



Guidance for the use of silvicultural systems to increase woodland diversity



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1. Introduction

This guidance provides advice for woodland owners and managers about using silvicultural systems to move towards reducing clearfelling and increase the structural diversity of woodlands. The primary focus of this guidance relates to conifer woodlands but it also considers silvicultural systems in the management of broadleaf woodlands.

This supports one of the aims of *Woodlands for Wales* the Welsh Governments woodland strategy which has a commitment that “*Clearfelling will be avoided where alternative management systems would make a better contribution to ecosystem services*”

In this guide we:

- Identify a range of silvicultural options available to forest managers in Wales;
- Explain the range of benefits or services that can be delivered from the woodland ecosystem using different silvicultural systems, and assesses their relative contribution;
- Identify a series of recommendations, key actions and priorities;
- Explain the link between this guidance and other strategies for diversification, such as *A guide for increasing tree species diversity in Wales*
- Explain the role of thinning in achieving diversity; and
- Provide a link to sources of information about the selection and management of silvicultural systems.

It is essential that in delivering structural diversity to maintain the principles of **sustainable forest management** as set out within the UK Forestry Standard (UKFS) and that the associated Forestry Guidelines are followed.

1.1 What do we mean by Silvicultural Systems?

“A silvicultural system is the process of tending, harvesting and regenerating a forest. Different objectives in forest management (e.g. conservation in ancient and semi-natural woodland vs. production of timber from a conifer plantation) are likely to lead to the adoption of different silvicultural systems” - [Forest Research website](#)

Woodlands for Wales states that we should seek to avoid clearfelling.

In this guidance we use the following terminology when describing silvicultural systems:

Minimum Intervention: Management with no systematic felling or planting of trees. Operations normally permitted are fencing, control of exotic plant species and vertebrate pests, maintenance of paths and rides and safety work.

Standard Clearfelling: In the UK Woodland Assurance Standard (UKWAS) (& UKFS) clearfelling, in a larger area of woodland, is defined the removal of trees from an area greater than 0.25 ha. In this guidance we define standard clearfelling as the removal of trees from an area greater than 2 ha.

Small coupe felling – In UKWAS this is an area between 0.25 (0.5) and 2ha that is cleared of trees.

Low Impact Silvicultural Systems (LISS): these are silvicultural systems which minimise the environmental impact of operations. They include group selection, shelterwood, small coupe felling, coppice or coppice with standards and minimum intervention.

Continuous Cover Forestry (CCF): This is an approach to management whereby the forest canopy is maintained at one or more levels without clearfelling. CCF is just one example of LISS. In this guidance we have identified two systems for CCF – **Simple** where there are 1 or 2 canopy layers and **Complex** where there are 3 or more canopy layers.

Coppice: Management based on regeneration by re-growth from cut stumps (coppice stools). The same stool is used through several cycles of cutting and re-growth.

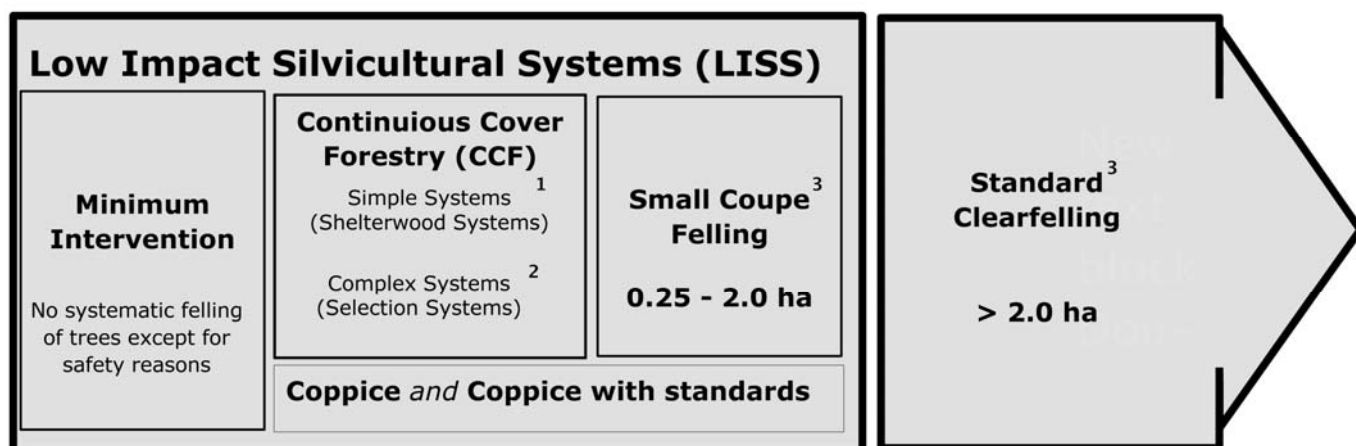
Coppice with Standards: Coppice with a scatter of trees of seedling or coppice origin, grown on a long rotation to produce larger sized timber and to regenerate new seedlings to replace worn out stools.

Short rotation forestry (SRF)– Tree crops which are typically harvested between 8 and 20 years of age.

The diagram below illustrates how this range of systems fit into this guidance:

Silvicultural Systems

.....defined by the extent of felling operations



Notes:

- ¹ Simple Systems - generally one or two canopy layers (age classes) - mostly shelterwood systems where regeneration occurs under an overstorey of maturing trees that can be removed providing a cover of regeneration has been achieved
- ² Complex Systems - three or more canopy layers - selection systems where individual or groups of trees are removed to allow regeneration to occur creating uneven aged stands with several to many age classes.
- ³ UKWAS defines any felling over 0.25 ha as clearfell (including Small Coupe Felling). 'Standard Clearfelling' is a term used in this guidance to identify areas which are larger than those which can be classified as LISS.

2 Moving away from clearfelling

Lower Impact Silvicultural Systems (LISS) including Continuous Cover Forestry (CCF) have increasing relevance to help you successfully achieve the broad range of outcomes sought from woodlands as set out in *Woodlands for Wales*. In combination with increasing tree species diversity, increasing the spatial and structural diversity of woodlands is necessary for successful adaptation to our changing climate and securing a more resilient woodland resource. We must acknowledge that we face some difficult challenges arising from a history of an almost exclusive clearfell management using non-native species. The nature of our climate, soils and terrain mean that options are limited in many areas.



2.1 Advantages of increasing structural diversity

- **Increasing resilience to climate change**

It is predicted that climate change will result in an increasing risk to trees from **pests and disease**, there will be changes in the seasonal distribution of **rainfall** that will cause more frequent summer drought and winter flooding, and although the climate will become warmer, **exposure** will remain a limiting factor.

Extreme weather events such as **high rainfall**, **storms** and **high winds** are expected to become more frequent; and there could be **increased growth rates** of some species, particularly in west Wales where the climate becomes warmer and soil moisture does not become limiting.

It is important to consider climatic limitations for tree species and how our changing climate may affect your choice of silvicultural system.

The benefits of increasing diversity:

- o Structural diversity, particularly when combined with species diversity, creates more resilient woodlands which in the medium to long-term can reduce economic and commercial risks to the owner.
- o A stand with a range of age-classes and species is at less risk of severe damage from a particular incidence of pests or disease. Severe damage typically comes from an agent that affects a particular species and / or stage of tree growth.
- o Structural diversity favours the development of stronger trees throughout the stand, reducing the risk of windblow.
- o When windblow does occur, it is less likely to cause severe damage to stands with structural diversity. Even-aged plantations are more susceptible to catastrophic damage arising from severe storms - and (as we frequently see) windblow damage will continue to spread through even-aged stands until it reaches a windfirm boundary ("green edge").
- **Timber and wood fibre production**
 - o There is potential to grow a wider range of timber products including high-quality timber, using a range of LISS
 - o Use of LISS can give us greater flexibility with regard to harvesting at desired log sizes, and the ability to take advantage of favourable markets
 - o We must be aware of the increased level of management input and skill required for producing high-quality timber in LISS, and the cost that this involves
- **Woodlands for people**
 - o LISS enable forests to be managed for timber production while minimising the impact on communities and recreation
 - o LISS result in fer landscape "shocks" (such as may be caused by large clearfells)
 - o A range of silvicultural systems (including small clearfells) results in a more varied landscape, with less visual monotony.
- **Environmental quality**
 - o Structural diversity provides a wider range of habitats in a given forest area, resulting in greater biodiversity gain.
 - o LISS provide greater habitat stability, and fewer and less intense changes arising from harvesting operations
 - o Well-thinned stands under LISS often support a well-developed understorey and ground flora
 - o LISS systems provide greater protection to forest soils and watercourses; forest operations under these systems will cause less disruption to natural functions.
- **Delivering wider public benefits or ecosystem services**

Ecosystem services are the benefits to society that natural ecosystems, such as woodlands, provide. The services can be defined as follows:

- o Provisioning services – such as timber and woodland products
- o Cultural services – such as recreational opportunities, beautiful landscapes and health and well-being benefits.
- o Regulating services – such as the protection of water and soils providing shelter and shade.
- o Supporting services – such as carbon sequestration.

Appendix 1 provides an outline of the choice of management system and potential impacts on the provision of ecosystem services. It identifies site objectives and how beneficial any of the 4 main systems – clearfelling, small coupe felling, simple CCF and complex CCF – may be in achieving them.

3 Choosing Silvicultural Systems

We recommend an approach based on management planning, with clear management objectives. The best available information for the site and other factors should be used when choosing silvicultural systems.

3.1 Set management objectives for the site

Be clear about the management objectives for the woodland and the specific site and the constraints and opportunities they present.

3.2 Site based information

Information about the site itself will need to be gathered. This will include physical and environmental and social factors associated with the site.

Features such as soil type, terrain, existing tree species and surrounding woodland will have an influence on the choice of silvicultural system to use.

In addition the predicted effects of a changing climate on the appropriateness of different silvicultural systems and species choice will need to be considered.

4. Using silvicultural systems to increase structural diversity.

3 steps to be followed:

1. The **choice of silvicultural system** will be dependent on management **objectives**, site **conditions**, climatic **limitations** and the **species** - both current and future. This should be recorded in the forest plan
2. Rather than selecting and following a single silvicultural system for an entire forest, it is likely that a **range of systems** will be appropriate to meet objectives at a forest scale.
3. Managers must **be adaptive** in their approach to selection of silvicultural systems and be willing and able to change if management is not working. Managers must take account of the uncertainties of differing climatic change scenarios and working with unfamiliar management systems. It is essential to take action now to increase the resilience of our woodlands and forests.

4.1 Actions to implement silvicultural systems.

4.1.1 Recommended actions for all woodlands

Resources may be limited and structural diversity may take decades to achieve. Here we recommend areas for action.

- All stands should be considered for thinning as this is usually critical to achieving silvicultural objectives (and thus delivering the broader objectives of management). However there are a range of valid reasons for not thinning - For example “minimum intervention” and “no intervention” should be based on a sound rationale, preferably set out in the forest plan.
- **Economic constraints** should not unduly restrain the thinning of a particular site. Thinning is key to achieving a broad range of objectives not just timber and income.
- Investment in **permanent infrastructure** is critical to managing all CCF sites. Managers should identify a prioritised programme for the creation and maintenance of permanent infrastructure.
- **Adopt thinning regimes** appropriate to the silvicultural system – for example **crown thinning** will be increasingly appropriate to many CCF sites.
- Where CCF is chosen, prioritise conversion according to the age of the stand. Primary areas for transformation to CCF will be **young crops** (first/second thinning) where the process is most likely to succeed. Other highly suitable sites include those with **existing desirable structures** and/or presence of **regeneration**, and **high sensitivity** sites where a CCF system is seen as critical to secure specific social or environmental benefits.
- Identify areas for **Small Coupe Felling** as a rapid method of increasing species diversity and improving forest structure in stable uniform crops, or to initiate coppice working in broadleaved crops.
- Not all sites will be suitable for CCF or Small Coupe Felling. The **size of clearfell should be reduced wherever possible**, with the aim of increasing structural diversity of the forest and reducing the impacts of large felling operations.
- Use a variety of **regeneration methods** - natural regeneration, artificial planting, coppicing or underplanting. The methods will be related to the objectives for the stand, site conditions and, if natural regeneration is favoured, the likelihood of the preferred species regenerating. Site specific risks and the ability to manage them must also be considered - such as the ability to manage browsing mammals, vegetation competition etc.).
- Take opportunities to learn from work undertaken by others - Forest Research, Prosilva etc.

4.1.2 Recommended actions in native woodlands

The recommended actions in 4.1 apply to all woodland types, but there may be particular sensitivities associated with broadleaf woodlands, and sometimes different priorities for action.

- Site-native woodlands – especially semi-natural woodlands – have particular ecological and social importance. There is a presumption that clearfelling should be avoided.
- **Where possible native broadleaf stands should be managed using LISS.** It is entirely appropriate that particularly sensitive areas may need managing through

“minimum intervention”; however this should be a positive response to maintain woodland qualities rather than an aversion to active management of native woodlands.

- **Thinning of native woodland is as much a priority as any other woodland, and will provide income or products as well as improving woodland condition.** The developing woodfuel markets provide an opportunity to recover income from broadleaf thinnings which may have been regarded as entirely loss-making in the past.
- Coppice management is historically important in many areas, and coppice management systems should be encouraged in appropriate situations, such as even-aged native broadleaf stands and areas where grey squirrel damage is particularly severe.

Selection of management systems for native woodlands should where possible:

- **Identify LISS as the appropriate system for native broadleaved woodlands** including Plantations on Ancient Woodland Sites (PAWS). Only where there are particular threats or regular thinning is not possible should large scale clearfelling be undertaken. On PAWS protect features of ancient woodland remnants.
- **Encourage management to produce high quality timber where possible** given species, site conditions and past management.
- **Where the production of quality timber is not appropriate encourage systems of management that produce wood fuel** as a strategy to increase the economic viability or incentives for native woodland management
- Use Small Coupe Felling to initiate rotational coppice working and increase the use of Coppice or Coppice with Standards
- **Short Rotation Forestry should be considered** if it can be balanced with achieving other objectives

4.1.3 Recommended actions for Plantations on Ancient Woodland Sites (PAWS)

- When restoring PAWS to Native Woodland it is generally preferable to do this in a gradual way, avoiding the shocks to the forest ecosystem associated with clearfelling and replanting.
- LISS are often the most appropriate silvicultural systems to use when restoring PAWS, and gradual restoration of the site may often be combined with other management objectives (including timber production). It is often necessary to take additional measures to protect the ecological value of PAWS for example:
 - o Control of threats
 - o Maintenance of ancient woodland features
 - o Protection of native woodland ground flora during forest operations
 - o Halo thinning around remnant native trees
 - o Increased retention and protection of deadwood
 - o Protection of other site features associated with the ancient woodland (boundary features, charcoal platforms etc.)
- In some circumstances, use of LISS is not appropriate for PAWS restoration (and may be counter-productive). This is often the case where sites are threatened by softwood species (most notably Western Hemlock) which regenerate rapidly and can out-compete other vegetation. Another example would be where lack of management of existing conifers has resulted in windblow which is creating greater risk to the Ancient Woodland features than

controlled clearfelling. In these circumstances carefully planned clearfelling may be the best option taking care to protect the remnant features of the ancient woodland that are present.

- On PAWS the sensitive maintenance and restoration of ancient woodland features should be a high priority, and where this is actively being pursued will generally be the most important consideration when selecting a silvicultural system.

5. The selection of silvicultural system(s)

This section focuses on the range of silvicultural system options available to the manager, their definition and how they might contribute to achieving *Woodlands for Wales* outcomes. In selecting silvicultural systems account should be taken of the recommendations in Section 3.

5.1 Standard clearfelling

Definition: in this guidance this is a silvicultural system involving felling coupes larger than 2ha .

Note that the UKWAS classifies any felling over 0.25ha as clearfelling whilst recognising Small Coupe Felling as between 0.5 and 2ha. See also section 4.3 below

Conventional standard clearfelling of larger coupes may be the only realistic silvicultural option available in some circumstances. This includes where:

- Current tree species are unsuitable, or not the desired future species, and clearfelling is the only practical option for change.
- In mature conifer crops where transformation to CCF would be difficult and there is a risk of unacceptable levels of wind-blow
- Deforestation is necessary to reinstate priority open habitats such as deep peats
- Long term control of invasive tree species (such as Western Hemlock) require early complete removal rather than a long-term and expensive control measures
- Maintaining specific habitat conditions for priority species that require clearfell conditions (e.g. Nightjar) and sufficient habitat cannot be secured elsewhere in the forest
- Overriding economic limitations prevent transformation
- Terrain limitations restrict use of preferred silvicultural system and infrastructure cannot be put into place to allow the regular interventions required for LISS

Clearfelling can be positively advantageous in some circumstances, for example:

- Using **shorter crop rotations** allowing fast growing cash crops, then changing the species before the climate impacts take effect;
- **Creating structural diversity** at a large scale;
- Providing **economies of scale** that make challenging sites more simple and easy to work. Thereby realising investment income and commercial return.

5.2 Continuous Cover Forestry (CCF)

Definition: “CCF is an approach to forest management in which the forest canopy is maintained at one or more levels without clearfelling.

Definition taken from the UK Forestry Standard

The word ‘approach’ is important because **this is not following a specific silvicultural system**. there are **no standard prescriptions**, and **flexibility is**

CCF is one of the main tools to use to increase the structural diversity of woodlands and reduce the area of clearfelling. Managers have to decide whether the existing crop is suitable for conversion and if CCF will best suit management objectives. Key sources of information on selection and management of CCF are identified in **Appendix 2**

In selecting CCF the following need to be considered:

- Is CCF appropriate to achieve objectives?
- Is the **site** suitable (soil, climate) for the selected silvicultural system or can it be adapted (by improved access, other infrastructure)?
- Is the **species** suitable for the site, and for CCF methods?
- Is the site suitable for CCF but the current species are not?
- How easily can the stand be converted? Would it be better, economically and/or silviculturally, to start again? Consider replanting the required species and converting to CCF in the next rotation;
- Does the terrain (slope, roughness) limit choice? What (if anything) can be done about it? What infrastructure is required to make the site accessible and what is the cost (including time and effort) of doing this?
- Which areas should be **prioritised** for CCF conversion?

To fully understand what is meant by the term CCF see Forestry Commission Information Note 29 – *What is continuous cover forestry?*

In this guidance we will use the terms **simple** and **complex** CCF. There are a wide range of specific silvicultural systems encompassed within these headings.

Simple CCF

Defined as stands “...in which there will be one or two canopy layers of trees, mostly forms of Shelterwood Systems.”

For most existing conifer sites, where CCF is the chosen system, this is likely to be appropriate.

Simple CCF may also be considered as the first phase in the transition to more complex systems.

Complex CCF

Defined as stands “...where there are three or more canopy layers of trees.”

Complex CCF has the potential to be developed on a wide range of sites in the future but in the short term could be prioritised on:

- Where there is potential to grow high value timber

- Broadleaved woodland
- Mixed woodland - existing multiple species where the mixture should be maintained.
- Recreational/community sites

5.2.1 Setting priorities for transformation of conifer stands to CCF by age of crop

When considering conifer crops for transformation to CCF, and deciding on a transformation approach, crop age can be a simple way of organising priorities:

1. Establishment and pre thinning (0 – 14 years)

At this stage future silvicultural systems can be proposed. During this period flexibility and adaptability on the management of the stand is necessary. This is a critical period of stand development and you will need to review the health and growth of competing species. In mixed stands (line, intimate or group) monitor how these are competing against each other. Respacing or cleaning operations may be necessary.

2. First thin /young crops (15 – 29 years)

For sites selected for CCF **this age group should be prioritised for conversion**, assuming the species composition is acceptable or there are realistic opportunities to change or introduce tree species. Key actions include:

- Establishing a **permanent infrastructure** at first thinning if it does not already exist including a permanent racking system, main access and egress routes with hard standings where necessary;
- **Thin on time** to introduce racking and structure. Late thinning has the potential to reduce the conversion potential of any stand;
- Consider early first thin. Followed by crown thin at normal the age of first thinning. This has the potential to increase crop stability;
- Second thinning and beyond will usually be a crown thinning, possibly using 'frame trees' as the approach to initiate conversion of stands; Frame trees can be defined as stable, well-formed dominant trees, as they may need to be present on the site for a long time – spacing should be 'clumpy' and not regular. Stable trees will have a larger diameter for a given height.
- If sample marking is being used the highest priority stands would usually be second and third thinnings;
- Consider adopting a higher thinning intensity near exposed edges – providing your interventions are early enough. This will encourage the development of larger-crowned, deeper rooted trees which are better able to withstand windblow in future years, and provide some shelter to the rest of the crop.

Note that there is no single standard method here; the correct approach depends on species, site and your objectives.

3. Semi-mature stands 30 – 44 years

Depending on previous interventions, the terrain and existing infrastructure, these crops will usually require higher input to convert to CCF. This will specifically be the case for crops that have passed second thinning age).

- Thin on time and regularly
- Successful conversion will still require good infrastructure
- Select a residual basal area for the stand, which on current knowledge should be about 18-25m³ for larches and pines, and 25-35m³ for spruces and Douglas fir Forestry Commission Information Note 40 - *Transforming even aged conifer stands to continuous cover management*.
- Thin little and often
- Look for opportunities to commence the underplanting of new species where you wish to diversify tree species.

4. Mature crops 45+ years

These stands will be **difficult to convert to CCF unless sympathetic management has already been carried out and good infrastructure exists.**

Consider carefully the practicality and cost of converting these stands and the options available. Identify those stands where investment should be made and most gained in terms of achieving objectives. The same principles apply to these older stands as to the younger ones previously described. Regular interventions must be made. Sometimes it is better to start again. This decision can only be made on a stand-by-stand basis.

Remember to consider other LISS (notably small-coupe felling) are available alternatives: as if CCF is not considered viable, it does not necessarily mean that large clearfells are appropriate.

5.2.2 Establishment in CCF

Using natural regeneration as a processes for stand management is one of the key strands to future management of sites where CCF is intended. This is a significant change for many forest managers in Wales, where we have been almost totally reliant on clearfelling and restocking regimes. **Adaptation of operational and business planning will need to take account of this less reliable natural process. It is important to** learn from, and be adaptable and responsive to events as production of viable seed will depend on tree species and age, also seed production will vary from year to year.

Establishment operations will still be required and may include ground preparation, underplanting, weeding, respacing and forest protection.

5.2.3 Underplanting

Underplanting should be considered within CCF crops. It will be necessary in many cases to supplement existing or expected natural regeneration, introduce new species (to diversify monocultures) and to introduce genetic diversity. Without intervention it is likely that many crops designated as CCF will remain or could become monocultures with the most invasive species predominating.

Consideration of how much shade the stand is casting, in relation to the light-demanding nature of the trees to be planted. In some instances side-light gives opportunities for

underplanting, and some well-thinned stands may be well suited to underplanting without further moderation of the canopy. In many instances, a further thinning intervention, with the introduction of canopy gaps, may be necessary to ensure the success of underplanting.

5.2.4 Respacing

Respacing is an important operation that can help support both structural and species diversity. **When respacing, take positive action to create structural and species diversity, where it will contribute to the long-term objectives of the stand and the species are suitable.** Any silvicultural system that utilises natural regeneration will, in most cases require respacing to both favour target species and allow appropriate tree spacing for stem development.

See FC Practice Note 16 *Respacing naturally regenerating SS and other conifers*

5.3 Small coupe felling (SCF)

Definition: a system involving clearfelling areas of over 0.25 ha but under 2.0 ha*

*FCW definition – UKWAS defines small coupe felling as being between 0.5ha and 2.0ha

This system has significant potential in helping increase species diversity in stable crops of single species or those with limited species diversity. Its use is limited however to more stable mature stands or younger crops where these small scale premature clearfells can be made to introduce species diversity. Small scale working can be more expensive and management intensive but should not be allowed to act as a deterrent.

When younger crops are identified for SCF, consider whether it is necessary, and possible, to introduce additional “green edges” via severance cuts and ride creation. The existence of a good network of rides can be a great help when planning coupes in the mature crop.

Increased use of SCF is appropriate where:

- There are large scale monocultures with limited species diversity and exposure/risk of windblow is low. This will normally be younger crops or more sheltered mature crops.
- Sites are most at risk from climate change. Consider premature felling (usually age 20 to 40 years) using SCF to introduce new tree species quickly, but consider economic implications
- There is a wish to initiate coppice management in broadleaf woodlands

5.4 Coppice and coppice with standards

Definitions:

Coppice - management based on regeneration by re-growth from cut stumps known as coppice stools. The same stool is used through several cycles of cutting and re-growth*

Coppice with standards - coppice with a scatter of trees of seedling or coppice origin, grown on a long rotation to produce larger sized timber and to regenerate new seedlings to replace worn out stools

* UKWAS definition.

Coppice can be used as a very successful management system to:

- **Restore and bring native woodland into management.** Many native woodlands would have been managed as coppice or coppice with standards in the past and restoration to a coppice regime could form an important part of management;
- Provide significant financial advantages by the **reduction of establishment costs** in subsequent rotations as well as simplifying management for woodland managers less familiar with forest management such as the more complex CCF systems;
- Provide **potential for biomass production** whilst retaining the opportunity for adaptation at a later stage (with some species) to more complex systems such as retaining standards to maturity;
- Be **easier to administer** and estimate yield than more complex CCF systems;
- Has **potential to provide a wider range of products** on one site, though this does increase the complexity of management (coppice with standards);
- Help **manage tree protection** issues such as grey squirrel control or browsing mammal damage: coppicing can reduce the at risk period with rapid early growth.

A disadvantage of coppice systems is that it reduces opportunity for genetic change between generations. If this is a concern, it is perfectly possible to combine coppice management with encouraging normal natural regeneration, or include some enrichment planting.

Bringing native woodland into a coppicing regime has significant potential for smaller, isolated areas of woodland, but in most cases will be part of a wider range of management regimes. It can create a range of unique habitats and, if a variety of species are used, offers a range of management opportunities. Species that are of significant interest are Ash, Lime, Alder, Sweet Chestnut and Birch. Other species do coppice, including some conifers, and may have potential for development such as Coast Redwood, Eucalypts and Hornbeam. Ensure wider management objectives are taken into account, particularly when considering management of ancient woodlands. Increasing the range of species we use in Wales is critical to resilient forests. However, the scale we use for diversification is also important.

5.5 Short Rotation Forestry (SRF)

Definition: Short Rotation Forestry is defined as the practice of cultivating fast-growing trees on a rotation of eight to 20 years old.

* from UKWAS

When felled, SRF trees are replaced by new planting or, more usually, allowed to regenerate from the stumps as coppice.

SRF is primarily an alternative management regime for the production of short rotation biomass crops aimed at the wood fuel market. Some tree species are particularly suited to this system of management and there are a series of experiments being carried out to improve knowledge of SRF throughout the UK. Managing crops on shorter rotations (such as SRF) has potential advantages as it gives the opportunity to change species quickly as the climate changes and reduces risk by utilising more tree species to create greater diversity. Mostly (to date) it is seen as an opportunity for new planting sites, but it could be considered for use in Wales when restocking as an alternative management system utilising species that coppice well.

It should be noted that modern SRF tends to involve highly-mechanised harvesting, sometimes involving specialist equipment or contractors.

Opportunities and broad management implications of SRF include:

- For biomass/wood fuel markets - considerable potential as an alternative market for forest managers and SRF could provide a cost effective opportunity to exploit this market. There are some potentially very fast grown species that have good economic potential such as Sweet chestnut, Eucalyptus and Ash. Location to market is critical (wood/biomass power stations/Combined Heat Energy plants);
- To create some structural diversity to larger broadleaved woodlands;
- As a potentially flexible system, depending on species used and could be developed into high forest or coppice with standards;
- Use of stock that coppices well will reduce subsequent establishment costs;
- To increase the potential options for tree species diversity on the poorest sites where there are a limited range of suitable species. (e.g. use poorer quality conifer timber species such as Grand fir and noble fir that could be grown on short rotations for biomass)

5.6 Low input woodland management for predominantly environmental outcomes

5.6.1 Riparian / other semi open habitat

The designation and management of these areas is not within the remit of this guidance. Use FC *Forest and Water Guidelines* for the management of riparian areas. FCW will be developing guidance for creation of open habitats.

5.6.2 Natural Reserves (NRs)

Definition: Natural reserves are predominantly wooded, are permanently identified and are in locations which are of particularly high wildlife interest or potential. They are managed by minimum intervention unless alternative management has higher conservation or biodiversity value.

- UKWAS definition.

Predominantly wooded areas **managed in perpetuity by minimum intervention**. Conservation of biodiversity is the prime objective.

These areas will offer opportunities to form 'new natural' woodlands capable of supporting species able to colonise forest areas, but requiring stable and permanent refugia from which to expand into the managed forest. They include semi-natural native woodland, planted native woodland and non-native plantations. Within NRs, natural processes will normally predominate. Forests are naturally dynamic but within British forests most change is controlled or imposed by man. NRs provide the opportunity for natural dynamics to develop in a way rarely seen at present. Intervention should only take place to protect the NR or adjoining areas of forest.

5.6.3 Minimum intervention

Definition: Management with no systematic felling or planting of trees. Operations normally permitted are fencing, control of exotic plant species and vertebrate pests, maintenance of paths and rides and safety work.

- UKWAS definition.

They are generally similar to Natural Reserves.

Minimum intervention should only be used where there are clear objectives and reasons for each designation. Temporary constraints such as access or financial constraints are acceptable.

5.7 Thinning

Thinning is the most important intervention to be made to implement most silvicultural systems, and for achieving objectives.

Thinning is vital element of sustainable forest management and has many purposes, including:

- Encouraging the growth of high-quality timber
- Helping to maximise the quantity of good-quality timber that a stand can produce
- Improving stand stability...
- ...resulting in more options for management in older stands
- Improving conditions for biodiversity
- Providing revenue from timber (or wood fuel / fibre)

The benefits of LISS are outlined in section 2. Thinning is an essential requirement for most types of LISS.

The transition from clearfell to thinning dominated timber production will be necessarily slow.

In the short term, the following actions can be taken to make progress:

- **All** crops should be assessed for their suitability for a regular thinning, with assessments starting prior to predicted time of first thin;
- Clear objectives should be identified for each thinning intervention. These should include environmental and social objectives, not just volume and production targets;
- Timely or early first thinning must be standard practice. This is essential to the subsequent achievement of future stand objectives, even if the thinning is uneconomic;

5.7.1 Exceptions to 'thinning for all'

There are some valid exceptions to the rule including:

- Natural Reserves;
- Exceptionally steep sites where regular access cannot be made and improved access cannot be constructed;

- Riparian zones will usually have minimal harvesting for timber with the exception of maintaining good quality riparian habitat;
- Coppicing systems often do not require thinning.

5.8 Infrastructure and access

To develop LISS systems including CCF **it will be essential that forests and woodlands have the appropriate access and infrastructure in place to allow management by the chosen silvicultural system.** More frequent extreme weather (especially rainfall) will make this increasingly important. Regular thinning and / or coppicing require specifically designed access to allow interventions to be carried out. Infrastructure both to and within stands should be planned and prioritised.

It is recommended that **first and second thinning-age** crops should be prioritised for the development of permanent internal infrastructure of tracks and other access features. All sites assigned to CCF, whatever the age will need internal infrastructure to be developed at some stage.

5.9 Economic impacts of increasing structural diversity through implementing silvicultural systems

Diversifying woodlands successfully means working towards a range of objectives, and securing a valuable forest resource in the long-term. This requires a recognition of the economic costs of change **which should be considered as part of** future management and economic planning.

Consider the following factors:

- **Establishment costs:** Achieving successful regeneration will be an important part of controlling costs. CCF systems in which regeneration is successful, can be cheaper than clearfell systems that require restocking. Intensity of management, particularly in managing intimate mixtures or more complex silvicultural systems will be greater. LISS typically involve more management input and supervision.
- **Timber flow:** In CCF systems the flow of timber from stands will be much different to clearfelling (although the shelterwood removal phase in simple systems may provide a considerable yield). This consideration should be balanced against regular higher thinning yields under CCF, and the possibility of growing higher-quality timber.
- **Operational:** There will be increased outputs from CCF thinnings but these need to be balanced against lost efficiency at clearfelling (though over storey removal is still necessary in shelterwood systems).
- **Marketing:** A wider range of products are likely to be produced under LISS, and the quantities in which they are produced may have positive and negative impacts.
- **Infrastructure:** As noted above, good infrastructure needs to be developed and maintained for CCF management. It is necessary to consider the cost of this, in relation to the benefits it will have in reducing subsequent operation costs.

Economics of thinning

The recommendation is to thin all forest stands except where overriding environmental objectives prevent interventions (**See section 4.1**), however it is recognised that costs

associated with early thinning can be high. Managers need to evaluate overall outcomes of thinning (necessity of thinning in achievement of long term objectives) vs. cost.

The thinning operation should be seen as helping to achieve the long term objectives for the woodland.

As an alternative to thinning, coppicing can have significant financial advantages, reducing establishment costs of subsequent rotations.

Appendix 1: Choice of management system and potential impacts on the provision of ecosystem services

It may not always be possible to ‘allocate’ all the listed objectives to specific sites but by understanding and identifying these objectives and their relative priority you will be able to make more informed decisions with the best information currently available.

When interpreting the woodland objectives at a site level, identify the potential of the site in meeting these objectives and be clear about the operational constraints that may affect the site and future management.

Ecosystem service	Management system			
	Clearfelling	Small coupe felling	CCF – simple structure	CCF – complex structure
Water quality	Forests managed according to UKWAS guidance operate within the <i>Forests and Water Guidelines</i> that aim to mitigate the risks of clearfelling to water quality.	As clearfelling – the smaller scale working decreases any risks associated with clearfelling on water quality.	Once the structure is formed there will be generally lower levels of site disturbance and the presence of a mature canopy and/or young trees minimizes risks to water quality.	Once the structure is formed the presence of continuous canopy cover and generally lower level of site disturbance minimizes risks to water quality.
Water flux	Clearfelling has the potential to create the greatest fluctuations to waterflow and latest <i>Forests and Water guidelines</i> identifies “at risk” areas and sets out measures to mitigate the risks associated with clearfelling.	Reducing the scale of clearfelling does help mitigate some of the risks associated with larger scale clearfells.	Once the structure is formed there will be generally lower levels of site disturbance and the presence of a mature canopy and/or young trees minimizes risks but overstory removals may still have some effect on water fluxes.	Once the structure is formed the presence of continuous canopy cover and generally lower level of site disturbance minimizes the level of water flux.
Soil erosion	Forests managed according to UKWAS guidance operate within the <i>Forests and Water</i> and <i>Forests and Soil Guidelines</i> that aim to mitigate the risks of clearfelling to soil erosion. Risks are low on flat ground and higher on steep slopes.	As clearfelling – and the smaller scale working decreases any risks associated with clearfelling for soil erosion.	Reduced risks associated with clearfelling operations and the subsequent bare ground phase. In general stands do not pass through a restocking phase that may involve some form of ground preparation so there are reduced risks for soil erosion. Ground preparation may be used but is likely to be low impact scarification.	Reduced risks associated with clearfelling operations and the subsequent bare ground phase. In general stands do not pass through a restocking phase that may involve some form of ground preparation so there are reduced risks for soil erosion. Ground preparation such as low impact scarification may be used during the transformation but once the structure is formed would not usually be used.
Climate change mitigation	In general the choice of one of the four management systems will only have a marginal effect on the potential for climate change mitigation. The main reason for this is that the carbon dynamics of forestry are time dependent and responses to different management systems are complex. The four			

Ecosystem service	Management system			
	Clearfelling	Small coupe felling	CCF – simple structure	CCF – complex structure
	management systems will produce different forest structures that will change with time. Each will produce a different stream of harvested wood products and will have variable effects on both direct and indirect fossil fuel substitution. The main exception to this marginal difference between the four systems is on soils with high carbon content. In general CCF reduces or removes the need for operations that disturb forest soils and therefore it is logical that this should help to maximize forest soil carbon stocks on these soils. However, knowledge and experience of CCF on such soils is limited.			
Biodiversity – stand scale	Clearfelling is a significant disturbance to a forest environment similar to the effects of catastrophic windblow. The change will favour some species, such as open ground specialists, and be detrimental to others that are more sensitive to disturbance.	Effects will be similar to clearfelling although the smaller scale of working will reduce the magnitude of the changes.	Stands will fluctuate between the stand initiation, stem exclusion and understory re-initiation phases. This will not favour species that require continuity of habitat.	A complex structure provides continuity of habitat and at any one time there should be elements of all four phases of stand development (The three listed for CCF – simple as well as 'all-sized').
Biodiversity – landscape scale	A diverse landscape should ideally have elements of clearfelling, CCF- simple structure and CCF - complex structure in addition to other stand types such as natural reserves			
Recreation	All the main options for management systems require a sequence of forest operations to intervene in the stand. Good planning, regardless of silvicultural system will reduce conflicts with recreation. Large scale clearfell is the most likely to have a detrimental effect on high profile recreational centres and should be used as a last resort. Investment in less visually intrusive silvicultural systems close to these centres should be considered a priority.			
Landscape – internal views	Even-aged stands can look attractive if well thinned and have the major advantage that vistas and panoramas of the surrounding landscape can be produced when trees are felled.	Similar to clearfelling if the position of coupes is applied in sympathy to the surrounding landscape.	These systems produce attractive forest stands but structural diversity is not as great as complex systems and opportunities for creating views to the surrounding landscape are more constrained than with clearfelling.	These systems produce structurally diverse forests that could be considered internally as the most attractive forest stands but opportunities for creating views to the surrounding landscape are more constrained than with clearfelling.
Landscape – external views	Clearfelling can look unsightly in the landscape and should be strategically placed in the landscape to minimise impacts.	This system is a useful compromise to reduce the negative impacts of larger scale clearfelling.	The appearance of continuous cover helps eliminate any negative landscape effects traditionally associated with clearfelling.	The appearance of continuous cover helps eliminate any negative landscape effects traditionally associated with clearfelling.
Landscape	Creating a diverse and attractive landscape could have elements of all management systems if appropriately used.			
Communities	Any of the four management systems considered in this table can bring significant benefits to local communities but the objectives and benefits need to be clearly set out in discussions and consultations with stakeholders.			

Appendix 2 Supporting information and references

In using a wider range of silvicultural systems with which some managers may be less familiar and for which there is limited experience in British conditions. The following will provide support and guidance.

References:

Forestry Commission (2011) *The UK Forestry Standard* Forestry Commission, Edinburgh

<http://www.forestry.gov.uk/theukforestrystandard>

Forestry Commission (2011) *Forests and Water. UK Forestry Standard Guidelines*. Forestry Commission, Edinburgh

Forestry Commission (2011) *Forests and Soil. UK Forestry Standard Guidelines*. Forestry Commission Edinburgh [http://www.forestry.gov.uk/pdf/FCGL006.pdf/\\$FILE/FCGL006.pdf](http://www.forestry.gov.uk/pdf/FCGL006.pdf/$FILE/FCGL006.pdf)

Forestry Commission Wales (2010) *A guide for increasing tree species diversity in Wales*. Forestry Commission, Edinburgh.

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Kerr, G. Mason, B. Boswell, R. Pommerening, A. (2002) *Monitoring the transformation of even-aged stands to CCF* Forestry Commission Information Note 45 Forestry Commission, Edinburgh [http://www.forestry.gov.uk/pdf/fcin45.pdf/\\$FILE/fcin45.pdf](http://www.forestry.gov.uk/pdf/fcin45.pdf/$FILE/fcin45.pdf)

Mason B (2010) *Respacing naturally regenerating Sitka spruce and other conifers* Forestry Commission Practice Note 16. Forestry Commission, Edinburgh

[http://www.forestry.gov.uk/pdf/FCPN016.pdf/\\$FILE/FCPN016.pdf](http://www.forestry.gov.uk/pdf/FCPN016.pdf/$FILE/FCPN016.pdf)

The UK Woodland Assurance Standard (UKWAS) 2011

<http://ukwas.org.uk/wp-content/uploads/2011/11/UKWAS-Third-Edition-Interim-Publication-Format-December-2011.pdf>

Welsh Assembly Government (2009) [Woodlands for Wales – the Welsh Assembly Government's Strategy for Woodlands and Trees.](#) Welsh Assembly Government.

Useful websites

[Continuous Cover Forestry Group](#)

[Forest Research - Continuous cover silviculture](#)

[Forestry at Aberdeen University](#)

[Institute of Chartered Foresters](#)

[Prosilva](#)

[School of Environment and Natural Sciences - University of Wales, Bangor](#)

[UK Woodland Assurance Standard](#)