

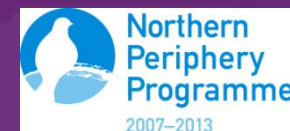


Developing the Scots Pine Resource

Workpackage 4

Assessing and Forecasting Scots Pine Timber Quality in Northern Scotland

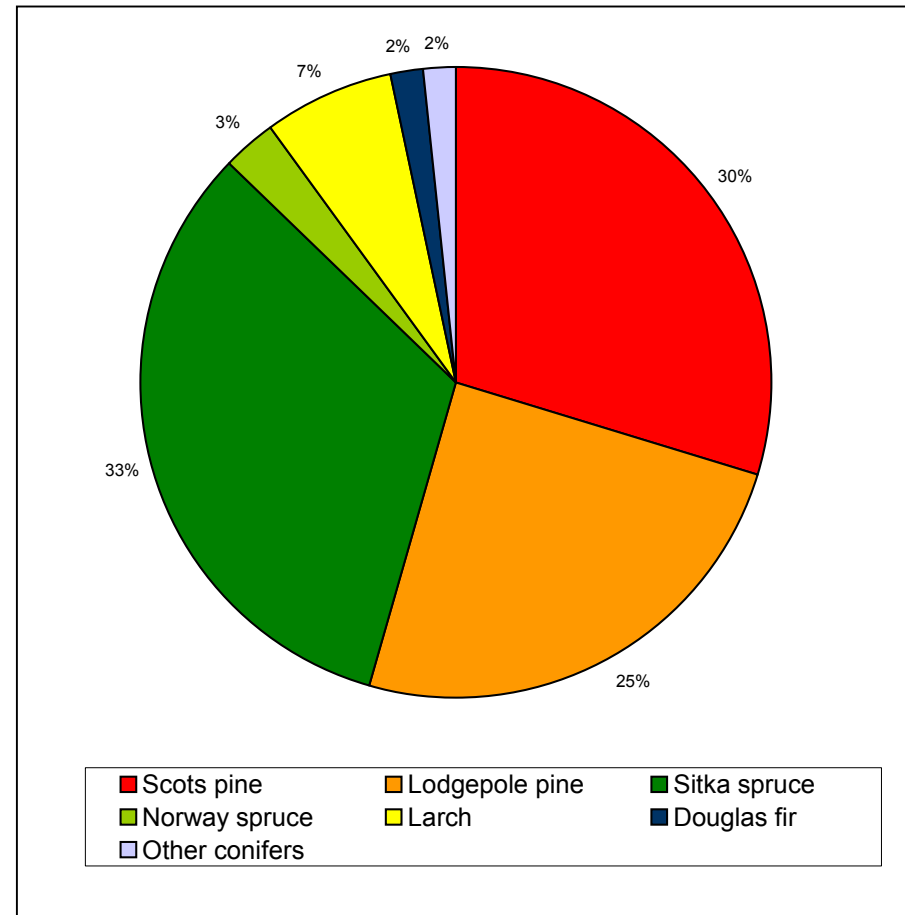
Elspeth Macdonald, Tom Connolly & Barry Gardiner

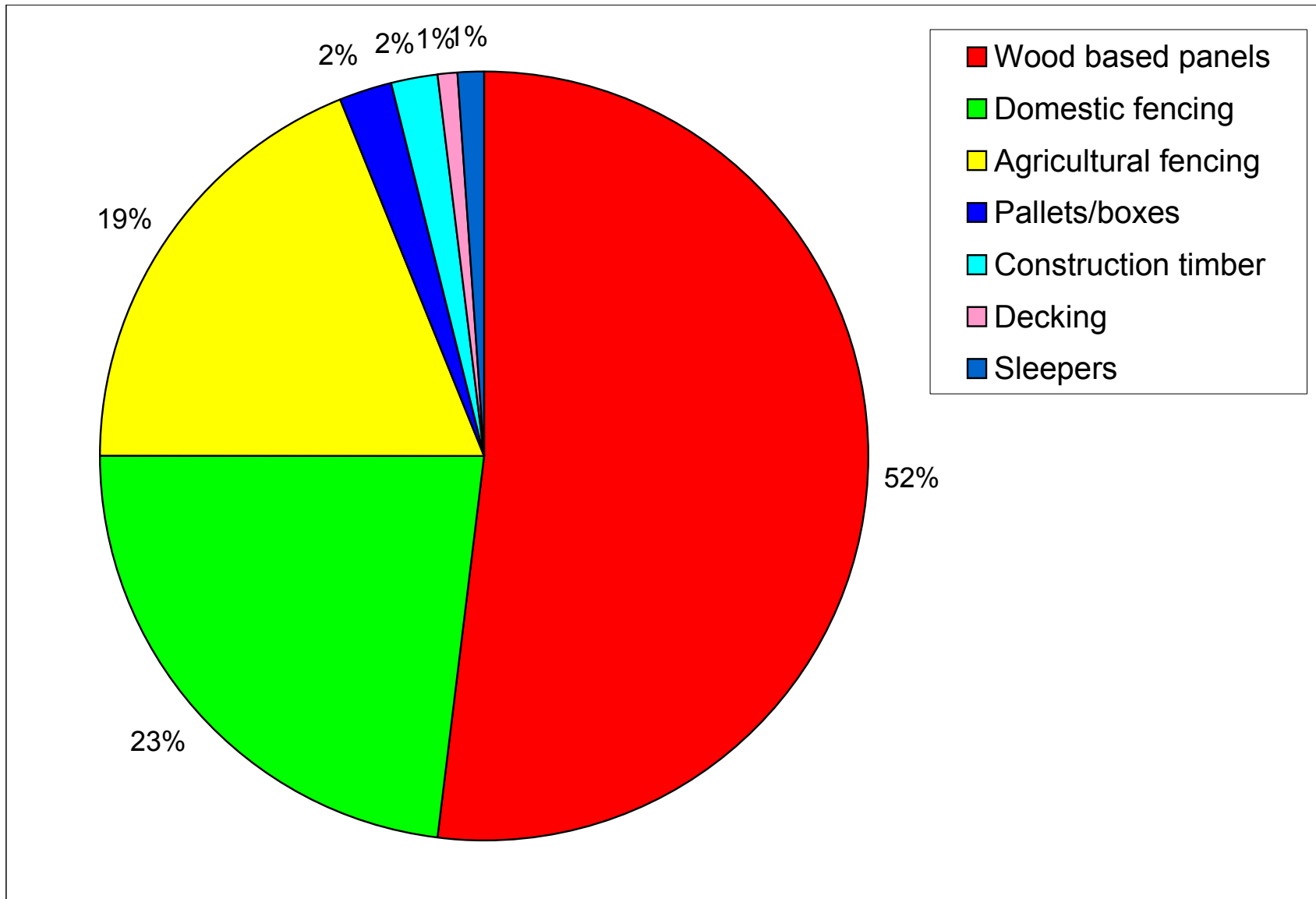


- Scots pine resource, utilisation and market potential
- Timber quality assessment methods
- Survey approach and methods
- Survey results
- Conclusions and future work

- 220k ha Scots pine high forest in Britain ~ 16% of conifer area
- Almost half is in northern Scotland (Grampian and Highland)
- Of this, 65% is in private ownership
- Timber availability is forecast to continue increasing over the next 20 years

Grampian & Highland: conifer species breakdown





- Product areas assessed against a range of technical and commercial criteria
- Potential markets highlighted:
 - Outdoor uses such as garden, landscaping and playground products
 - Stress-laminated timber bridges
 - Massive timber panels
 - External cladding



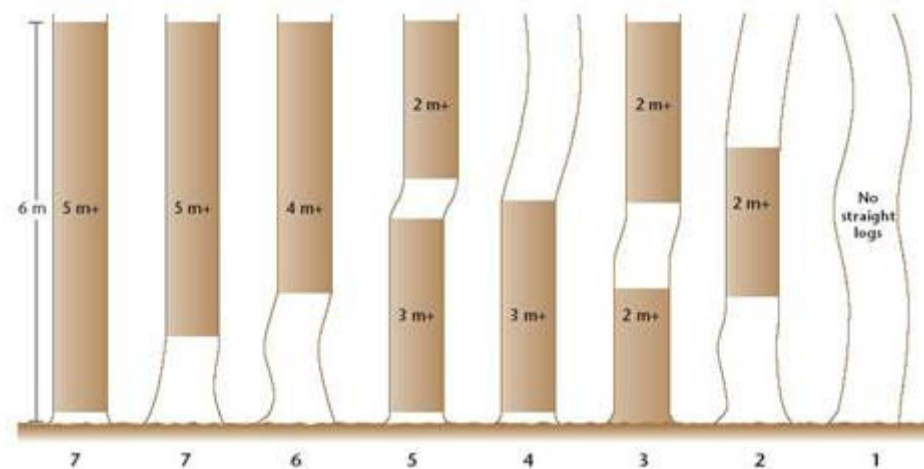
- Most important factors:
 - Straightness
 - Absence of bluestain
 - Knottiness (number, size and condition of knots)
 - Log dimensions.
- Other significant factors: ovality, taper, black knots and crop variability







- Study conducted to test methods for assessing Scots pine timber quality in standing trees and logs:
 - Stem straightness score (using system developed for Sitka spruce)



- Height of lowest dead branch, live branch and live whorl
- Using portable acoustic tools to assess mechanical properties



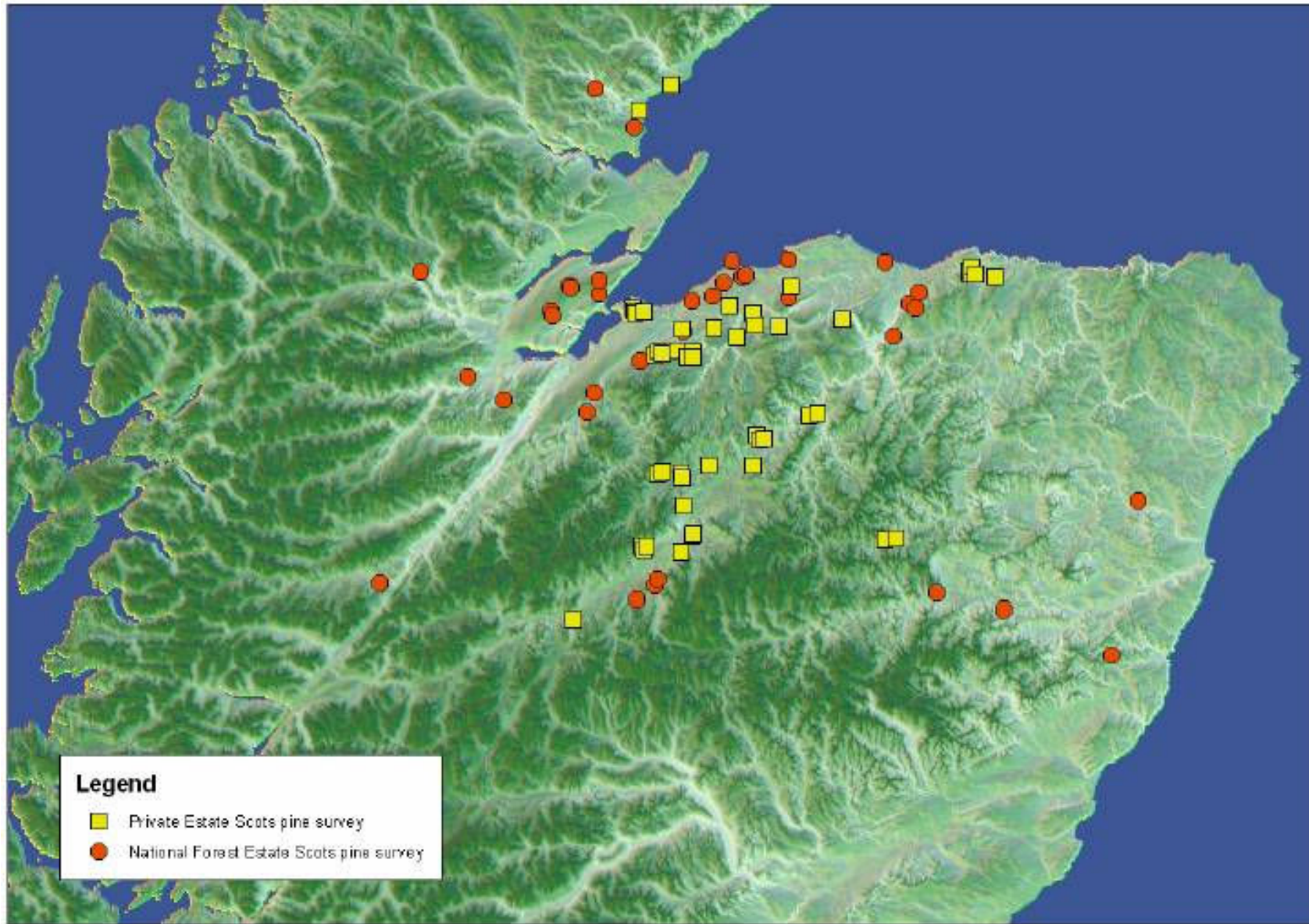


- Stem straightness score and height of lowest dead branch can be used to predict log grade
- Height of lowest dead branch can be used to predict appearance class of sawn timber
- Measurements of stress wave velocity with portable acoustic tools can be used to assess the mechanical properties of Scots pine timber in standing trees and logs



- Sample stands: planted from 1921 - 1970
- 87 stands assessed - weighted to reflect pattern of age class, ownership and geographical distribution of Scots pine resource
- Area of sample stands surveyed is 1.3% of area of Scots pine in this age class in National Inventory
- 7647 trees measured

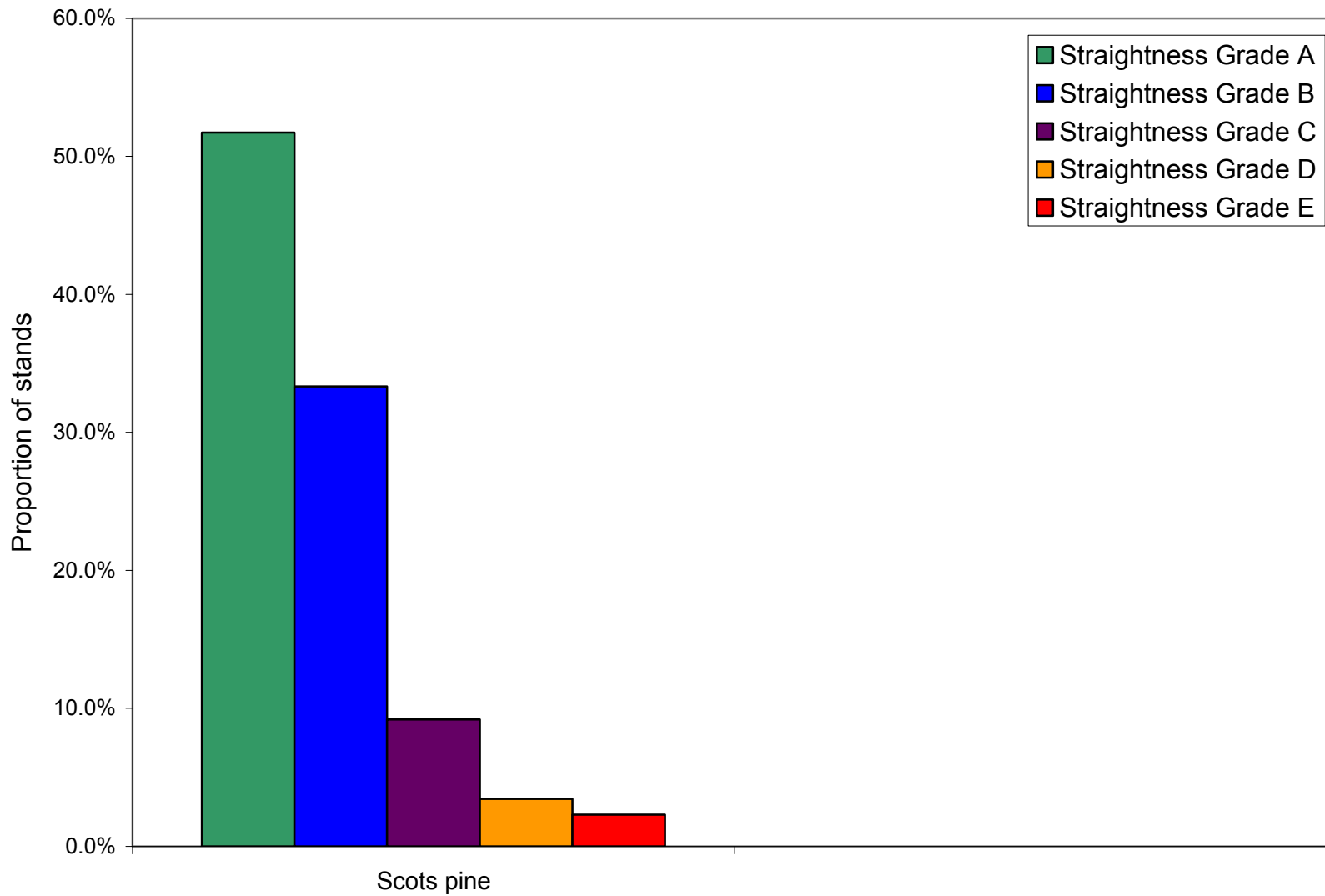


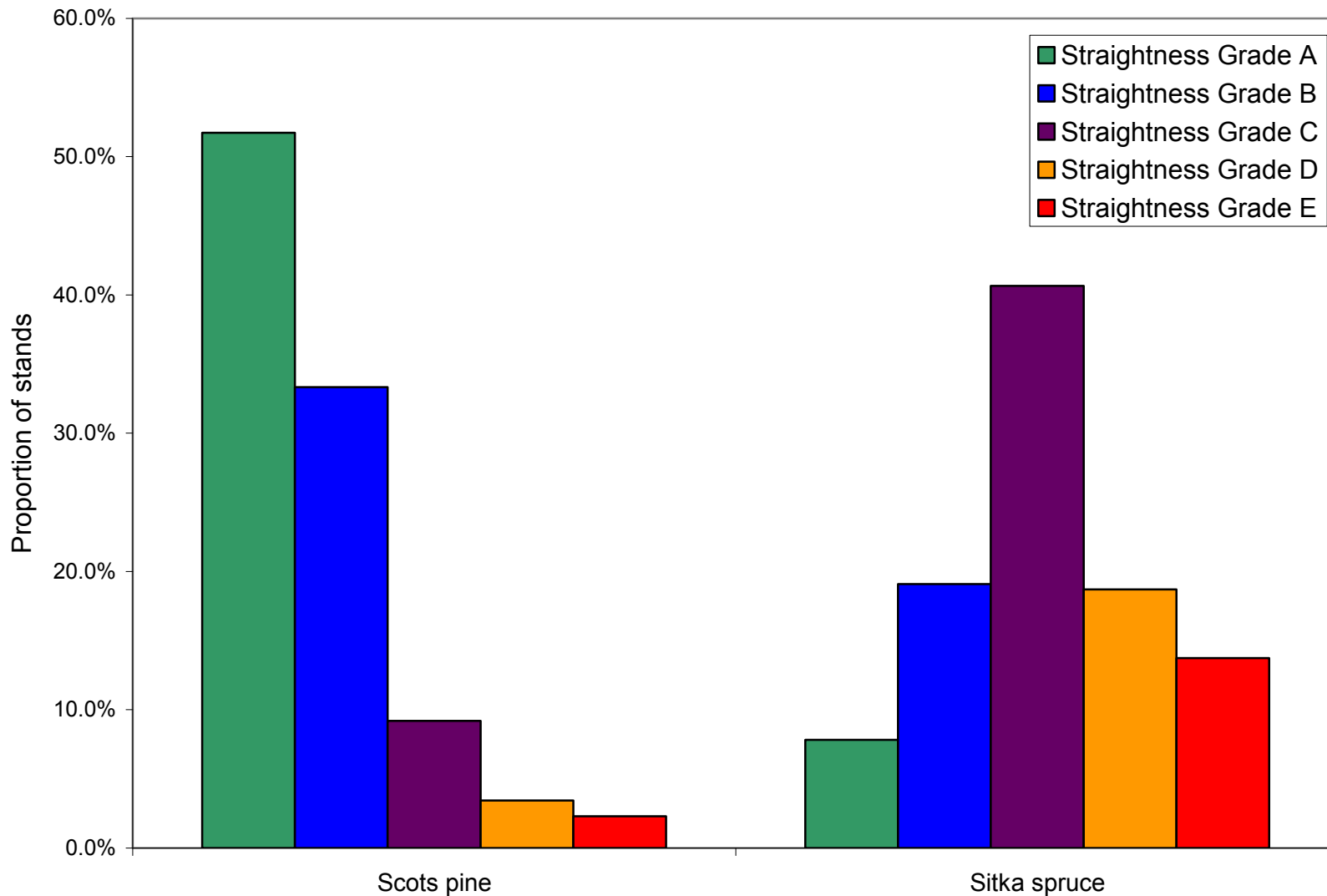


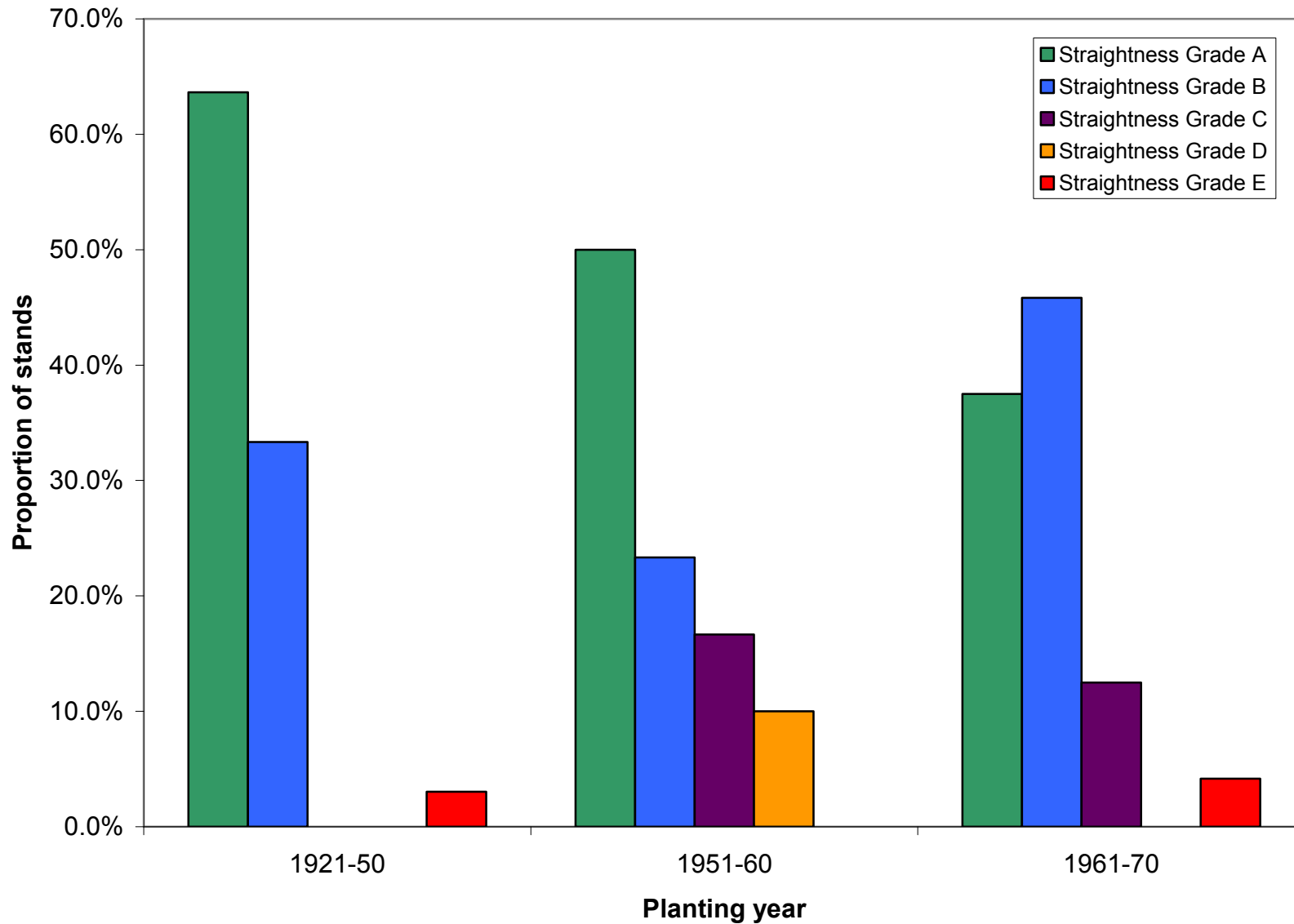
- Age
- Diameter at breast height (DBH)
- Stand Top Height
- Stocking density
- Elevation
- Climatic data (exposure, accumulated temperature, moisture deficit)
- Basic soil quality assessment
- Standing tree timber quality assessment:
 - Stem straightness score (1-7)
 - Stand stem straightness grade (A → E)
 - Height of lowest dead branch
 - Stress wave velocity

	Mean	Minimum	Maximum
Age (years)	56	38	84
Mean DBH (cm)	26.0	15.4	40.5
Stocking density (stems/ha)	763	163	1920
Top Height (m)	18.0	8.4	24.9
Elevation (m asl)	178	3	430
Median Stem Straightness Score	4	4	6
Mean height of lowest dead branch (m)	1.7	0.3	6.0
Mean stress wave velocity (km/s)	4.20	3.01	5.17

- Stem straightness – important for log grade, log length and sawn timber recovery
- Stand straightness grades A (best) – E (worst) allocated on basis of straightness score distribution





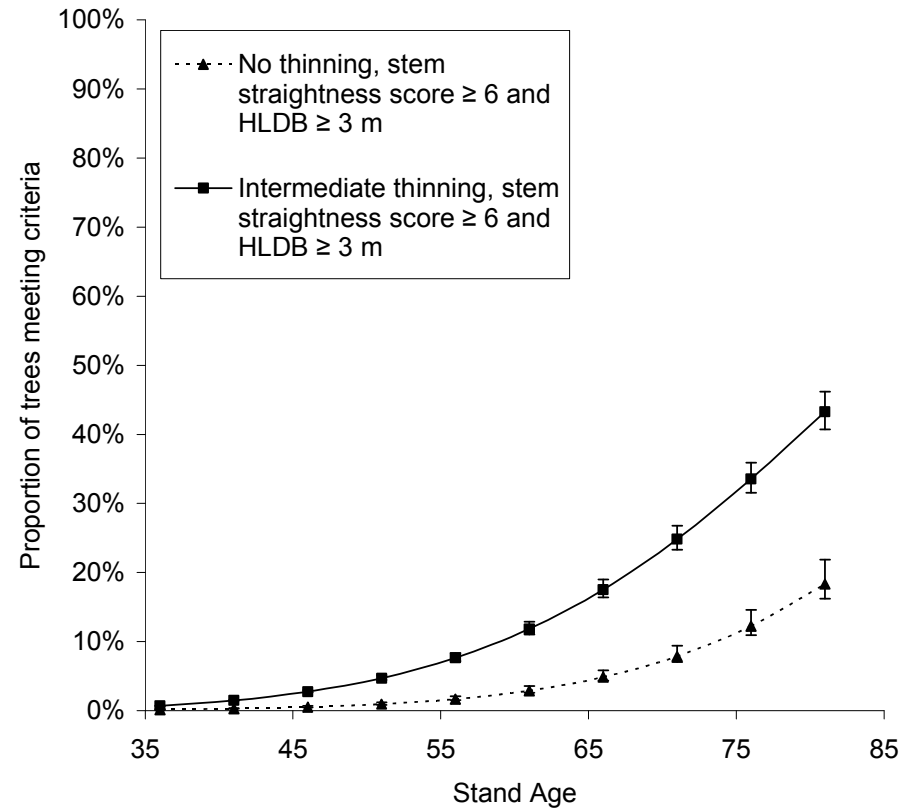
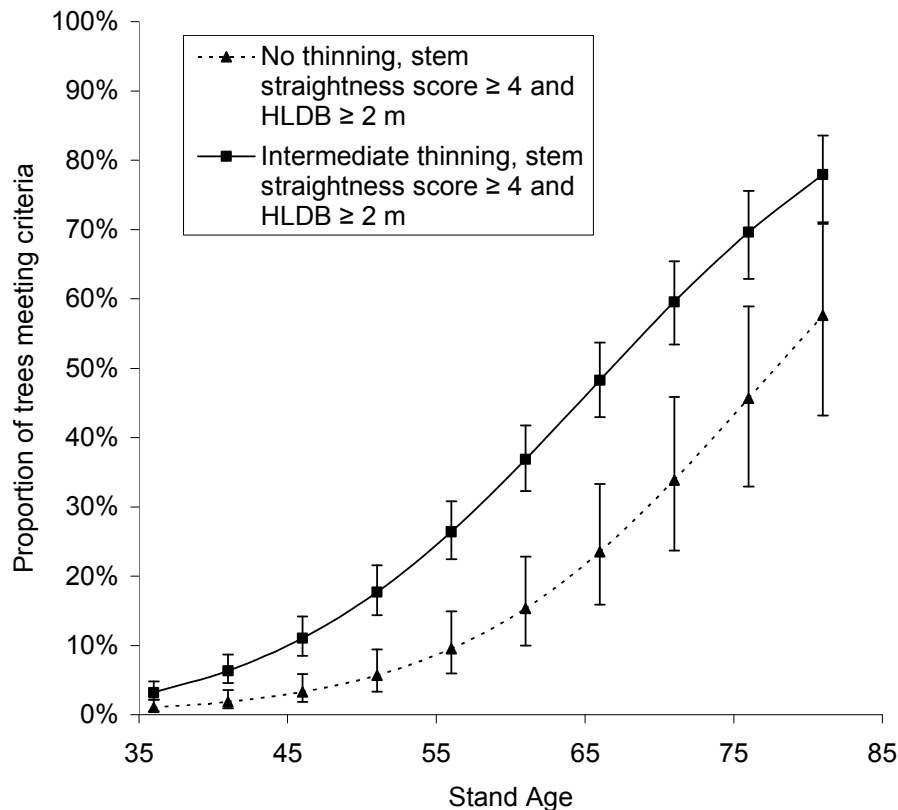


- Significant factors: age, mean DBH and stocking density
- Best model based on stand age but only explains 10% of variation
- Analysis suggests large tree to tree variation in straightness within stands, less between stands:
 - Genetic variation
 - Factors affecting individual trees – microclimate, physical damage from wind, snow, insects etc

- Height of lowest dead branch (HLDB) affects log grade, sawn timber mechanical properties and sawn timber appearance grade
- About 50% of variation due to differences between stands, and 50% due to within stand variation
- Age a key factor:
 - Trees < 60 years, only 5% had HLDB \geq 3m
 - Trees \geq 60 years, 44% had HLDB \geq 3m
- Model based on age and stand mean DBH can be used to predict stand mean HLDB → explains 78% of variation
- Model could usefully be integrated with inventory data and production forecasting

- Log grading based on stem straightness and knots
- Models developed to predict log quality, measured by the proportion of trees in a stand meeting specified criteria:
 - a. Straightness score ≥ 4 **and** HLDB $\geq 2\text{m}$
 - b. Straightness score ≥ 6 **and** HLDB $\geq 3\text{m}$
- Models based on age (positive) and stocking density (negative) explain 76% of variation
- Standard yield models for Scots pine can be used to illustrate impact of thinning and rotation length on log quality

- Predicted effect of thinning and age on the proportion of trees in a stand meeting specific criteria



- Stress wave velocity in standing trees is related to stiffness and the strength grade of sawn timber
- Previous work: segregating out trees with velocity of <4.5 km/s increased strength class from C20 to C22
- 29% of trees sampled exceeded this threshold
- Integrating an acoustic tool with a harvester head enables segregation during normal operations - development is ongoing

- Around 50% of variation in stress wave velocity was due to differences between sites
- Significant factors included Accumulated temperature (AT5), elevation, stocking density, mean DBH and age
- Best model based on AT5, stocking density and Stand Density Index – explained almost 30% of variation
- Stands on warmer sites have higher values of stress wave velocity
- Results consistent with work on Sitka spruce in Britain and radiata pine in New Zealand - possibly linked to longer period of latewood formation on warmer sites

- Stand age is a key determinant of log quality
 - Survey of Scots pine management: average Scots pine felling age is 63 years (FC – 57, private - 74)
 - To maximise log quality, extend rotations to at least 80 years
 - Economic analysis required to fully evaluate impact of extending rotations
- Significant tree to tree variation in all timber quality attributes suggests scope for improvement through:
 - Selective thinning
 - Tree breeding
 - Plant best seed orchard material available
 - Potential for greater gains if new seed orchards established
- Warmer sites more likely to yield timber with better mechanical properties

- Further development and testing of predictive models
- Linking models to digital resource maps and production forecasts
- Refining thresholds for segregation of trees using acoustic tools
- Economic analysis of silvicultural options

- Funding: Forestry Commission, EU Northern Periphery Programme, Highlands & Islands Enterprise and Scottish Enterprise.
- Data, maps and access: Forestry Commission Scotland (North Highland, Inverness, Ross & Skye and Moray & Aberdeenshire Forest Districts), Altyre Estate, Alvie & Dalraddy Estates, Ballindalloch Estate, Ballogie Estate, Candacraig Estate, Cawdor Estate, Cawdor Forestry Ltd, Drummuir Estate, Glentruim Estate, Knockando Estate, Logie Estate, Moray Estates, Muckrach Estate, Revack Estate, Rothes Estate, Rothiemurchus Estate, Seafield Estates, Scottish Woodlands Ltd, Sutherland Estates.
- Data collection – Dave Auty, Sandy Bowran, Fraser McBirnie, Stuart McBirnie, Alistair MacLeod, Calum Murray, Steve O’Kane, Colin Smart, Duncan Williams