Forestry Commission Scotland

# Interim Guidance on the Grant Aiding and Planting of Eucalypts in Scotland

## INTRODUCTION

Eucalyptus species are increasingly being considered for planting as biomass crops in Scotland because of their rapid growth rates and the relatively high calorific value of their timber. This combination gives the potential for eucalypt crops to be grown on very short rotations (~10 years) and to be more productive than any other timber crop currently grown commercially.

Given the relative paucity of information available on the use of Eucalyptus species in the UK, the intention of this interim guidance is to briefly examine the various issues in a Scottish context and provide recommendations for its use.

Short Rotation Forestry (SRF) grown on a rotation of 15 years or more is currently supported under the woodland creation measure of Rural Priorities in the Scotland Rural Development Programme (SRDP).

SRF is like any other form of woodland creation with the requirement for re-stocking to meet the UK Forestry Standard and associated documents. SRF crops funded under Rural Priorities would not be eligible for restructuring grants for subsequent SRF rotations following harvesting.

FCS is in the process of establishing 6 energy forestry trial sites. Three species of *Eucalyptus: E. nitens* (two provenances*), E. glaucescens,* and *E. gunnii* will be tested for growth, yield and their local effect on soil structure, nutrition and carbon in this experiment. These species have been chosen as being potentially among the hardiest and most productive in UK climatic conditions.

The UK Department of Energy and Climate Change (DECC) are funding Forest Research to test the same species as in the FCS trials and undertake larger scale plantings of *E. nitens* at 6 sites in England.

Guidance on SRF is set out at:

http://www.forestry.gov.uk/website/forestry.nsf/byunique/infd-7rlm3l

The guidance suggests a range of species that could be used for SRF, including *Eucalyptus* spp.

Currently, with the exception of the energy trials sites, the only planting of *Eucalyptus spp.* in Scotland has been a few small areas in the south west. However, there is

interest in further planting, including plans to use *Eucalyptus spp.* for restocking at site near by Tighnabruaich, Argyll.

## THE KEY ISSUES WHEN CONSIDERING PLANTING EUCALYPTS

The following key issues have been identified and are addressed below.

- Risk of physical damage
- Potential for invasiveness
- Landscape impacts including impact of short rotations
- Hydrology and water quality
- Biodiversity
- Fire risk
- Protection of soils when harvesting
- Impact on soil fertility and carbon of consecutive short rotations

## RISK OF PHYSICAL DAMAGE

Eucalypts are largely untested in UK conditions at a forest scale. A key consideration in species choice is frost hardiness. Of the 800 or so eucalypt species, only around 20 can be considered hardy enough to reliably survive away from the southern and western coastal fringes. Of these, many are not of suitable form or growth rate to be considered for biomass.

The four species below are the most likely useful candidates, with *Eucalyptus nitens*, though the least hardy of the four, being preferred because of its superior form and growth rate.

| Species | Common Name | Growth Rate (m/yr) | Frost Tolerance (°C) |
|---|---|---|---|
| *E. dalrympleana* | Mountain Gum | 1.5 - 2.0 | -14 |
| *E. glaucescens* | Tingiringi Gum | 1.5 - 2.0 | -16 |
| *E. gunnii* | Cider Gum | 1.5 - 2.0 | -18 |
| *E. nitens* | Shining Gum | >2.0 | -12 |

The frost tolerance given is the 'critical' temperature at which severe damage and death can be expected. However, temperatures higher than this can still cause damage. Tolerance to a specific frost event depends upon the acclimatisation of the trees, which requires a progressive period of chilling. Following a warm period, sudden temperature drops, particularly during late-spring or early-autumn frosts, can

cause damage well above the critical temperature. The effects of frost may also be exacerbated by wind chill/desiccation and by the duration of the cold period. Soil freezing will reduce water availability and may damage eucalypt roots, particularly of young trees, increasing the likelihood of desiccation.

Hardiness does vary with seed origin, therefore inland, higher altitude origins within Australia are preferred, or provenances of seed selected from adapted trees growing in cooler regions of other countries. To reduce the risk of failure, species should only be planted in areas where the critical frost tolerance temperature is unlikely to be exceeded.

Good growth of eucalypts is limited by the accumulated temperature of the planting site. Research suggests that the minimum acceptable accumulated temperature for a eucalypt crop is 1200 degree days above 5°C. The elevation and aspect of sites that meet or exceed this criterion will vary according to geographic location, but broadly speaking planting at higher elevations is possible in the south and east (Ecological Site Classification (ESC), Pyatt *et al*, 2001). The Climate Zone map (Appendix 2) is based upon ESC; the climatic zones 1 to 9 (warm zones) are suitable for eucalypts. However, lower winter minimum temperatures can be expected in the east and the further the site is from the sea, therefore, climatic site choice needs to be tempered by the critical temperature criterion.

Climate change overall is likely to increase average temperatures, therefore increasing the potentially suitable planting area available. However, the longer growing season, allied with the oceanic climate fluctuations that the UK experiences, is likely to increase the risk of unhardened eucalypts being damaged by early or late frosts. This may have the actual effect of reducing the suitable area, or necessitating a change to hardier species.

The severe winter of 2009/10 killed young *Eucalyptus nitens* at a DECC funded site near Canonbie, where the temperature fell to -15°C, well below the critical temperature of -12°C. In an average winter, this site could have expected no lower than around -10°C. Climate change is likely to increase the return period between such severe events, reducing the risk of not achieving the 10 - 12 year rotation needed to maximise yield.

All eucalypts have the ability to rapidly regenerate from epicormic buds, and most will coppice. Therefore, non-critical damage, e.g. top shoot death, can be overcome, though there will be a loss of productivity.

In the event of crop death, provided that a sufficiently long growing period has elapsed, the crop will still have value as biomass. It is estimated that a period of 5 years growth is the minimum required to produce a viable crop on a suitable site.

It should be made clear that under the conditions of the felling licence and any restructuring grants received from SRDP, that the applicant bears the whole risk of any crop failure. If the crop fails, the applicants have a legal requirement to ensure that woodland is re-established on the site.

## POTENTIAL FOR INVASIVENESS

Eucalypts begin to set viable seed from around age 5, which can be held on the tree within woody seedpods (gumnuts) for several years. However, seed is small and requires specific conditions for its release and germination, in particular long, hot, dry periods and moist, competition-free germination sites. Post-germination, young seedlings are prone to drought and cold damage. The seed drops directly to the ground from open pods. It has no specific mechanisms for wind or water dispersal, and there are no biological vectors for seed movement, though its size and light weight will facilitate a degree of wind dispersal and dry eucalypt seed will float, though it sinks after absorbing water. While the seed of some species requires pre-chilling before germination e.g. *E. nitens*, others do not e.g. *E. gunnii*, and most will germinate readily at ~15°C. Incidences of natural eucalypt regeneration are rare in Scotland and where it does occur it is in close proximity to existing trees, which suggests that most seeds do not find suitable germination sites or that they are predated either as seeds or very young seedlings.

Though most eucalypts will coppice (*E. nitens* does not), none of the species likely to be grown in the UK has the ability to sucker or colonise new ground by any other vegetative means.

Formal assessments of the risk of invasiveness of tree species are being carried out under Defra's UK Non-Native Organism Risk Assessment Scheme. A preliminary risk assessment has been made on the *Eucalyptus spp.* to be used in the energy forestry trials which, subject to an ongoing peer review, indicates that the risk of invasiveness is low.

Climate change would seem unlikely to increase the risk of invasiveness, though warmer summers could facilitate better flowering, seed-set and an increase in seed fall. The key restrictive elements of lack of suitable seed germination sites and low seed dispersal rates will remain.

## LANDSCAPE IMPACTS INCLUDING IMPACTS OF SHORT ROTATIONS

SRF will have certain characteristics which may impact upon the landscape; the main one being the shorter rotations bringing more frequent landscape change. FCS plan to do some work on this in the coming year but the management of any SRF crops will have to meet the UK Forestry Standard and associated guidelines (see Appendix 3 for more detailed information).

SRF has similarities to SRC in that it is a monoculture of fast growing species on a short rotation. The publication FC Guideline Note 2 – "*Short rotation coppice in the landscape*" (2001) provides a useful reference on how to handle non-standard forest crops and potential applicants should be made aware of this.

Eucalypts, due to their evergreen nature and largely conical growth form when young, have a similar visual impact to conifers. This should be taken into account when landscape planning.

The key criteria for successfully siting eucalypt SRF in order to minimise both the effect on the local landscape and visual intrusion are:

- Integration with the local landscape character, ensuring that the size and scope of any planting is consistent with and complimentary to the existing landscape structure. Eucalypt SRF is likely to fit best into lowland, mixed woodland situations, rather than open, upland ones.

- Mitigating visual impacts by good design with regard to external and internal scale and shape, so as to blend with existing structures and avoid visually sensitive locations.

- Minimise the impact on the historic environment. Because of the recognised deep rooting of eucalyptus SRF species care should be taken to ensure that the archaeology and cultural features of a site are fully investigated and considered prior to its establishment.

## HYDROLOGY AND WATER QUALITY

Concern has been raised that the establishment of energy crops, and particularly *Eucalyptus* spp., could have an adverse impact on water resources. Eucalypts are water hungry and will root deeply and widely in search of water. Research has shown that a closed canopy eucalypt crop may transpire twice as fast as a conifer one (Honeysett *et al*, 1992). On light sandy soils and shallow or indurated soils, particularly in the drier east of the country, it is highly likely that eucalypts, if planted

on a large scale, would deplete ground water resources and thus begin to seasonally affect catchment water flows. However, in the wetter and milder west of the country, where most eucalypt planting is likely to be concentrated, this should be less of a problem.

The new revision of the Forestry and Water Guidelines linked to the UK Forestry Standard, shortly to become available, will advise on the suitability of land for SRF. Particularly relevant sections (as given in the current draft) are:

WG2 – Avoid new planting or restocking where catchment assessments based on critical load calculations and relevant supporting information indicate this will lead to deterioration in water body status or prevent recovery to good status.

WGFPR2 – Forest management should contribute towards achieving the objectives of River Basin Management Plans and ensure that forestry pressures on the aquatic environment are addressed.

WGFPR12 – Where new woods are proposed, the sensitivity of downstream water bodies and wetlands to a reduction in water quantity should be considered: consultation with the water regulator and conservation agency should be carried out.

WG4 - Avoid short rotation forestry or coppice, and the harvesting of whole trees, forest residues and tree stumps on soils classified as at high risk of increased soil and water acidification, regardless of water body status.

WG74 - Where the maintenance of water flows is an issue, consult the water regulatory authority, (or water undertaker), and conservation agency before carrying out large-scale woodland establishment; especially involving conifer or short rotation crops with a high water use. Consider the projected impacts on future water yield, including the effects of climate change.

WG81 - Favour locally native species in the riparian zone and control the spread of invasive and non-native species

Climate change scenarios as given in the Forestry Commission Scotland Climate Change Action Plan (http://www.forestry.gov.uk/ccapscotland) all indicate a reduction of rainfall in the east of Scotland. This would seem likely to make the east increasingly less suitable for water-demanding eucalypts, as it will for spruce.

The rapid growth and ability to tolerate periodic water-logging of some eucalypt species e.g. *E. gunnii*, may make them suitable candidates for consideration in flood plain management schemes. However, this requires further consideration and SRF

would be expected to benefit water quality in comparison to improved agricultural land cover due to lower chemical inputs and reduced soil disturbance, however there is little information available.

## BIODIVERSITY

There is little information on this in a UK context. *Eucalyptus spp.* are likely to support very low levels of biodiversity within stands or in the soil. Their leaves and leaf litter contain high concentrations of volatile oils which are not readily used by herbivorous or soil dwelling species, although the flowers can produce copious nectar that may be used by pollinating insects. There are many reports in global literature of toxic inhibition of germination and growth of other plant species (allelopathic effects), which inhibits the growth of an understory (but these have not been tested in UK).

In addition to these specific properties, SRF as a management system results in negligible mature or open phase habitat and rapid rates of change at any one site.

So, to meet forestry policy aims and the UKFS and biodiversity guidelines, greater emphasis should be put into securing open areas, native woodland and/or use of other tree species within the management unit than for other types of forest.

Deer and rabbits will freely browse most eucalypts, except for *E. glaucescens*, which appears largely immune. Therefore, fencing and/or other protection is essential, which may impact on local mammal and bird movements.

Applicants must adhere to the UK Forestry Standard in their planting proposals.

## FIRE RISK

Leaves of eucalypts are relatively slow to breakdown and have a high volatile oil content, which contributes to the severity of fire events in their native Australia. However, in the UK, given the relatively short rotations and subsequent smaller crown area, leaf litter build up is less likely to be an issue. Additionally, the likely locations and climatic attributes of the crops will be less conducive to fire. Overall, fire in eucalypt crops is not considered a greater risk than with conifer crops, but the situation will be kept under review.

## PROTECTION OF SOILS WHEN HARVESTING

As with all crops being harvested on shorter rotations, best practice should be adopted to minimise damage to soils. This may be a greater issue with eucalypts planted on wetter soils where it will be difficult to protect the ground with brash mats during harvesting because the sparser branching habit is likely to create less supportive brash. The relatively rapid succession of harvesting operations may exacerbate soil damage. This is an area for further investigation.

Potential ways of overcoming these problems include:

- The use of machinery that is lighter and/or has tracks that reduce the ground pressure compared to conventional harvesting machines.
- Designing specific SRF harvesting methods and systems to minimise ground disturbance e.g. using long-reach harvesters.
- Planning extraction racks to use the most supportive areas of a site.
- Reinforcing racks with brought in materials e.g. artificial tracking, stones, timber, or other surface stabilising materials. This can be effective but may be expensive.

## IMPACT ON SOILS AND CARBON

Most species of eucalypts are tolerant of a wide range of soil types, though deep, more mineral soils are preferred, and deep peats should be avoided.

Soil pH is not critical, with moderately acid (pH 4.5) to slightly alkaline (pH 7.5) being an acceptable range.

Soil nutrition is also not critical for first rotation crops, though trees will respond to the application of a balanced NPK fertiliser. This is probably beneficial for early rapid establishment, particularly on poorer soils and restock sites. It is likely that eucalypts will reduce soil fertility on many sites, requiring some fertiliser input at planting in subsequent rotations, though this may well be similar to that required by conifer crops.

Shorter rotations may have a negative impact on soil carbon levels due to the increased disturbance during harvesting and restocking, particularly on organic soils. However, stumps and below-ground root growth will increase carbon on previously unforested sites. The overall balance is not yet fully understood. These issues will be addressed on the energy forestry sites, but will not cover all soil types.

## CONCLUSION

Eucalypts, with their rapid growth rates and the relatively high calorific value of their timber, may be a promising alternative species for woodfuel production in the right conditions. FCS' energy forestry trials together with the trials in England will provide additional, valuable information over time.

Although there has been no systematic examination of invasiveness in the UK, on current evidence, the risk of eucalypts being invasive can be considered to be low. However, the affect of extensive plantings is untested and will need further monitoring.

This interim guidance is intended to highlight the major issues but those considering planting Eucalyptus species should see professional advice on suitability for their specific site conditions.

Given the lack of available information on eucalypts potential applicants should be clear that they will bear the risk of any crop failure.

Appendix 1 summarises the potential risks of planting eucalypts and how these risks may be controlled and reduced.

## REFERENCES

BELL, S. & MCINTOSH, E. (2001), *Short Rotation Coppice in the Landscape*, FC Guideline Note 2, http://www.forestry.gov.uk/website/publications.nsf/WebPubsByISBN/0382F67DB8C1F12180256F9E00597C34

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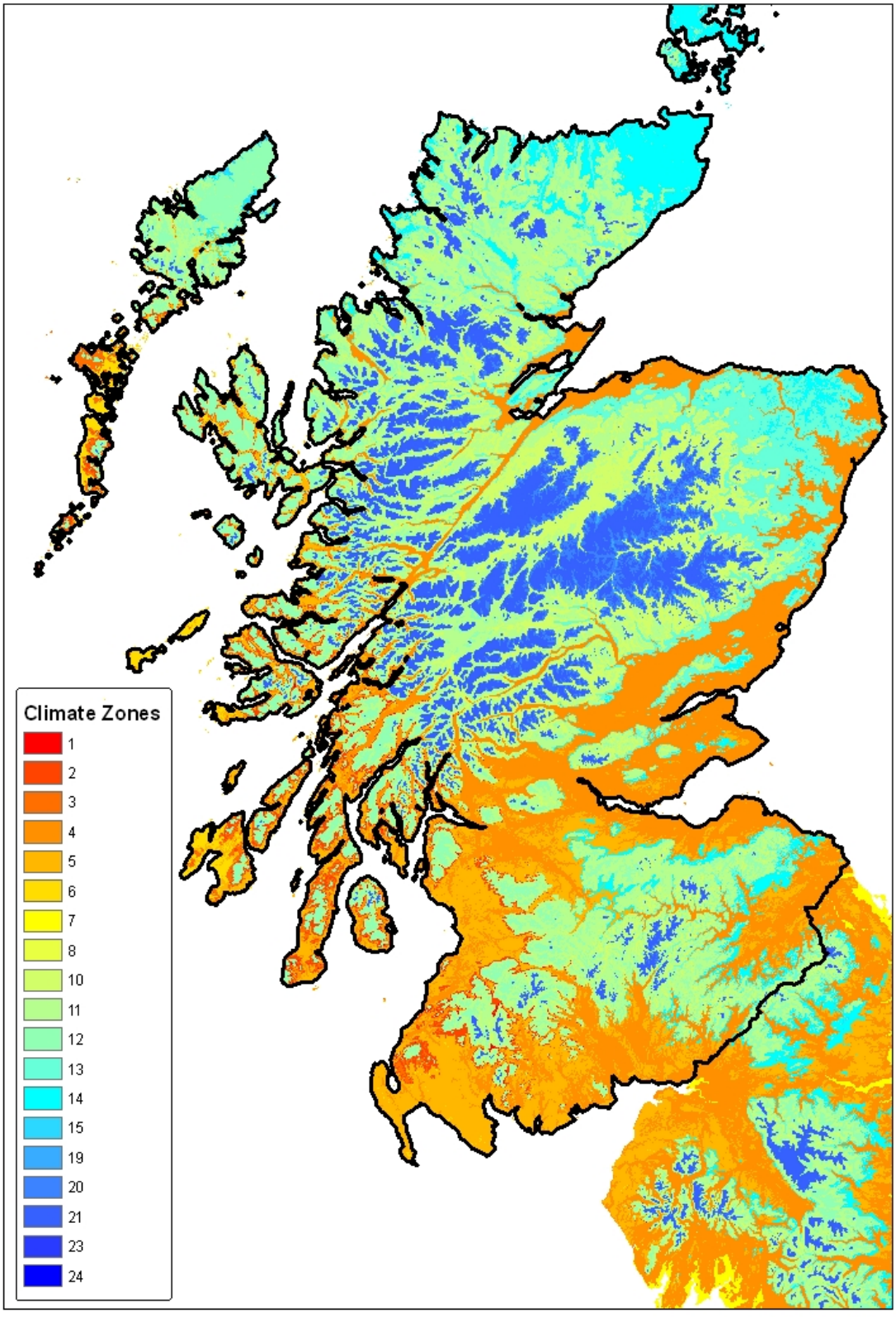
## Appendix 1: Summary table of major risks of eucalypt planting.

| RISK | ELEMENT | LEVEL | MITIGATION/CONTROL |
|---|---|---|---|
| **Physical damage** | Cold | High | Avoid planting in areas that experience minimum temperatures below 'critical' for the species.<br><br>Plant hardier species and seed origins.<br><br>Avoid planting in areas that have an accumulated temperature below 1200 degree days above 5°C. |
| **Invasiveness** | From seed | Low (under review) | Monitor regeneration when crops begin to set seed (Yr 5 onwards). |
| | Vegetative growth | No Risk | None required. |
| **Landscape impact** | Short rotation | Moderate | Refer to FC Guideline Note 2 " *Short rotation coppice in the landscape"* (2001). |
| | Evergreen monoculture | Moderate | Treat as conifer crop.<br><br>Integrate sensitively into existing landscape structure.<br><br>Best suited for mixed lowland woodland. |
| | Archaeological | Moderate | Avoid planting in areas where initial surveys have identified remains. |
| **Hydrological impact** | Water quantity | Moderate | Refer to "*Forestry and Water Guidelines*".<br><br>Risk likely to be greatest in drier east of Scotland. |
| | Water quality | Low | Refer to "*Forestry and Water Guidelines*". |

| RISK | ELEMENT | LEVEL | MITIGATION/CONTROL |
|---|---|---|---|
| **Biodiversity impact** | Exotic species incompatible with native flora and fauna | High | Meet UKFS and Biodiversity Guidelines.<br><br>Monitor species composition. |
| | SRF management model | Moderate | Plan for open areas and other species use to enhance suitability. |
| | Deer fencing | Moderate - Low | Meet UKFS and Biodiversity Guidelines.<br><br>Monitor wildlife movements. and adapt fencing as necessary. |
| **Fire** | Volatile oils in stems and foliage | Low | Treat and monitor as conifer crop. |
| **Soil damage** | Low level of brash during harvesting operations | High | Consider novel harvesting methods.<br><br>Create semi-permanent or artificial extraction tracks. |
| **Impact on soils and carbon** | Soil pH | Moderate | Plant on soils of pH 4.5 - 7.5. |
| | Soil type | Moderate | Avoid soils with a high organic content. |
| | Nutrition | Moderate - Low | Follow UKFS and Forestry and Water Guidelines. |
| | Short rotations | Moderate | Monitor - may adversely effect soil carbon. |

## Appendix 2: Climate zones in Scotland.



| | Zone Number | Accumulated Temperature (degree days >5°C) | Moisture Deficit (mm) | Exposure (DAMS) |
|---|---|---|---|---|
| WARM | 1 | >=1200 | =<90 | <=14 |
| | 2 | >=1200 | =<90 | >14 and <=18 |
| | 3 | >=1200 | =<90 | >18 |
| | 4 | >=1200 | >90 and <=160 | <=14 |
| | 5 | >=1200 | >90 and <=160 | >14 and <=18 |
| | 6 | >=1200 | >90 and <=160 | >18 |
| | 7 | >=1200 | >160 | <=14 |
| | 8 | >=1200 | >160 | >14 and <=18 |
| | 9 | >=1200 | >160 | >18 |
| COOL | 10 | >=775 and <1200 | =<90 | <=14 |
| | 11 | >=775 and <1200 | =<90 | >14 and <=18 |
| | 12 | >=775 and <1200 | =<90 | >18 |
| | 13 | >=775 and <1200 | >90 and <=160 | <=14 |
| | 14 | >=775 and <1200 | >90 and <=160 | >14 and <=18 |
| | 15 | >=775 and <1200 | >90 and <=160 | >18 |
| | 16 | >=775 and <1200 | >160 | <=14 |
| | 17 | >=775 and <1200 | >160 | >14 and <=18 |
| | 18 | >=775 and <1200 | >160 | >18 |
| ALPINE | 19 | <775 | =<90 | <=14 |
| | 20 | <775 | =<90 | >14 and <=18 |
| | 21 | <775 | =<90 | >18 |
| | 22 | <775 | >90 and <=160 | <=14 |
| | 23 | <775 | >90 and <=160 | >14 and <=18 |
| | 24 | <775 | >90 and <=160 | >18 |
| | 25 | <775 | >160 | <=14 |
| | 26 | <775 | >160 | >14 and <=18 |
| | 27 | <775 | >160 | >18 |

**Appendix 3:**

# Interim guidance on landscape and visual impacts of eucalyptus plantations

The preferred establishment and management systems for Short Rotation Forestry (SRF) potentially introduce the following issues for the Scottish landscape:

- They are a monoculture planting of a tree species that retain a uniform physical and textural appearance throughout all the stages of development.
- They introduce relatively rapid phases of spatial change with rapid growth from establishment (up to 2 metres annually) to cropping at semi-maturity in relatively short rotations (as few as 10 year intervals).

Introducing Eucalyptus species as SRF potentially adds further issues to be considered:

- It is an introduced species occasionally seen individually or in small groups in parks and gardens but not as a current species of choice in Scottish forestry.
- Although physically it has many visual characteristics of a broadleaf tree it is an evergreen. On a forest scale, this attribute will introduce an unfamiliar feature to the Scottish landscape in winter.

As with all forestry, SRF should comply with the UK Forestry Standard (UKFS) and associated suite of Guidelines (all of which are currently under review and to be replaced early 2011). With respect to landscape the UKFS states on page 4 that:

> *Forestry expansion must be balanced with the needs of other land uses and must respect the character of the landscape.*

As with SRC, SRF falls within the EIA Regulations for forestry. Should FCS consider that there is the potential likelihood of significant environmental impacts (including landscape and visual) from the proposals, the developer will be asked to prepare and submit supporting information in the form of an Environmental Statement.

Generally, SRF plantations share some of the key characteristics of short rotation coppice (SRC). For that reason it is considered that the FC Guideline Note *Short Rotation Coppice in the Landscape* is an appropriate main reference for landscape design guidance for SRF.

Generally, the key criteria for successfully siting eucalyptus SRF to minimise both its effect on local landscape character and visual intrusion are as follows:

## 1. Integration with local landscape character

- Generally, lowland landscapes (such as *Arable Land* and *Permanent Grassland* described in the FCS publication *Creation of Small Woodlands on Farms* (SWOF)) with their inherent diverse pattern of enclosed farmland spatially structured by woodland and tree belts, can more readily accommodate eucalyptus SRF than open, upland landscapes.

- Care should be taken with the overall scale of the eucalyptus SRF which should reflect the relative scale of the enclosure pattern. If the plantation is too large scale the eucalyptus SRF will be seen as a new and dominant element in the landscape, at odds with local landscape character.

- Care should also be taken with the overall extent of eucalyptus SRF, both individual plantings and the cumulative effect of successive proposals. Although such lowland landscapes may have the capacity to absorb eucalyptus SRF, there will come a point where successive plantations contribute towards the further enclosure of the landscape and perception of rapid change to what may be considered the traditional landscape character.

- Within more open grassland (such as *Hill Land* and *Unimproved Grazing* as described in SWOF) and moorland, integrating eucalyptus SRF may be more challenging. In these more open and, in places, upland landscapes, such plantations could have a significant effect on the character of the local landscape.

- Care should be taken to ensure that the scale of the planting is appropriate to the landscape. In wide open landscapes a small scale plantation can appear as an intrusive feature, whereas too large scale can significantly alter the character of the local landscape.

- Care should also to be taken with its location. If located on the upper or mid-slopes it may appear as an incongruous new feature 'floating' and disconnected from the landscape. Advantage should be taken of linkages with lower ground and associations with any existing landscape features, such as woodland belts.

- Care should be taken with both the external and internal (management unit) shapes of the plantation. In the absence of a strong enclosure pattern, these shapes should reflect the influences of the underlying landform. As with woodland design, the internal shapes should consider a hierarchy of scale (small to lower slopes grading to larger to upper slopes) and achieve appropriate interlock and coherent sequence of felling and restocking all to achieve a harmonious pattern in the landscape.

## 2. Mitigating visual impacts

- Care should be taken when siting eucalyptus SRF in visually sensitive landscapes. Good design with regards to both external and internal scale and shape, coupled with locating the plantation to take advantage of existing adjacent features (especially woodland, trees and hedgerows) can do much to mitigate potential visual impacts.
- Further, keeping the edge of the plantation away from the immediate proximity of visually sensitive locations (such as viewpoints, tourist routes and footpaths) can help mitigate its visual impact.

## 3. Minimising impacts on the historic environment

- Because of the recognised deep rooting of eucalyptus SRF species care should be taken to ensure that the archaeology and cultural features of a site are fully investigated and considered prior to its establishment.

## References

FC Guideline Note *Short Rotation Coppice in the Landscape* – Simon Bell & Elizabeth McIntosh (2001)
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