even-aged Stands to Continuous Cover Forestry</a> , Forestry Commission Information Note 45.
9.	Harmer, R., Beauchamp, K. and Morgan, G. (2011) <i>Natural Regeneration in western hemlock plantations on ancient woodland sites</i> . <a href="#">Forest Commission Research Note 011</a> .

## 15. Appendix 1: Natural Regeneration Survey Methodology (written by Ben Griffin and Nick Evans)

### 15.1 Natural Regen Survey Methodology

Survey each coupe where natural regen is occurring. Walk through each coupe to get an idea of the amount and composition of natural regen. Map areas of regen in GIS using a toughbook and GPS.

Minimum polygon size 0.25ha, mapped to a homogenous area based on species and size.

Data on toughbook:

- SCDB information (read only)
- Ortho-rectified Aerial Photos

#### [Natural Regen PGDB](#)

On the toughbook:

1. Set up the project.
2. Start Arc GIS.
3. Add all crop data and aerial photo.
4. Add the PGDB "Nat Regen". Within this add "Natural Regen Survey".
5. Before mapping, set snapping tolerances at a suitable level to reduce the chances of overlaps, also set sticky tolerances to prevent accidentally moving polygons.

### 15.2 Mapping the areas of regen

1. Make sure you have the editor tool bar (Right-click on tool bar and choose the editor option).
2. Click on the editor toolbar, choose "start editing".
3. Find the PGDB where you have saved it and click OK.
4. In the editor toolbar choose the 'create new feature' task and ensure the target theme is "Natural Regen Survey".
5. Draw the shape on the map as it is on the ground, use the GPS to help with this (it is possible to use the GPS active link with the toughbook to help with this, or for mapping large areas it is possible to create a track within the GPS all around the area, which can be downloaded later).
6. Once the shape is mapped on the GIS it is important to enter the correct data. For each shape enter the following data:
  - a. Name of Surveyor.
  - b. Date of survey – important to date the survey data for future comparison and management.
  - c. % of Polygon with NR – A subjective value by the surveyor of the extent of the polygon occupied by NR in 5% classes.
  - d. Species – From drop-down species list (up to four separate species can be described).
  - e. % of species – The % of each species present in the polygon (note; a single species would always therefore be 100%).
  - f. Total % checker – a useful check for the surveyor.
  - g. Regen over 1.5m in ht – if the average height of all regen within the polygon is 1.5m or greater,

consider including it in the SCDB.

- h. Planting year for regen over 1.5m ht – Required for SCDB entry. The P year is described as being the number of years growth from the 1.5m ht to the year of survey, as counted by whorls. I.e. Regen having an average (regardless of species) of 3 years of growth whorls above a height of 1.5m would be classified as Pyr 2006 if they were surveyed during 2009.
- i. Type of regen cover – used to qualify the density score:
  - Predominately in Patches
  - predominately uniform
  - mixture.
- j. Stems / ha – selected by bands:
  - Less than 1100
  - 1100-2500
  - 2500-5000
  - 5000+
- k. Mammal damage – Limited to damage of leaders:
  - 0-5%
  - 5-10%
  - 10-25%
  - 25-50%
  - 50-75%
  - 75-100%.
- l. Predominant Ground vegetation cover:
  - Mosses
  - Heath
  - Fine leaved grasses
  - Broad leaved grasses
  - Bracken
  - Gorse or Broome,
  - Rhododendron.
- m. Comments – Free text field for surveyor.
- n. Area – Provides an area of each drawn polygon.

When surveying it is important to save your edits regularly to ensure that data is not lost.

### 15.2.1 Checking the data:

1. Start Editing.
2. Select all features within the shapefile.
3. Use the “validate feature” tool.
4. This will highlight any data that is incorrect e.g. incorrect planting years or percentage data.
5. Select all features in the shapefile and then select clip to remove all the overlaps.
6. Calculating areas.

When editing the shapefile open the table and go to the area ha field in the table and right click and choose calculate geometry then choose area in hectares. This will update all the areas.

7. Calculating total percentages.

When editing the shapefile open the table and go to the total percent field, right click and choose field calculator. In the next window that opens choose enter the equation below in the box.

[Prct\_Species\_1] + [Prct\_Species\_2] + [Prct\_Species\_3] + [Prct\_Species\_4]

Then OK, this will add up all the percentages for each species to check if they add up to 100.

### 15.2.2 Survey Features:

Where you find unexpected features, map these using the Survey Features shapefile. To do this you need to first add the Survey Features shapefile then start editing, ensuring Survey Feature shapefile is the target. Simply add the point and then enter the details in to the “description” field and stop editing and save edits.

You can find data collection sheets and the database file on the Operational Guidance intranet page for OGB4 – [click here](#).

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