CEBC

CENTRE FOR EVIDENCE-BASED CONSERVATION

SYSTEMATIC REVIEW No. 31

WORKING TITLE: DOES THINNING OF SPRUCE OVERSTORIES INCREASE THE GROWTH RATE AND SURVIVAL OF SPRUCE SEEDLINGS AND YOUNG SAPLINGS?

CONSULTATION DRAFT REVIEW PROTOCOL

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COVER SHEET

Title	**Working title: Does thinning of spruce overstories increase the growth rate and survival of spruce seedlings and young saplings?**
Systematic review	**N°.31**
Reviewer(s)	***Victoria Stokes***
Date draft protocol published on website	11th July 2007
Date final protocol published on website	*n/a*
Date of most recent amendment	*n/a*
Date of most recent SUBSTANTIVE amendment	*n/a*
Details of most recent changes	*n/a*
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Sources of support	Forestry Commission
Conflicts of interest	None

1. BACKGROUND

In some Sitka spruce plantations extensive natural regeneration has been observed with seedling densities as high as 300,000 ha^{-1} (McNeill & Thompson 1982, Clarke 1992). Management of natural regeneration is a critical part of continuous cover silviculture as it removes the need for costly under-planting. The regenerating seedlings tend to originate from the dominant seed trees of the overstorey, helping to ensure that they will be genetically suited to the site.

Management of existing seedlings on a site can be complex; although Sitka spruce has an intermediate shade tolerance and will germinate and survive under its own shade (Malcolm et al. 2001) it is thought that the seedlings may persist for years in "check" with very little growth, i.e. a form of seedling bank. However, managers have experienced different results when thinning or removing the overstorey in an attempt to modify the seedling microclimate and reduce competition for light, nutrients and moisture. Although there have been some successful attempts, resulting in increased growth and survival of the seedlings, on other sites (for example, Clocaenog and Craigvinean) there has been little or no response, often resulting in seedling death. Some managers are therefore reluctant to intervene and tend to either neglect the stand or intervene using standard management techniques.

Little is known about the reported seedling deaths in these unsuccessful cases. Conversations with managers indicate that this may be due to seedlings entering a physiological state of "check" where they are morphologically and physiologically adapted to shade and less-able to respond to increased irradiance, greater temperature fluctuations, increased potential evapotranspiration, etc. Seedlings in this state may not have the resources (e.g. perhaps leaf chlorophyll or Rubisco contents) available to respond to the reduction in competition. Alternatively death may be due to poor stomatal control and excessive water loss in the more exposed environment, perhaps in conjunction with poorly developed root systems which do not reach mineral soil.

However, the high cost of physiological studies of seedling survival means that experiments aiming to clarify the processes involved are difficult and expensive. Measurements would need to be carried out on a wide range of sites to capture the full range of environmental conditions and factors which may be involved. It is likely that there is already a large amount of existing information (published and un-published) which could be accessed, collated and analysed to provide a detailed overview of the impact of particular management interventions on seedling growth and survival without the need for further site-specific field studies.

To provide an unbiased summary and analysis of these data, information would need to be collated from a wide range of sources. The published literature, demonstration sites and practice guides have a strong bias towards reporting successful incidences of regeneration while those that are unsuccessful are not widely reported. These experiences tend to be written off as "failures" and the reasons for this are rarely analysed in depth.

A wide-ranging, unbiased review of the available information may provide enough data to carry out a meta-analysis with the possibility of clarifying the effect of

different management practices on growth and survival of seedlings in a variety of site types.

2. OBJECTIVE OF THE REVIEW

2.1 Primary question

Does thinning of spruce overstories increase the growth rate and survival of spruce seedlings and young saplings?

Table 1: Definitions of components of the primary systematic review question

Subject	Intervention	Outcome
Sitka spruce or hybrid spruce seedlings and/or saplings from natural regeneration or planted understories	Thinning or removal of sitka spruce or hybrid spruce overstories. Release of understorey spruce from overstorey competition. Vs. No thinning of the overstorey.	Change in survival rate of seedlings or saplings. Change in growth rate of seedlings or saplings.

2.2 Secondary question

What influence do environmental and treatment conditions (light penetration, soil type, climate, thinning intensity, thinning history) have on the impact of the thinning?

3. METHODS

3.1 Search strategy

The following computerised databases will be searched:

1. ISI Web of Knowledge
2. Science Direct
3. Directory of Open Access Journals (DOAJ)
4. Copac
5. Scirus
6. Scopus
7. Index to Theses Online (1970-present)
8. Digital Dissertations Online
9. JSTOR
10. CABI Databases
11. TREE CD

The following search terms will be used:

1. (Sitka OR "hybrid spruce" OR *Picea sitchensis*) AND regeneration
2. (Sitka OR "hybrid spruce" OR *Picea sitchensis*) AND (seedlings OR saplings)
3. (Sitka OR "hybrid spruce" OR *Picea sitchensis*) AND understor*
4. (Sitka OR "hybrid spruce" OR *Picea sitchensis*) AND (overstor* removal OR thinning)
5. (Sitka OR "hybrid spruce" OR *Picea sitchensis*) AND (canopy removal OR thinning)
6. (Sitka OR "hybrid spruce" OR *Picea sitchensis*) AND seedling release
7. (Sitka OR "hybrid spruce" OR *Picea sitchensis*) AND (growth OR survival)
8. (Sitka OR "hybrid spruce" OR *Picea sitchensis*) AND check
9. (Sitka OR "hybrid spruce" OR *Picea sitchensis*) AND thinning response

An internet search will also be performed using the meta-search engines www.alltheweb.com, www.dogpile.com, www.scirus.com (all journal sources) and http://scholar.google.com. The first 50 hits from each source will be examined for appropriate data.

The Forestry Commission library will be searched by hand. Questionnaires may be circulated to forest managers to collate experiential knowledge. Where appropriate authors of papers will be contacted to request data.

3.2 Study inclusion criteria

Relevant subject(s)
Sitka spruce or "hybrid spruce" seedlings or young saplings either naturally regenerated or planted under a mature sitka spruce or hybrid spruce canopy (a seedling is defined as less than 1.3m tall and a sapling as >1.3m tall but <7cm diameter at breast height).
The overstorey must be a minimum of 35 years old and consist of at least 70% spruce with no broadleaved or deciduous component.

Types of intervention
Overstorey thinning or complete removal.

Types of comparator
No overstorey thinning in the last four years.

Types of outcome
Change in the survival rate and/or growth of the seedlings and/or saplings.

Types of study
Studies where measurements of seedling growth have been taken on control (no thinning) and treatment groups. The thinning or release treatment may be applied at the tree, plot or stand level.

Studies where measurements of seedling/sapling growth increment have been taken prior to thinning treatment, with subsequent measurements post-thinning.

Site comparison studies will be included where data are considered to be of sufficient quality and relevance.

Experiential questionnaire data from forest managers may be used.

Potential reasons for heterogeneity
The following list of potential reasons for heterogeneity have been identified:

1. Age of seedlings/saplings
2. Basal area of overstorey prior to thinning
3. Basal area of the overstorey post-thinning
4. Intensity of thinning treatment
5. Time elapsed since previous thinning treatment
6. Time elapsed between experimental thinning treatment and assessment
7. Age of overstorey
8. Presence of grazing mammals
9. Soil type
10. Climate
11. Ground vegetation

3.3 Study quality assessment

Articles will be considered at full text and quality will be assessed by reviewers according to a hierarchy of evidence (Stevens & Milne 1997, Pullin & Knight 2003, e.g. a randomised control trial would be weighted higher than a site comparison study) admitting or excluding them from the study. A minimum of 25% of the articles will be considered by two of the reviewers and tested statistically to ensure agreement of quality is sufficiently high. Disagreement will be resolved by a third reviewer.

3.4 Data extraction strategy

Study characteristics, design, quality, results and reasons for heterogeneity will be extracted and recorded on specially designed data extraction forms. These may be modified in consultation with a statistician after piloting the method. Attempts will be made to collect primary data from authors where appropriate.

3.5 Data synthesis

A narrative thesis summarising the data will be produced including study characteristics, design, quality, tabulated results and reasons for heterogeneity. After consultation with a statistician, any data suitable for statistical analysis will be analysed using appropriate techniques for the type of data extracted; this may include meta-analysis.

4. Potential Conflicts of Interest and Sources of Support

No conflicts of interest to be declared. This systematic review is funded by the Forestry Commission. Some staff support may be provided by the CEBC funded by the Forestry Commission.

5. References

Clarke, G.C. (1992) The natural regeneration of spruce, *Scott For*. 46, 107-129.

Malcolm, D.C., Mason, W. L. & Clarke, G. C. (2001) The transformation of conifer forests in Britain – regeneration, gap size and silvicultural systems, In: Transformation of plantation forests: selected and edited papers from a IUFRO conference held in Edinburgh, Scotland in August 1999, edited by A. D. Cameron, W. L. Mason and D. C. Malcolm. Special Issue *For. Ecol. and Manage*, 151, 7-23.

McNeill, J.D. & Thompson, D.A. (1982) Natural regeneration of Sitka spruce in the Forest of Ae, *Scott. For*. 36, 269-282.

Pullin, A.S. & Knight, T.M. (2003) Support for decision making in conservation practice: an evidence-based approach. Journal for Nature Conservation, 11, 83-90.

Stevens A. & Milne R. (1997) The effectiveness revolution and public health. In: Progress in Public Health. Ed. G. Scally, pp. 197-225. Royal Society of Medicine Press, London.