Aspen/Sitka spruce mixture experiment **Draft 23rd Oct 2015**

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Introduction:

A key aim of current forest policy is to diversify stands and reduce reliance on monocultures of exotic species. Increasing threats from climate change and pests and diseases are driving managers to improve the adaptive capacity and resilience of stands.

One way of doing this is by developing mixed species stands, but little is known about the growth and productivity of some species when grown in mixtures. For both species to persist in the stand to maturity the growth rates need to be well-matched, with neither species out-competing the other. Recent research suggests that some combinations of species are mutually beneficial and can be more productive when grown in mixtures than in pure stands (Mason and Connolly 2014).

Introduction of a native broadleaved component to productive non-native conifer forests might increase resilience and biodiversity, and add landscape value. Aspen (*Populus tremula* L.) is native to Scotland and was probably once a widespread and common part of native woodland ecosystems. Results from a series of trials testing native aspen from different Scottish zones indicated that mean height of 1.5 – 3.0 m at age 6 can be expected, depending upon site quality (Mason et al. 2002). On suitable sites these growth rates are comparable to that of Sitka spruce during the establishment phase, suggesting that the two species could be compatible in planted mixtures.

Operational management of mixed stands can be difficult, particularly if the intention is for both species to persist in the stand and neither is being planted as a sacrificial nurse crop. While random or intimate mixtures may appear most natural, competitive interactions between the species are difficult to address and correct in such mixtures. Managers need a planting pattern that gives the flexibility to intervene and thin or possibly remove either species independently of the other, without producing a stand that has a negative visual impact on the landscape.

The objectives of this experiment are to:

- Establish a field trial to compare growth and productivity of different aspen/Sitka spruce mixtures with pure stands of aspen and of Sitka spruce.

- Test whether simple systems can be used to manage the stands in such a way so that both are part of a final crop.

The aims are to:

- Identify planting ratios of the two species that maximise productivity and are operationally practical.

- Demonstrate operational management of mixed stands.

Design:

A randomised block design with three replicate blocks and five treatments.

There will be two pure species treatments and three experimental mixture treatments (see below), planted at 2 x 2 m spacing.

Main plot size = 0.2 ha (45 x 45 m; 484 trees)
Assessment plot size = 0.1 ha (32 x 32 m; 256 trees)
Total experiment area = 3.0 ha minimum

Treatments:

Pure Sitka spruce
Pure aspen (10 clone mixture)
3:1 line mix (75% aspen)
1:1 line mix (50% aspen)
1:3 line mix (25% aspen)

See Figure 1 for diagrams of mixture layouts.

Requirements:

Minimum 3.0 ha restock site on surface water gley soil, on the PFE.
3630 aspen trees and 3630 Sitka spruce trees (plus beat-ups and surround allowance).
Site to have suitable ground preparation treatment, deer fencing (and vole guarding?).

Establishment operations:

Identification of suitable site	(TSU: *2 FO days*).
Ground prep – drainage and probably mounding	(FE).
Weed control and deer/rabbit fencing prior to planting	(FE).
Plot layout, tallying and marking of planting rows and species	(TSU: *4 days*).
Planting of 7260 trees in Winter 2016/17	(FE/TSU: *4 days*).
Weed control Summer 2017	(TSU: *3 days*).
Beating up with same species at the end of the 1st and 2nd years	(FE/TSU: 2 *days per year*).

Assessments:

Height assessment of 3840 trees in assessment plots at planting (*TSU: 6 days*).

Survival and height of 3840 trees in assessment plots at the end of the 1st, 2nd and 3rd growing seasons (TSU: 6 *days per year*).

Additional assessments as required in later years, depending on rate of development of the species.

Costs:

If the site, ground preparation, fencing and planting can be provided by FE staff (with some TSU time allowed for supervision), the estimated costs are:

Year 1	Site identification	2 FO days	tbc
	Ground prep, weeding, fencing	FE	
	Site layout and tallying	4 RW days	
	Planting 7260 trees	FE	
	Supervision of planting	4 RW days	
	Inspections and summer weed control	3 RW days	
	Beating up	2 RW days	
	Post-planting assessment (3840 trees)	6 RW days	
	End-of-year assessment (3840 trees)	6 RW days	
	Project management	3 PB4 days	
	T&S and materials		
	Total		
Year 2	Inspections and summer weed control	3 RW days	
	End-of-year assessment (3840 trees)	6 RW days	
	Beating up	2 RW days	
	Project management	2 PB4 days	
	Total		

NB: The cost of plants has not yet been included in the estimates above. Containerised aspen are approximately £1.50 per tree. It is hoped that either the FE or another funder might cover the cost of trees.

Future thinning:

The need for future thinning is difficult to anticipate and will depend on the relative growth rates of the two species in the different treatments. It is important that any future thinning should treat the plots equally i.e. by removing the same number of trees from all treatments.

In the current mixture layout shown in Figure 1 there is the option to release aspen if needed by removing rows 8 and 16 (marked 'x' on Figure 1)and continuing removal of those rows through all treatments.

An alternative thinning of rows 9 and 17/18 (marked 'o' on Figure 1) could be carried out to retain the Sitka in the 3:1 mix, but reduce Sitka competition in the 1:1 and 1:3 mixture.

If plots are aligned correctly on site (i.e. in a square grid) this would be operationally simple, and could also be applied to the pure plots.

If row 1 was also removed (not affecting the assessment plots) this would be equivalent to establishing a rack system at approximately 15 m spacing.

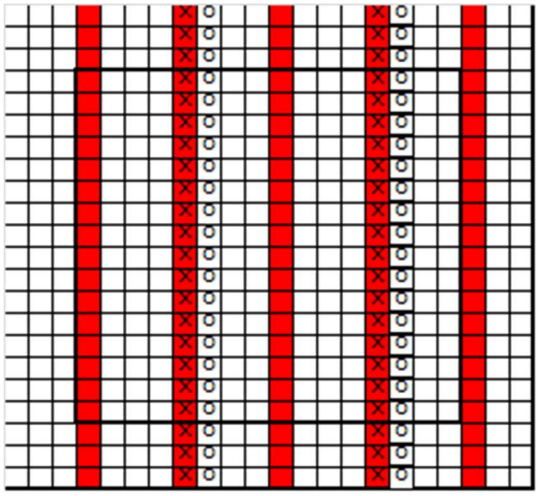
References:

Mason B, Easton E, Ennos R. 2002 Variation in aspen in Scotland: genetics and silviculture. In *The biodiversity and management of aspen woodlands* (eds Cosgrove P, Amphlett A), pp. 45–55. Grantown-on-Spey, UK: The Cairngorms Local Biodiversity Action Plan.

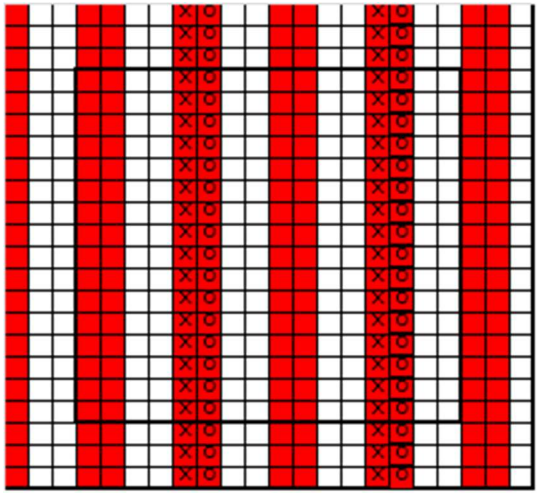
Mason, W.L. and Connolly, T. (2014) Mixtures with spruce species can be more productive than monocultures: evidence from the Gisburn experiment in Britain. *Forestry*; doi: 10.1093/forestry/cpt042.

Figure 1: Layout of mixed species plots, containing 484 trees per plot (0.2 ha). Bold line shows inner assessment plot of 256 trees (0.1 ha). Aspen = white, spruce = red.

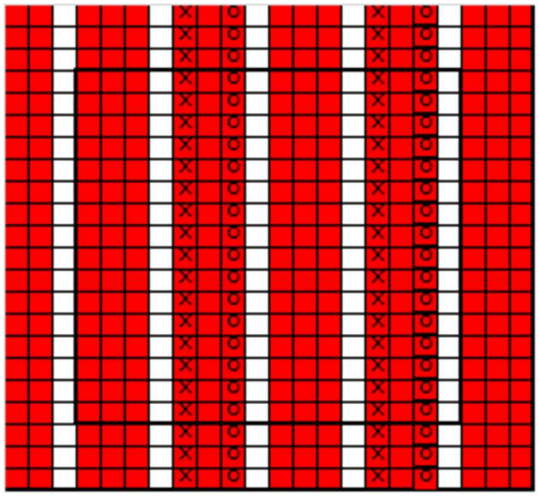
3:1 mixture



1:1 mixture



1:3 mixture



The X and O relate to different possible future thinning scenarios – we were looking for ways that managers could remove single rows aligned through the plots to achieve different aims.

Removing the X rows would release aspen if it was being outcompeted; removing the O trees instead would maintain some Sitka in the treatments were it was a minor component, but reduce it in the other treatments. Removal of these rows described in the experiment plan would also be equivalent to putting in a rack system at fairly regular spacing.