Where Is The Timber Quality Programme Today?
Options For The Future

Barry Gardiner

Timber Properties Programme Leader

Who We Are

- Alexis Achim: Project Scientist. Measurement and modelling of wood properties
- Barry Gardiner: Programme Leader. Simulation modelling, compression wood and resource assessment
- Elspeth Macdonald: Compression wood, silviculture and timber quality, sustainable construction
- Shaun Mochan: Impacts on industrial utilisation, impact of breeding on timber quality
- *Justin Gilbert: Forecasting timber availability and quality*
- *Jason Hubert: Stem form and conversion, broadleaf breeding*
- *Stephen Bathgate: Programming TQ models*
- *Steve Lee: Conifer breeding and impact on timber quality*

Partners

- Forestry Commission
- Scottish Enterprise
- European Union
- Glasgow University
- Napier University
- Aberdeen University
- Bangor Univsity
- BRE
- CEH
- INRA, Nancy & Bordeaux
- STFI, Stockholm
- Freiburg University
- FRI, Baden-Württemberg
- + other European Institutes

- Scottish Woodlands
- Tilhill Forestry
- Seafield Estates
- Annandale Estate
- Buccleugh Estates
- NE England Forestry Action Group
- Gordons
- Howie
- Wilson
- James Jones
- BSW
- UKFPA

Timber Properties Research Programme
(*began 1997*)

1. Assessing, predicting and forecasting timber quality in standing trees

2. Modelling effects of management practices on wood properties & timber performance

Timber Properties Programme: *Projects*

Project	Project Leader	Time Scale	Expected End-Users
Stem Straightness	Barry Gardiner	Ongoing (2008)	Forest & sawmill managers, policy
TQ Models	Barry Gardiner	Ongoing (2010)	Researchers & policy
Effect of Exposure & Windblow	Shaun Mochan	Completed (being written up)	Forest managers
CW in SS & SP	Elspeth Macdonald	Completed (analysis ongoing)	Researchers, forest/sawmill managers
Lodgepole provenance	Shaun Mochan	Completed	Forest managers
TQ of improved progeny	Shaun Mochan/Steve Lee	Completed (being written up)	Forest managers
CCF & TQ	Elspeth Macdonald	Completed (being written up)	Policy people, forest/sawmill managers
Drying of LP	Shaun Mochan	2006 (1st report being prepared)	Biofuel plant managers
Sustainable Construction	Elspeth Macdonald	2005-2008	Builders and architects
Resource Assessment for Sawmill Investment	Barry Gardiner	2005-2007	Sawmill managers
Scots Pine in N. Scotland	Elspeth Macdonald	2005-2009	Forest/sawmill managers, policy
Impact of Spacing	Alexis Achim	2006-2007	Forest managers, policy
Physiology of Stem form	Barry Gardiner	2006-2009	Researchers, foresters

Recent Projects

- Stem straightness in Sitka spruce
- Timber quality model for Sitka spruce
- Wind exposure effects on timber quality
- Effect of windblow on timber quality
- Lodgepole pine provenances
- EU Compression Wood project
- Review impact of conversion to Continuous Cover Forestry on timber quality

Stem Straightness

- Stem straightness identified as the single most important determinant of log quality in Sitka spruce
- A prototype method of assessing log quality in standing Sitka spruce trees, based on a visual estimate of straight log lengths in the first 6m of the stem, was developed in the early 1990s
- Scoring system further tested and used in survey of Sitka spruce stands in Scotland, N. England and Wales, 1998 - 2001

Stem Straightness Scoring System

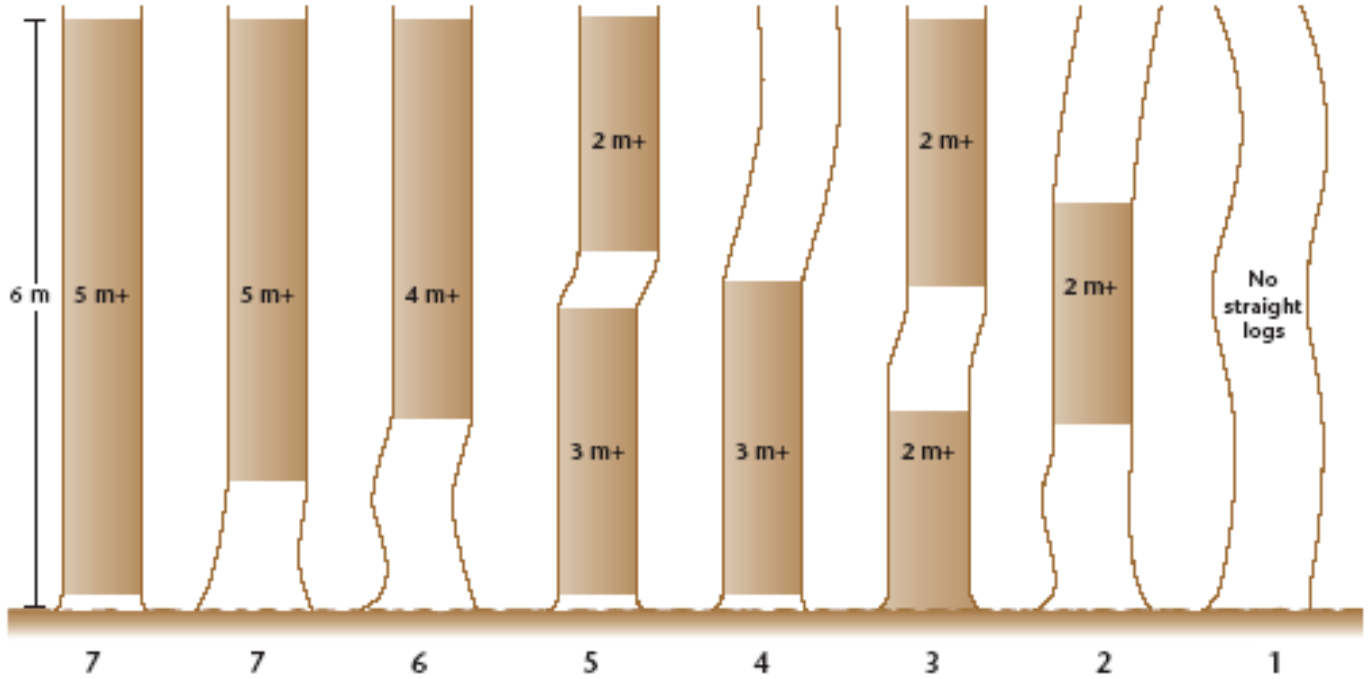
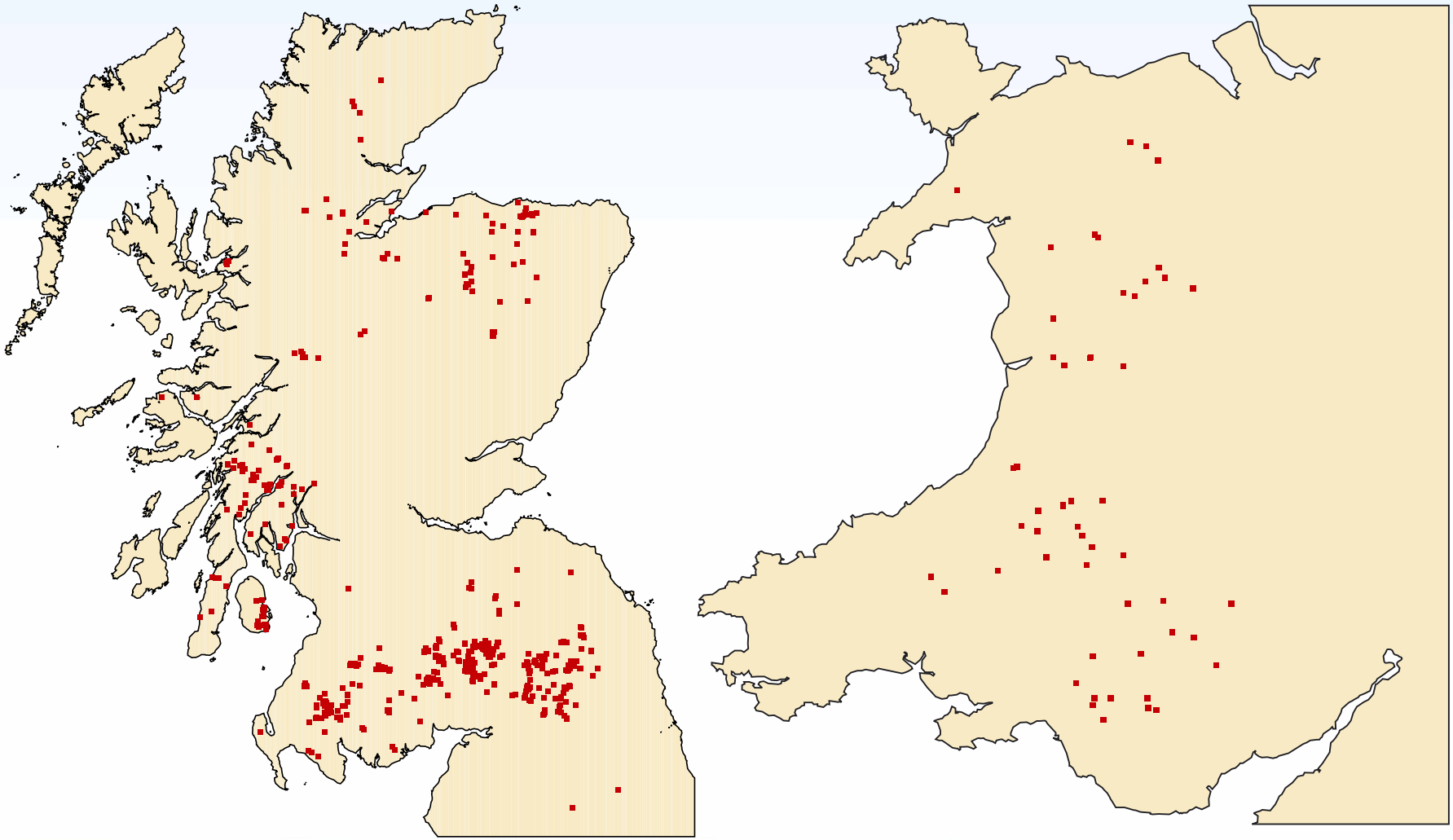


Figure 2

Straightness Score: different combinations of log lengths in first 6 m showing gradual reduction in quality from left to right (after Methley, 1998)

Survey Locations (*not to scale*)



Survey Results

- Factors associated with poorer straightness:
  - More recent plantings
  - Increased exposure and elevation
  - No thinning
  - Wider initial spacing
- Statistical models predicting straightness score from inventory data
- First step to forecasting quality (*i.e.* straightness) of future timber supplies from inventory data (planned for summer 2006)

Timber Quality Model

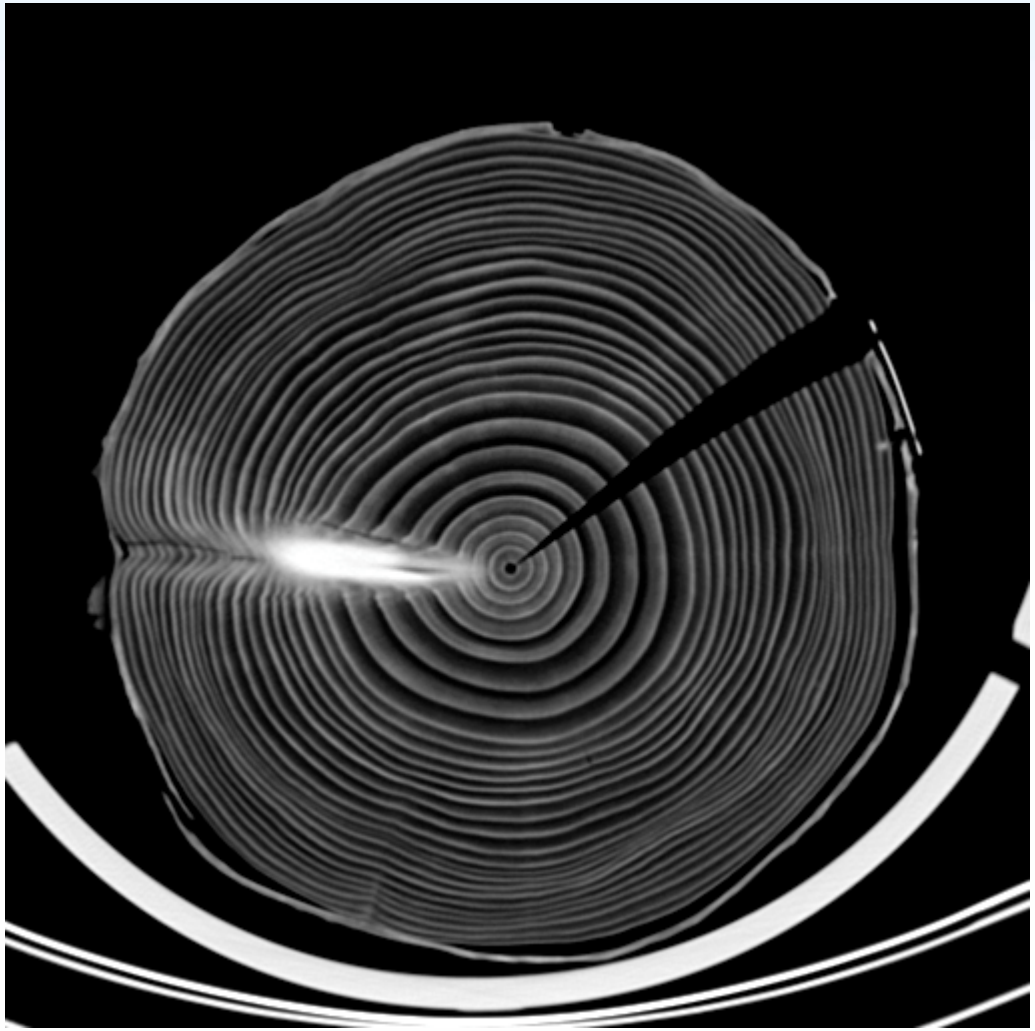
- A model predicting Sitka spruce wood properties has been developed with two main aims:
  - Predict effect of different management practices on timber properties and end-use quality
  - Estimate the effect of genetic gains from tree breeding upon timber properties and log outturn

Modelling Approach

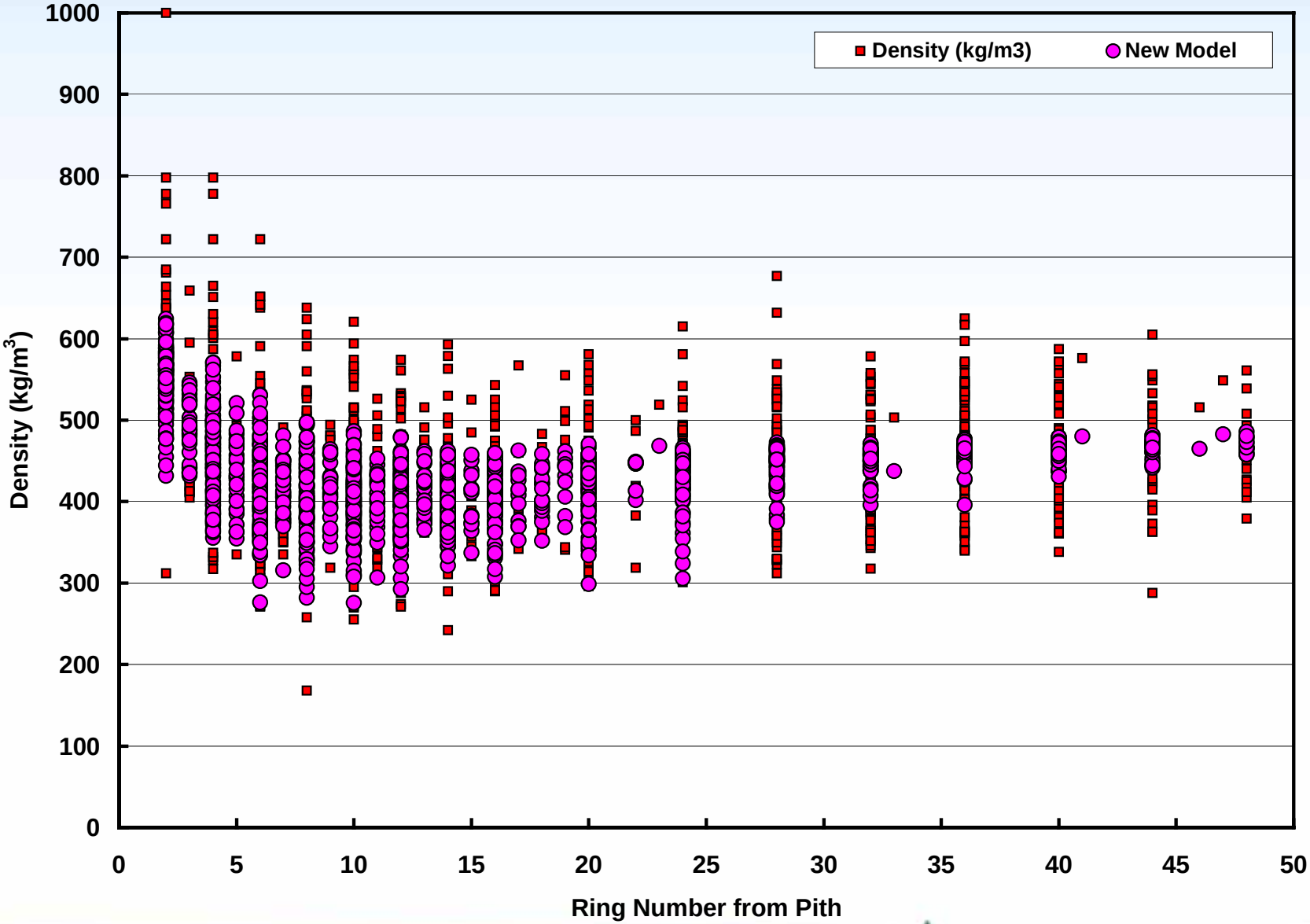
- Based on French modelling methods, working in collaboration with Dr Jean-Michel Leban and Dr Francis Colin, INRA, Nancy, France
- Data collected for **wood density, branching** and **spiral grain** from around 300 trees from 10 stands in 6 locations
- Aim to combine with Forest Research Sitka spruce growth models and sawn timber performance models developed by Building Research Establishment

Measurement of Density (CT Scanner)

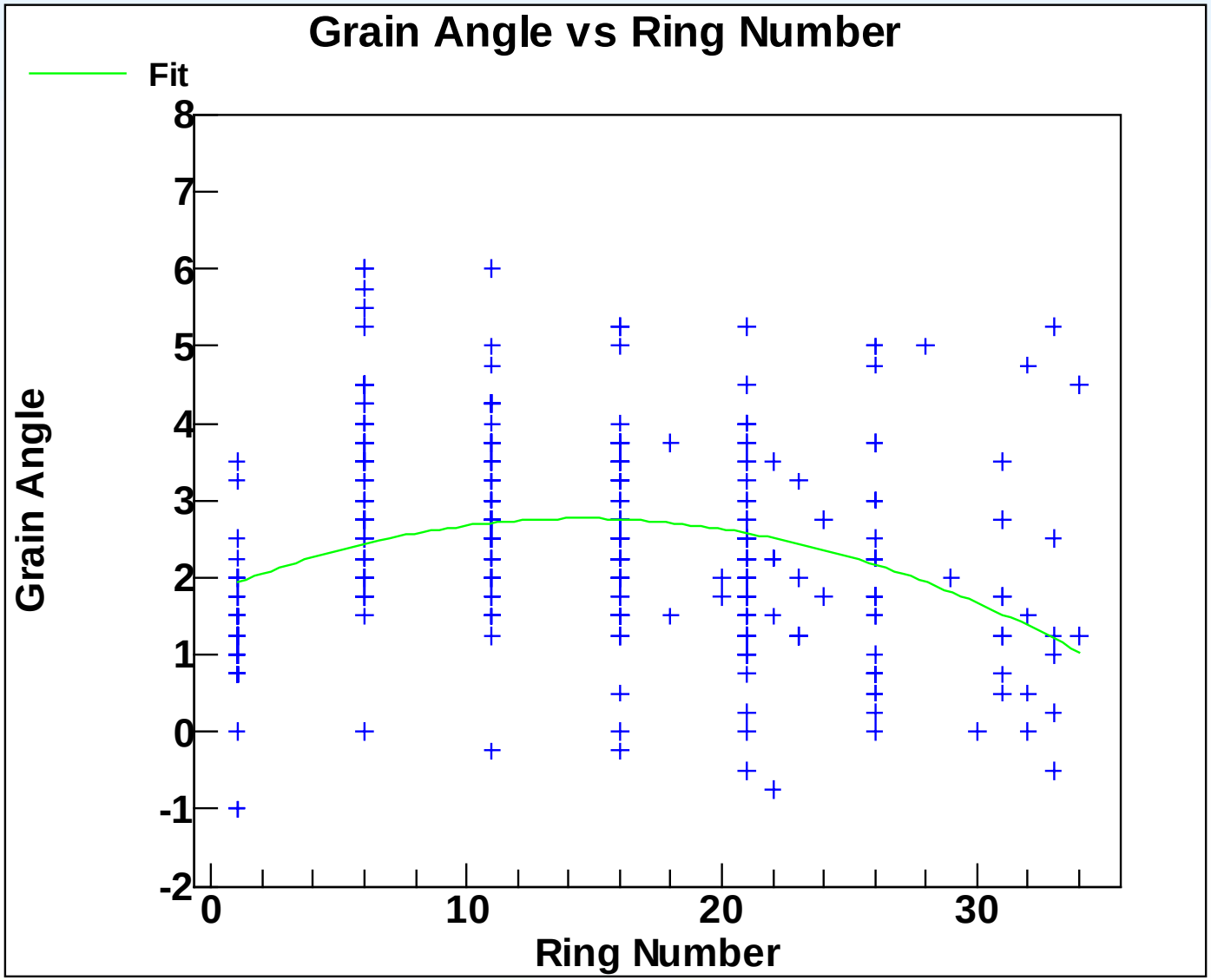
Disc from 1.3m (Kershope, 3.5m spacing)



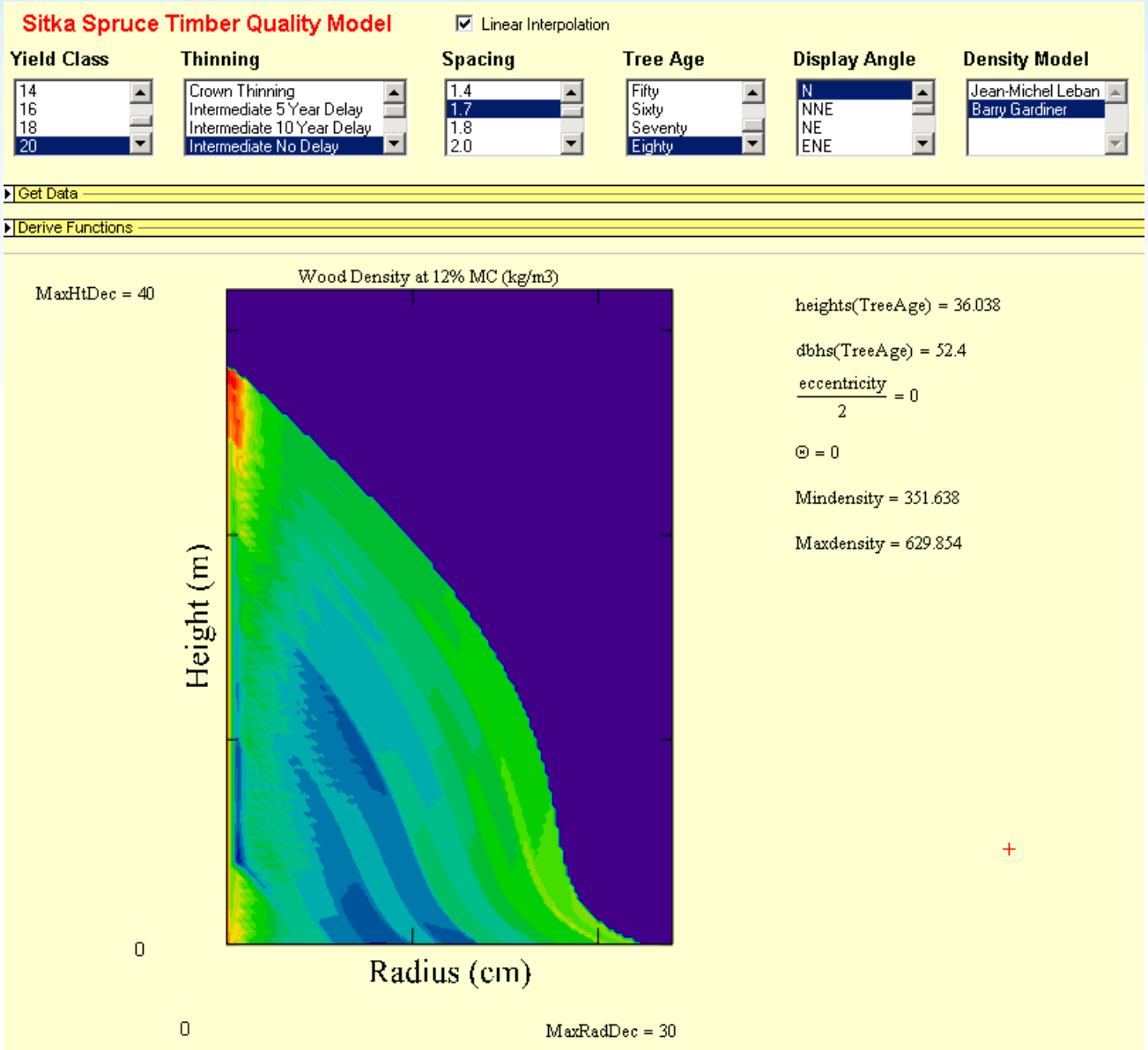
Density (kg/m^3) versus Ring Number



Measured & Simulated Grain Angle



Sitka Spruce Model in Mathcad®



Wind Exposure and Timber Quality

- Work carried out by Dr Franka Brüchert, during Marie Curie Fellowship
- Characteristics and timber from Sitka spruce at the edge and towards the centre of an exposed stand were examined
- An increased grain angle, more compression wood and greater within tree variation was found for trees closer than 1 tree height to the edge
- Replication of this work at another site supported these results
- Work currently being written up

Windblow and Timber Quality

- Project examined the quality of timber from windblown trees that were still living

- Results suggested:
  - up to 18 months after windblow, a high proportion of battens may be utilised for the construction industry
  - by 36 months there is a significant reduction in percentage battens passing stress grading

Lodgepole Pine Provenances

- Problems with abrupt (brittle) failure of lodgepole pine timber in service
- Tested 3 provenances (South Coastal, Interior and Alaskan) at 2 locations (Rosarie and Shin)
- Under impact testing South Coastal performed worst, Alaskan best (comparable to Scots pine)
- Information Note published

Impact of Compression Wood on Failure Mode

Simple Tension Failure

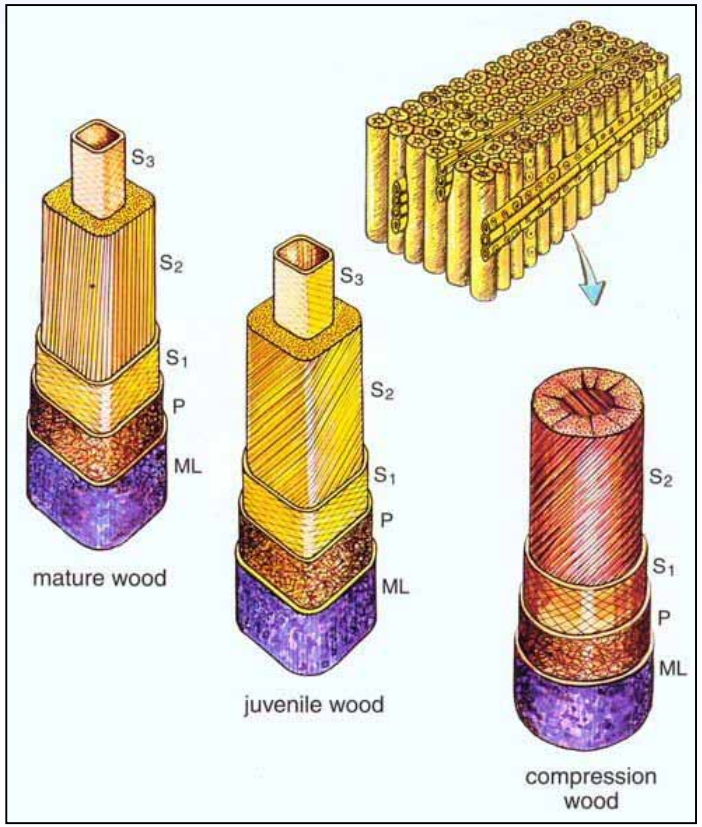
Brash Failure

Compression Wood

(EU 5th Framework Project)

Compared to normal wood, compression wood has:

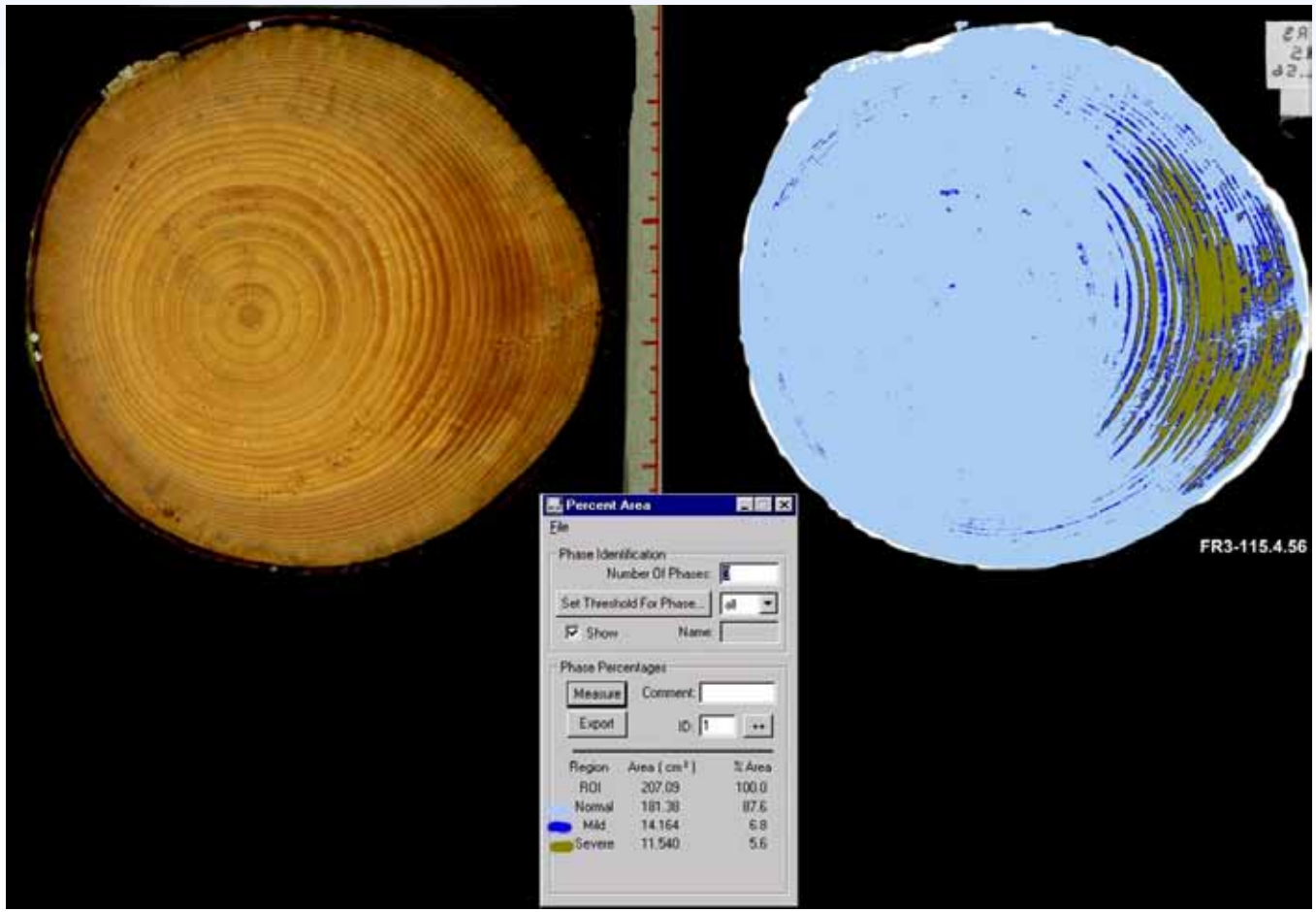
- Shorter fibres
- Thicker cell walls that are rounded in cross section
- High lignin content
- High microfibril angle



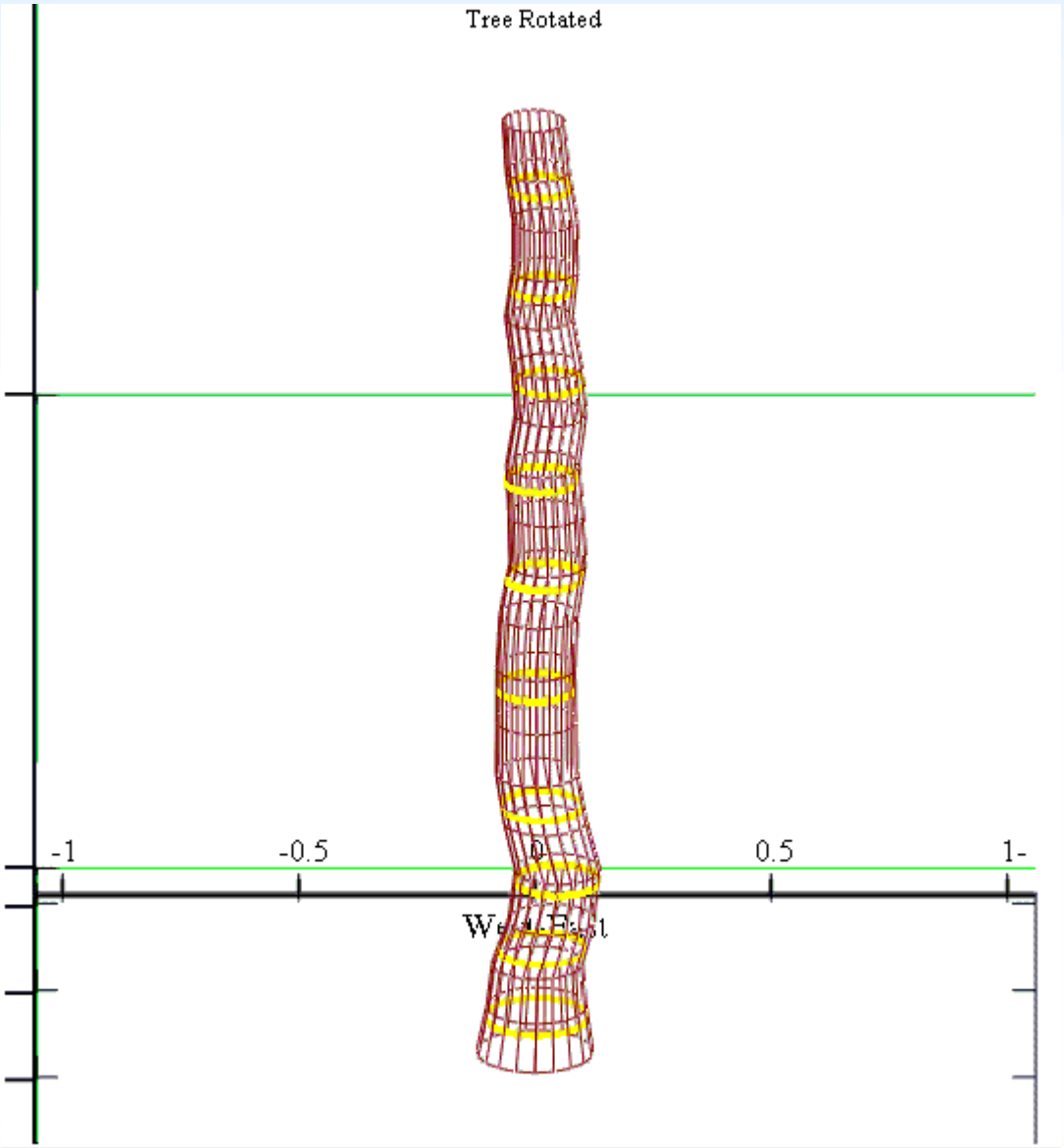
Effects on Utilisation

- High longitudinal shrinkage results in increased drying distortion
- Reduced stiffness and a tendency to fail in a brash manner
- High lignin content and short fibres less suitable for pulp

Image Analysis to Identify Compression Wood



Effect of Stem Shape



Stem shape was measured using laser relascope or digital

The distribution and severity of compression wood was examined in relation to tree shape

Analysis has shown amount of compression wood in trees a function of lean, sinuosity and dominance. Analysis ongoing with BRE & INRA

Implications of CCF on Timber Quality

Background

- GB forests are increasingly required to deliver a range of benefits in addition to timber
- To achieve this there has been a policy shift away from clearfelling towards wider use of continuous cover silvicultural systems
- This large scale change in silvicultural strategy is likely to have an impact on the supply and quality of timber produced, particularly during the transformation period (up to 50 years)
- An assessment of of this impact will inform investment in wood processing facilities

Effects Of Transformation To CCF On Log And Wood Properties

	Longer rotations	Gap creation	Increased thinning		Variability	Restricted genetic change
			Early thinnings	Later thinnings		
Diameter	+	+/=	+	+	=	-
Stem straightness	+	-/=	+	+	-	-
Branching/knots	+	-	+/=/-	+	-	-
Grain angle	=/+	-	+/=	+	-	-/=
Wood density*	+	SS DF - SP L =	-	SS DF - SP L =	SS DF -/= SP L =	SS DF +/= SP L =
Tracheid length	+	+/=/-	-	+	+/=/-	=
Microfibril angle	+	+/=/-	-	+	+/=/-	=
Juvenile wood	+	+/=/-	-	+	+/=/-	=
Compression Wood	=	- -	=/-	=/+	-	=

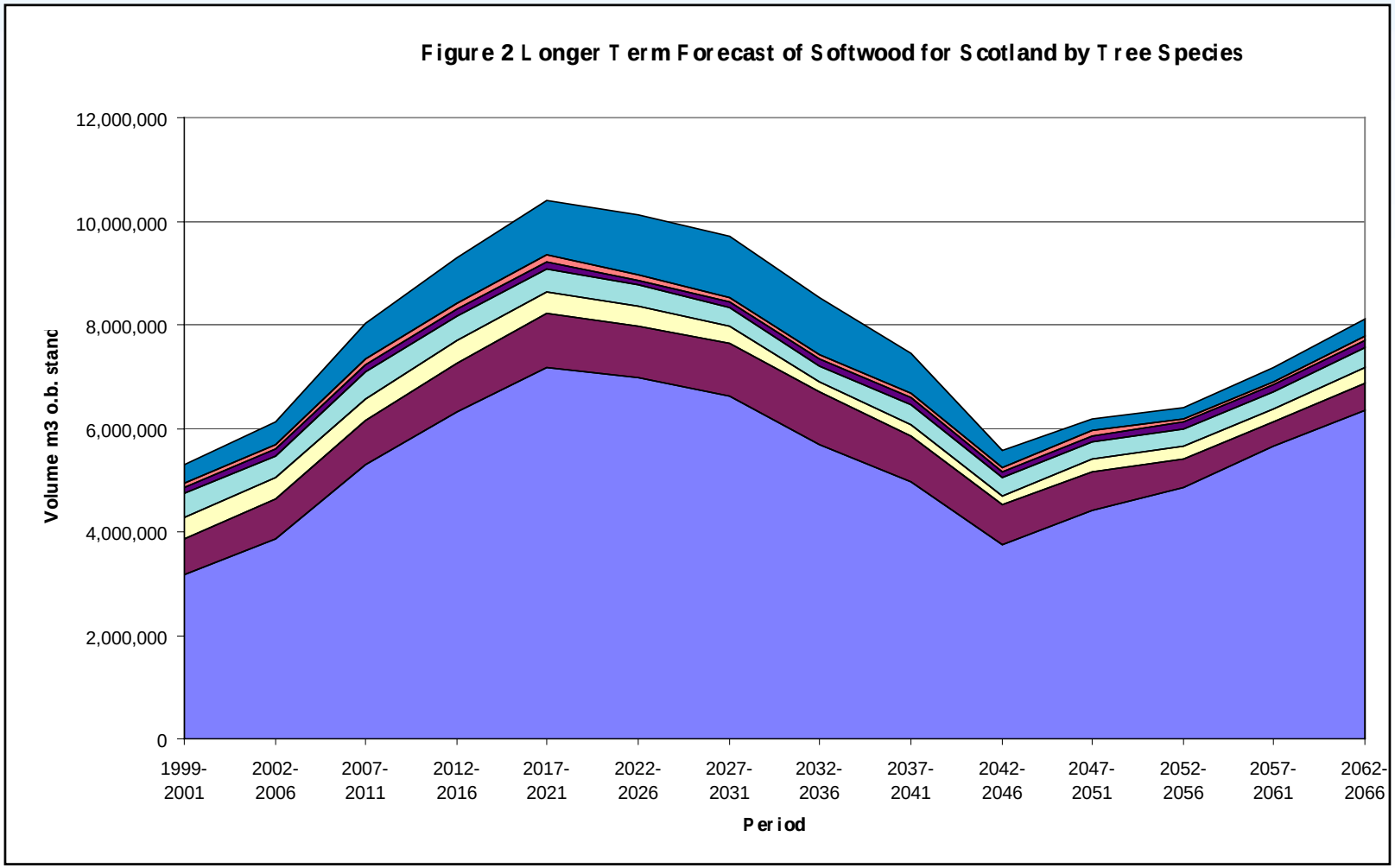
* SS = Sitka spruce, DF = Douglas fir, SP = Scots pine, L = larch

Report completed for SFT and review paper written for Forestry

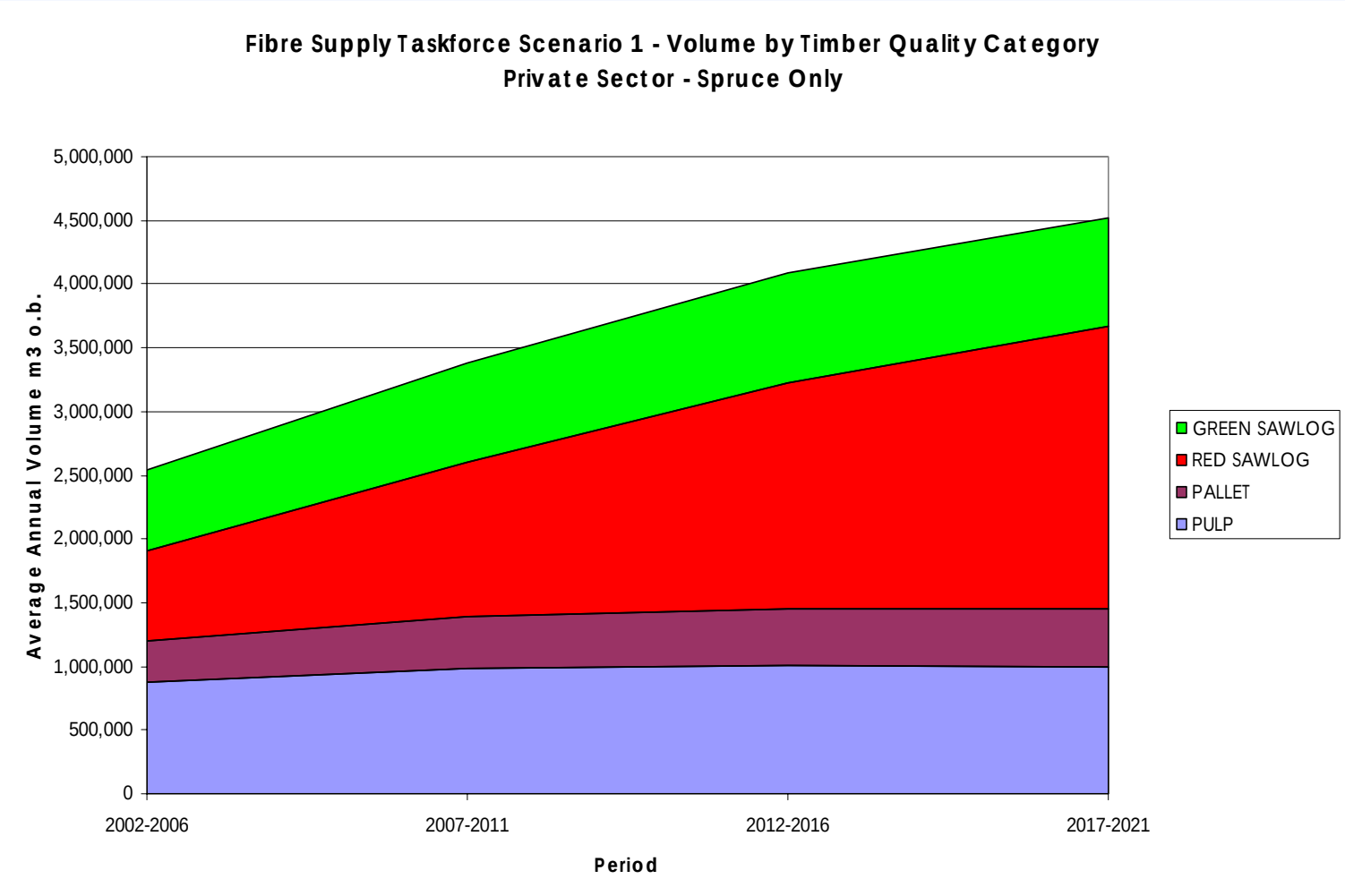
Current and Future Work

- Integration of straightness scoring with National Inventory ⇒ improved forecasts of resource quality
- Physiology of stem straightness in Sitka spruce and Scots pine
- Further development of timber quality model for Sitka spruce and start building model for Scots pine
- Evaluation of log out-turn and batten performance from improved Sitka spruce progeny
- Assessment of Scots pine resource in North Scotland
- Testing of tools for screening trees and logs for quality
- EFORWOOD (sustainability of European forestry/woodchain

The Success of Sitka



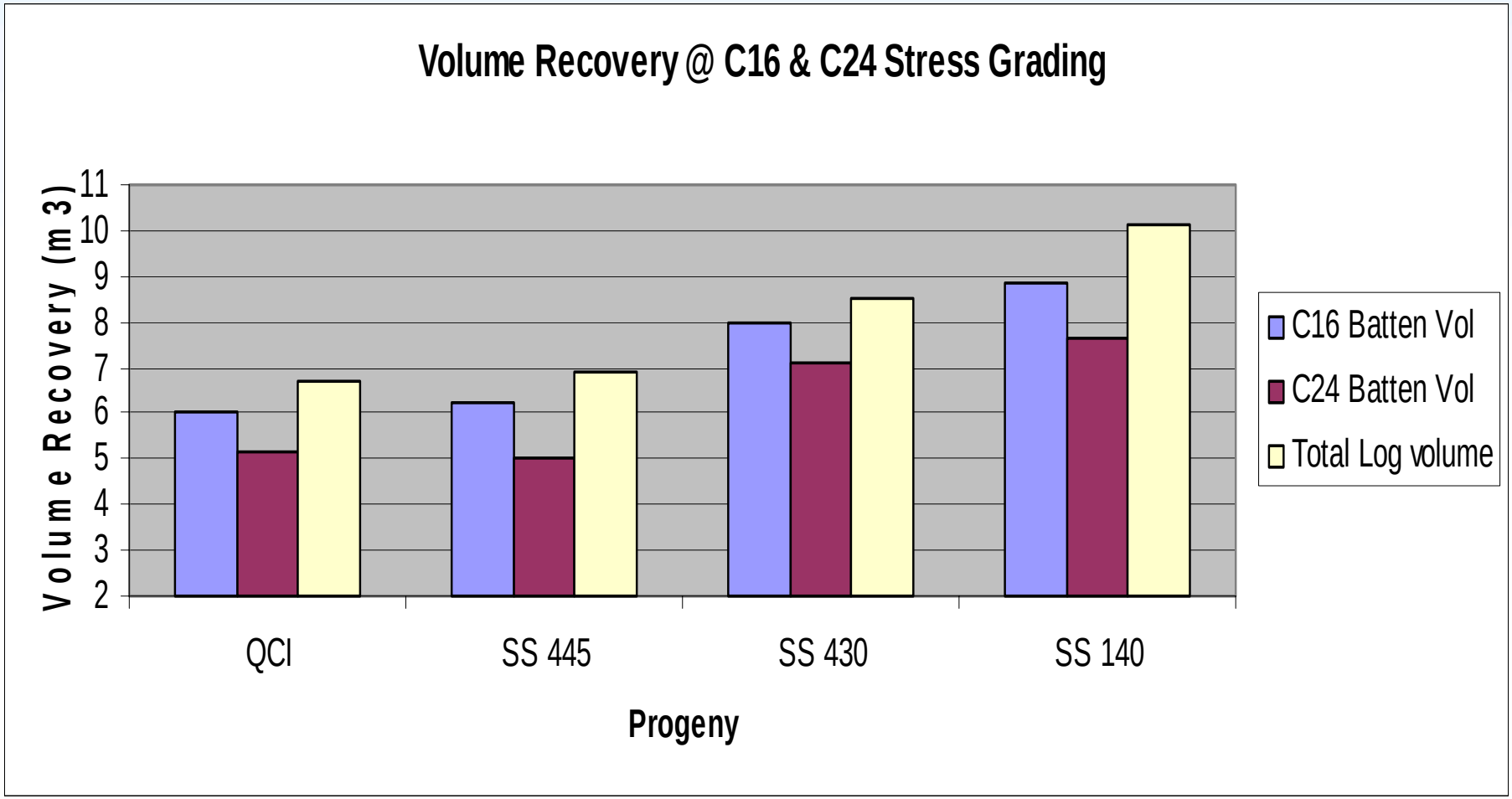
Quality of Future Supply?



Kershope 13 Progeny Experiment

- P68 Sitka spruce progeny trial in Kershope
- QCI and 3 improved progeny
  - 1: Much faster growing, lower density
  - 2: Faster growing, similar density, straighter, lighter branching
  - 3: Higher density, similar growth rate
- 144 for industrial evaluation (4 treatments x 3 replicates x 12 trees) and 48 for detailed laboratory evaluation and timber property modelling (4 treatments x 3 replicates x 4 trees).

Volume Recovery by Grade

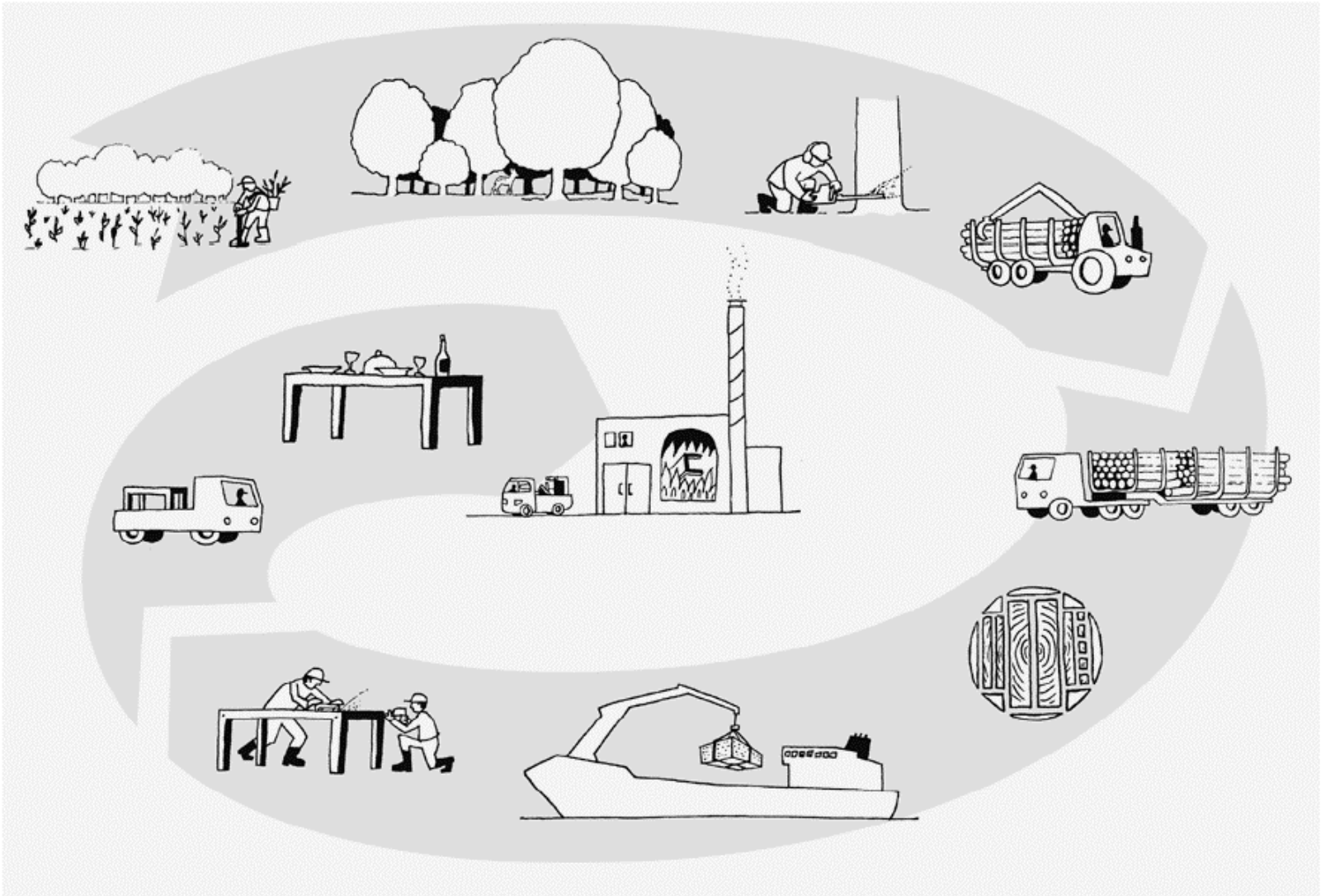


Scots Pine Timber Quality in N. Scotland

EFORWOOD Project

- Extremely large EU project looking at sustainability of the entire forestry woodchain.
- 38 partners. ~€13M
- Forest Research involved in sections on Forest Management (Bill Mason), Forestry to Industry Interaction (Barry Gardiner) and Social Forestry (Paul Tabbush)
- Sitka spruce case study site in Britain (possibly Ae forest)
- Main work in Workpackage 3.1 “Quality Assessment and Allocation” with STFI & FRI Baden-Württemberg

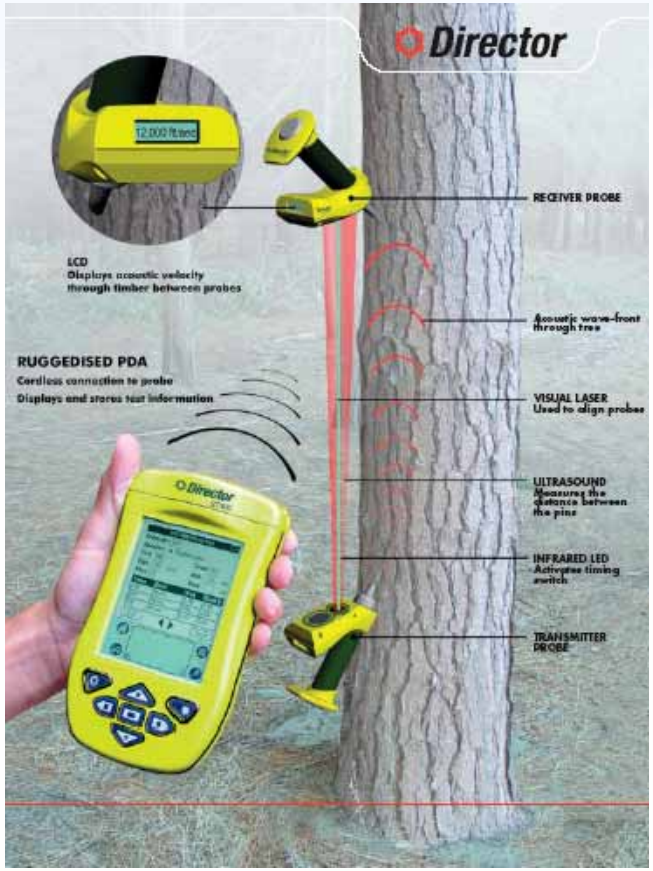
EFORWOOD Project (*Woodchain*)



Physiological Control of Stem Form

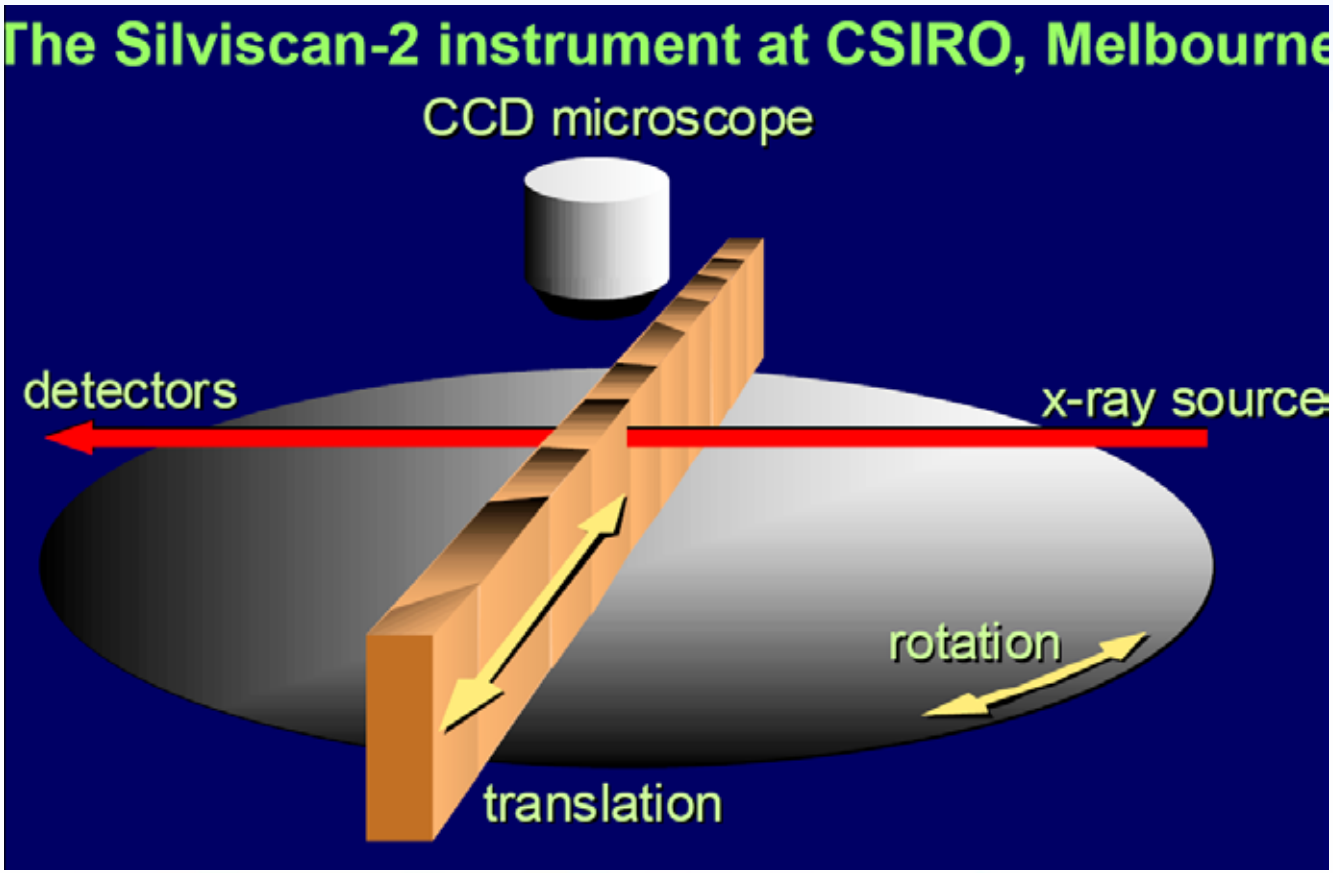
- Hypothesis that leader loss leads to poor stem form
- Developing techniques for splitting whole trees
- X-ray scanning of whole logs
- Plan to determine if bends associated with whorls
- Collaboration with Bangor Univ., and Oregon Univ.

Director ST-300 and HM-200

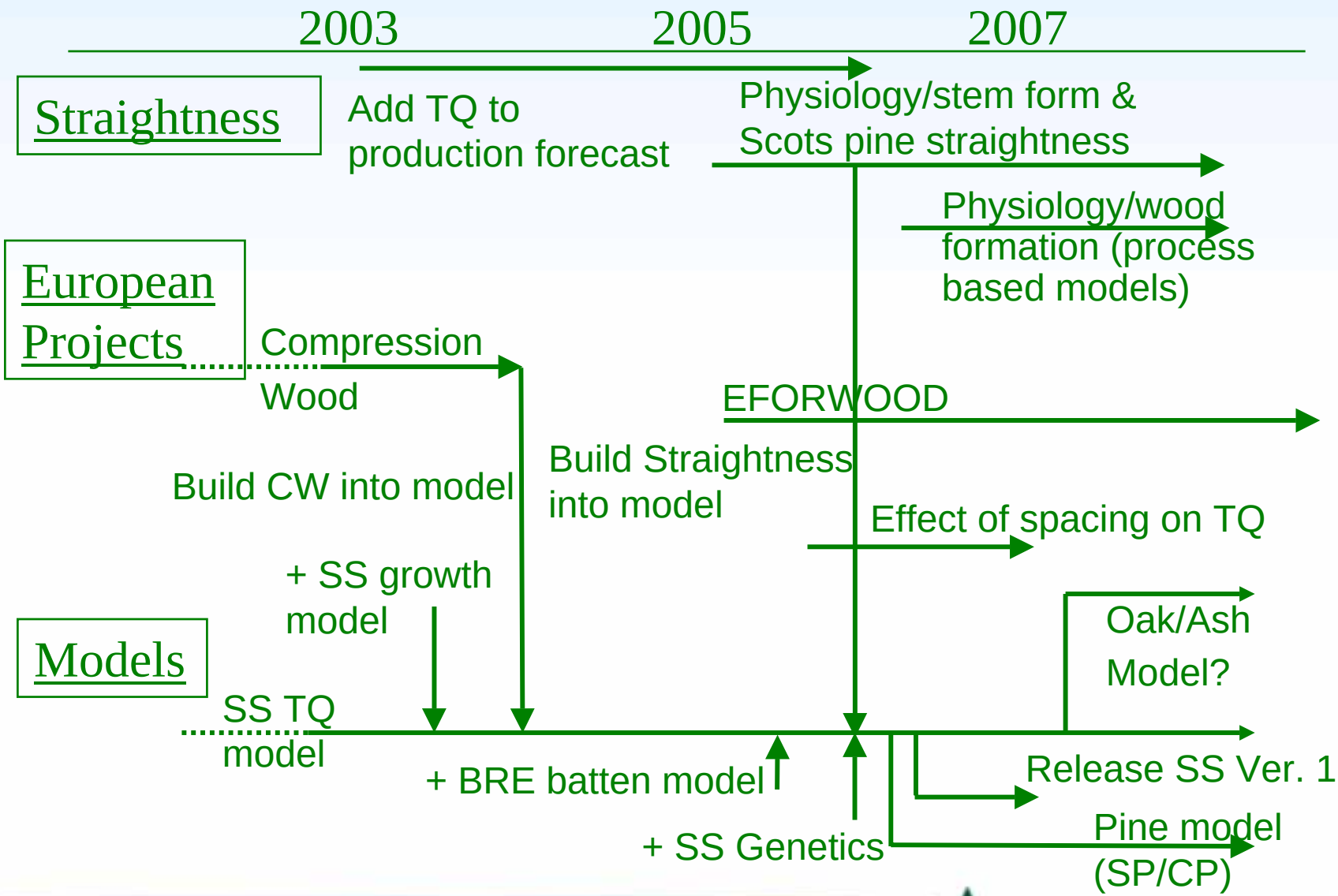


ITRAX X-ray Densitometer (*Glasgow University*)

Silviscan (*STFI, Sweden*)



Research Timeline



Summary and Future

- Work has been primarily on Sitka spruce but have also worked on lodgepole pine and Scots pine
- Initially surveyed the SS resource available
- Then began developing models for predicting impacts of management, site and genetics on SS TQ
- Some work very reactive, other work has longer term aims
- Models offer the possibility of integrating knowledge
- Need to integrate growth, timber, sawing & batten performance models
- Need to expand to other conifers (Scots pine, Douglas fir) and to broadleaves (oak, ash, birch?)
- Collaboration with industry and other GB and European universities and institutes essential and will become increasingly important
- Technology transfer through seminars, workshops, Information Notes, F&BT articles and computer models. Scientific papers are the QA for our work