Predicting sapstain and degrade after storm damage in stands of *Pinus radiata*

Scope

AIM: To monitor sapstain, wood degrade, and bark beetle development after storms in stands of *Pinus radiata.*

PURPOSE: To provide forest managers with reliable information on periods available for log salvage.

Funding

FOUNDATION FOR RESEARCH SCIENCE AND TECHNOLOGY (contract C04X0302)

FOREST HEALTH RESEARCH COLLABORATIVE (project 2010-02)

FOREST BIOSECURITY RESEARCH COUNCIL

TERTIARY EDUCATION COMMISSION ENTERPRISE MSc SCHOLARSHIP

Key Personnel

North Island

Ian Hood – overall task leader; Nth. Is. operational
Kane Fleet – field and disc processing
Rod Brownlie – image recording
John Bain – insect identification Nth. Is.

South Island

James McCarthy – MSc thesis; Sth. Is. operational
Eckehard Brockerhoff – Scion supervisor
Raphael Didham – University of Canterbury supervisor
Steve Pawson – entomology support

Colleen Carlson – biometrics and modelling
Katrin Walbert – molecular identification (fungi)
Remis Bakys – visiting STINT person

The inception:
Windthrow in a Nelson forest

- Wind storm 30 July 2008
- Heavy snow 15 Aug 2008

Damage in late winter

How long would logs remain salvageable?

Established a monitoring programme to find out

Outcomes

With time:

- Outer sapwood moisture content decreased
- % Sapstain increased
- Isolation of decay fungi increased
- Attack by bark beetles increased
- All proceeded more rapidly in severed than in still-rooted trees

Outcomes

Biological degrade agents:

- Sapstain fungi: *Diplodia pinea*
  (*Ophiostoma piceae* and *Grossmannia huntii* only after 67 weeks)

- Decay fungi:
  Phlebiopsis gigantea and *Stereum sanguinolentum*
  (*Schizophyllum commune* after 46 weeks)

- Bark beetles and wood borers:
  Hylastes ater and *Hylurgus ligniperda*
  (these, *Arhopalus ferus* and *Pachycotes peregrinus* were caught in background population monitoring funnel traps)

Conclusions

After a storm in late winter in the Nelson region:

- Severed stems:

A 10m butt log (22cm mid diameter) will AVERAGE <10%sapstain after 4 months.

- Still rooted stems:

This period will extend to one year.

- However, large variation between trees:

Economic log recovery will therefore also depend on proportion of trees below an acceptable sapstain threshold.

But what about…

…other regions?

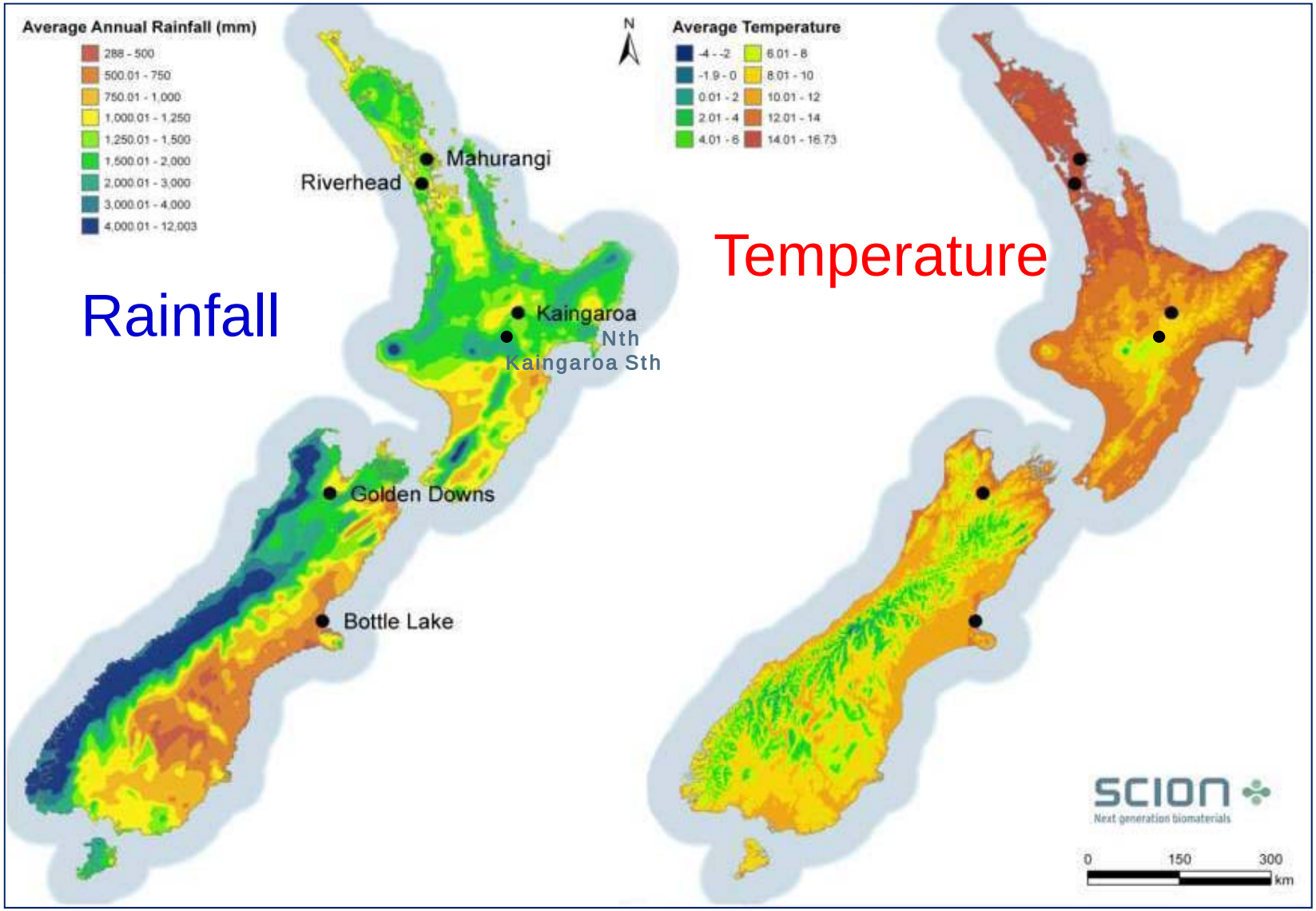
…different times of year?

The task has been expanded to solve these and related questions

Experimental Design

- 6 locations across New Zealand climate range (including Nelson)
- 2 felling times (summer and winter)
  (2 additional fellings, autumn and spring, at Nelson location, i.e. 4x)
- 4 or 5 sampling times after felling
  (spanning 6 months to one year)
- 6 to 12 trees per location per sampling time
  (destructive sampling)
- 5 discs 2.5 m apart along butt log on each tree

Locations in relation to climate

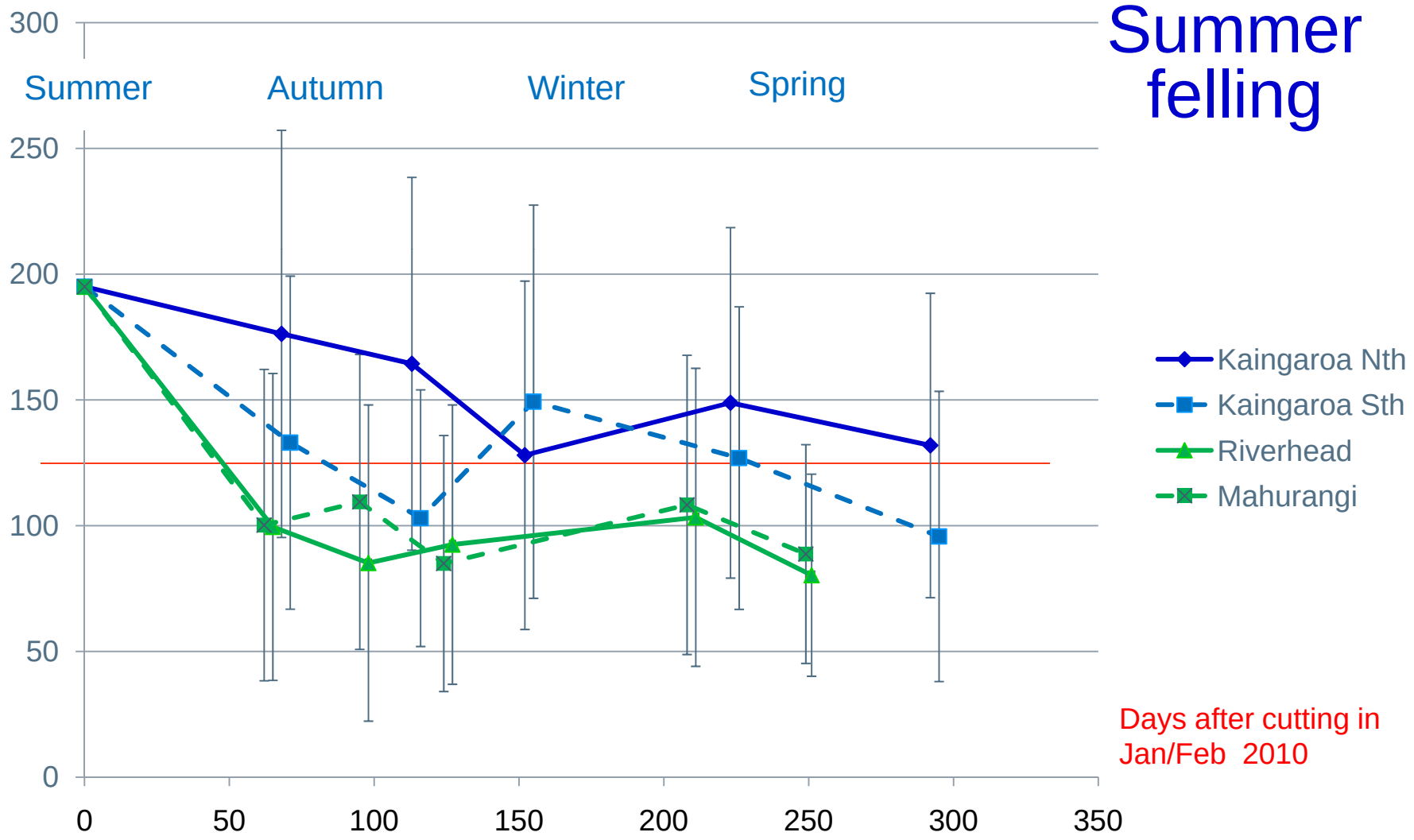


Disc processing

- Disc diameter measured
- Insect attack recorded
- Disc photographed
  (with or without prior skimming)
- % sapstain estimated
  (disc surface area affected)
- % sapwood moisture content determined
  (oven dry weight basis)

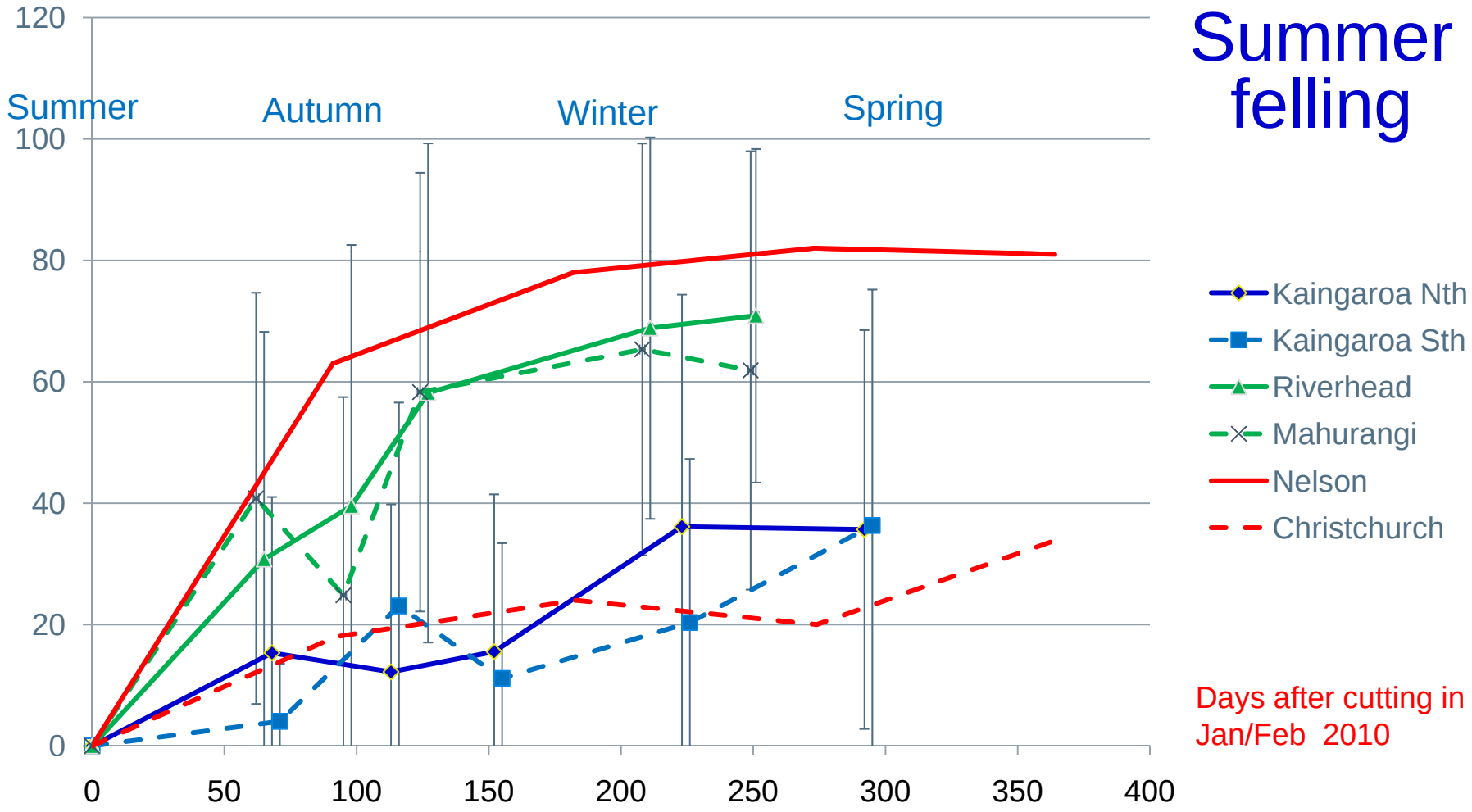
The story so far…

Mean % sapwood moisture content (with standard deviation)



The story so far…

Mean % disc with sapstain (with standard deviation)

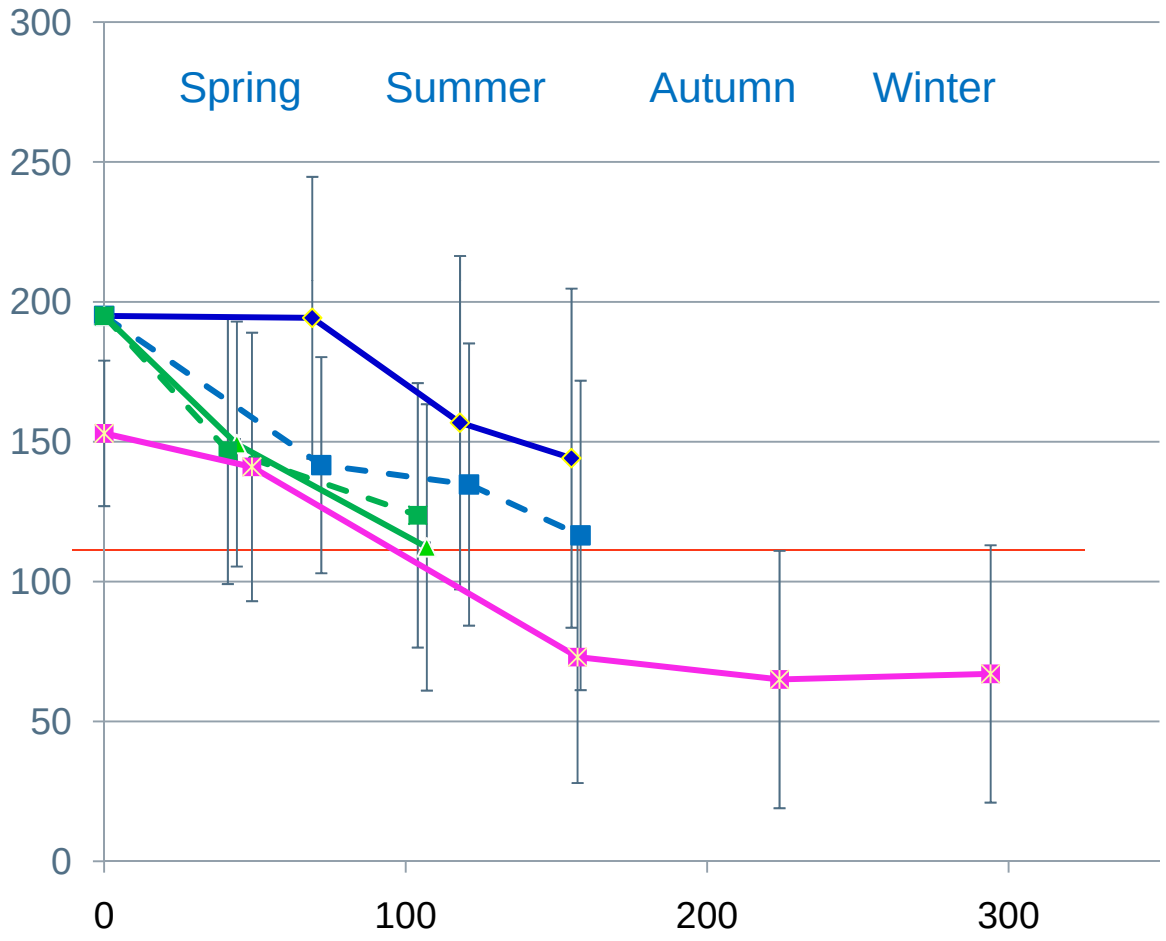


Summer felling

Days after cutting in Jan/Feb 2010

The story so far…

Mean % sapwood moisture content (with standard deviation)



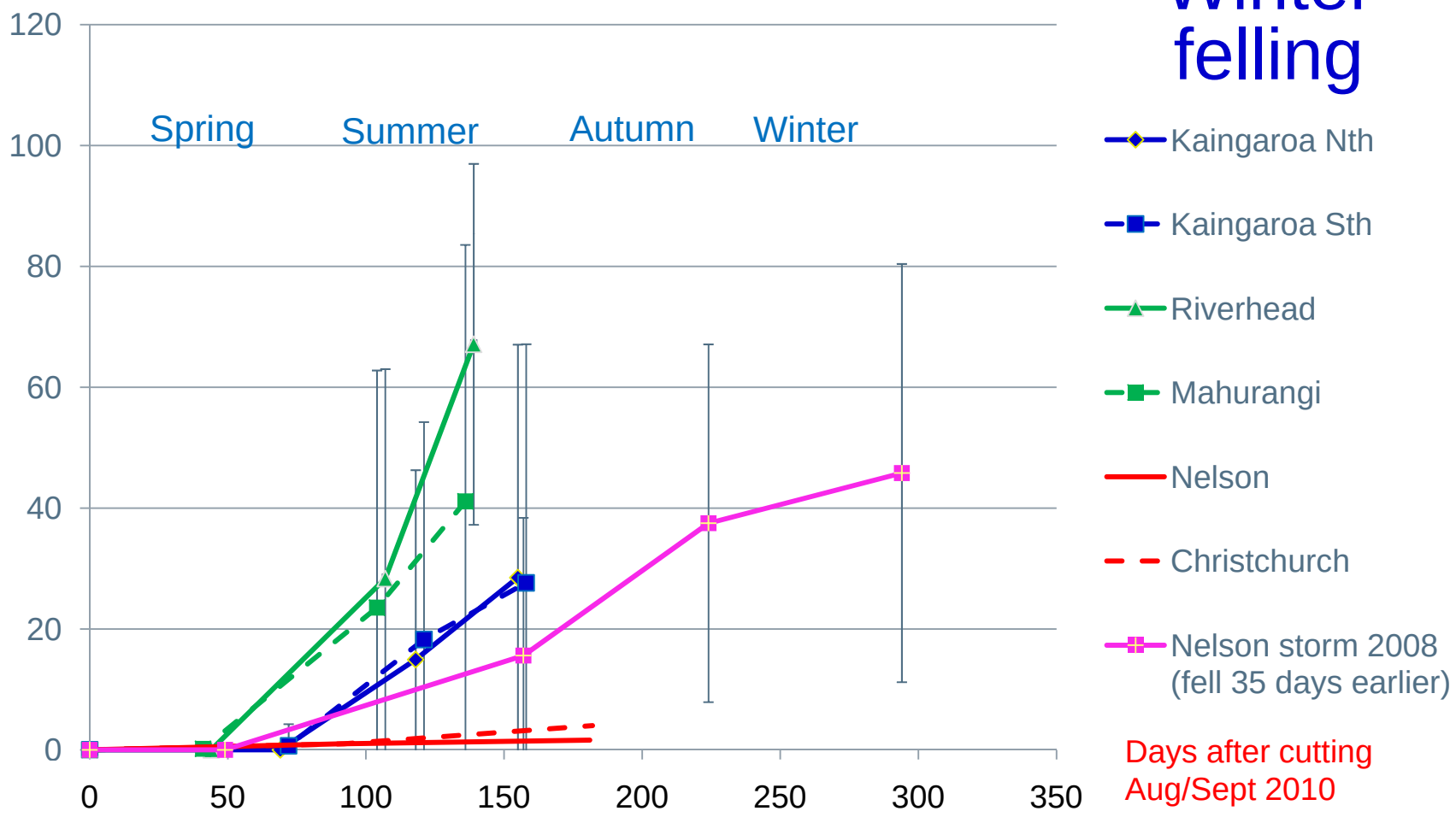
Winter felling

- Kaingaroa Nth
- Kaingaroa Sth
- Riverhead
- Mahurangi
- Nelson storm 2008 (fell 35 days earlier)

Days after cutting
Aug/Sept 2010

The story so far…

Mean % disc with sapstain (with standard deviation)



Some preliminary trends

- Sapstain has increased as sapwood moisture content has fallen
- Rates appear to vary between some regions and also between seasons
- Stem drying has been more rapid during summer and minimal during winter

- Sapstain appears to rise rapidly during summer and then more slowly during winter
- Bark beetle attack has been low during winter, but there has been some sapwood tunnelling by *Pachycotes peregrinus* and *Platypus apicalis* (site/region specific)

Additional aspect

Part of James' MSc thesis (South Island, only)

Objective:

What is the role of bark beetles in transmitting sapstain fungi?

Background:

Bark beetles were not important in transmitting sapstain fungi after a late winter storm at Nelson.

But what about other seasons and different locations?

Where to from here…?

- Construct comprehensive database through ongoing monitoring and sampling at all sites
- Subject data to analyses and modelling to determine trends
- Produce guidelines and protocol by 30 June 2012 to facilitate optimum economic log recovery after storms

Acknowledgements

– some of many people who have given advice or help -

Judy Gardner, Rita Tetenburg, David Pont, Andrew Dunningham, Rod Brownlie, Lucy Manning, Diahanna O'Callahan, Russell McKinley, Michael Watt, William O'Connor, John Lee, Jamie Agnew, Lindsay Bulman - proj. leader (Scion)

Jessica Kerr, Matt Walters, Neil Andrews, Craig Galilee, Matt Pearless, Alwin Sky, Erik Wardrop, Jason Tylianakis, Arvind Varsani (University of Canterbury)

Mark Forward, Fritz Buchendahl, Mark Bryant (Nelson Forests Ltd)

Marcel van Leeuwen (Selwyn Plantation Board)

Sam Middlemass, Elaine Birk (Rayonier Asia Pacific)

Malcolm Wano, Rex Mitchell

Nigel Heron, Colin Maunder , Wayne Cameron (Timberlands Ltd)

Revel Snowden (Central North Island Forest Management Ltd)

Ross Gee (Hancock Forest Management (NZ) Ltd)

Steve Hemsley (Waiariki School of Forestry)

Graham Wylie (C3 Ltd, Mount Maunganui) Peter Gadgil, Doug Ashford

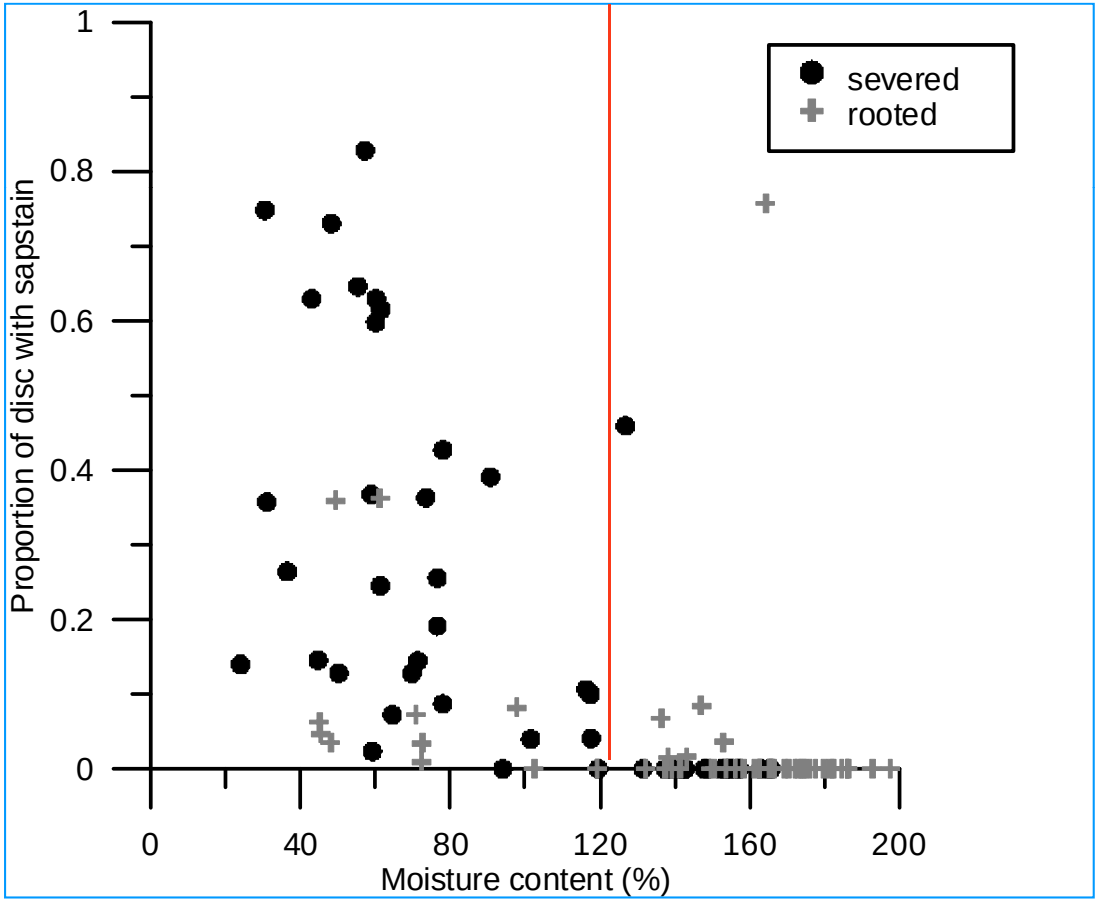
John Butcher, Gordon Hosking, John Ellis, Dennis Hocking, Colin Zeff, Ben Doherty

SCION
Next generation biomaterials

END

Outcomes

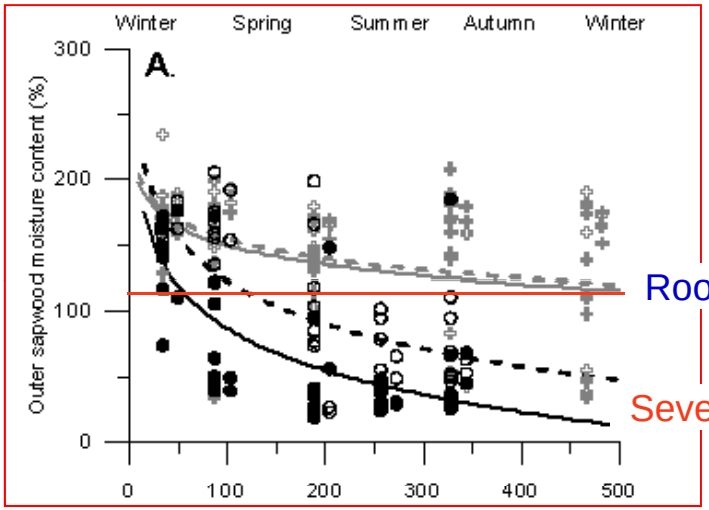
Relation between sapstain and moisture content:



Sapwood moisture content above ca. 120% prevents growth by sapstain fungi.

Outcomes

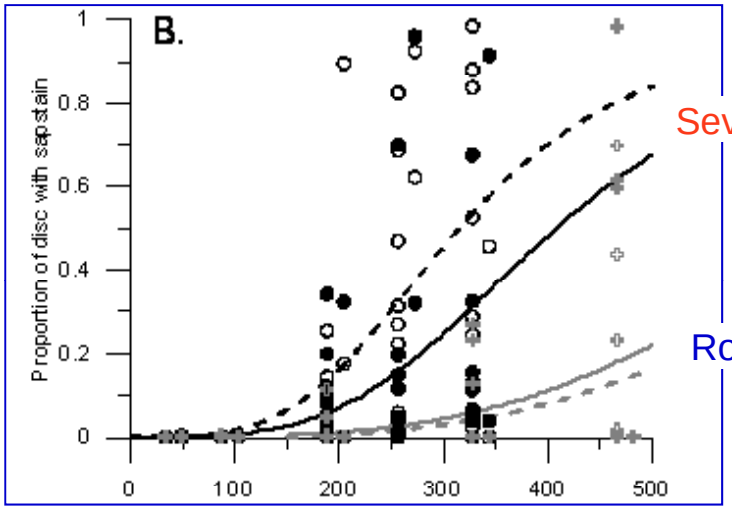
Moisture content



Rooted

Severed

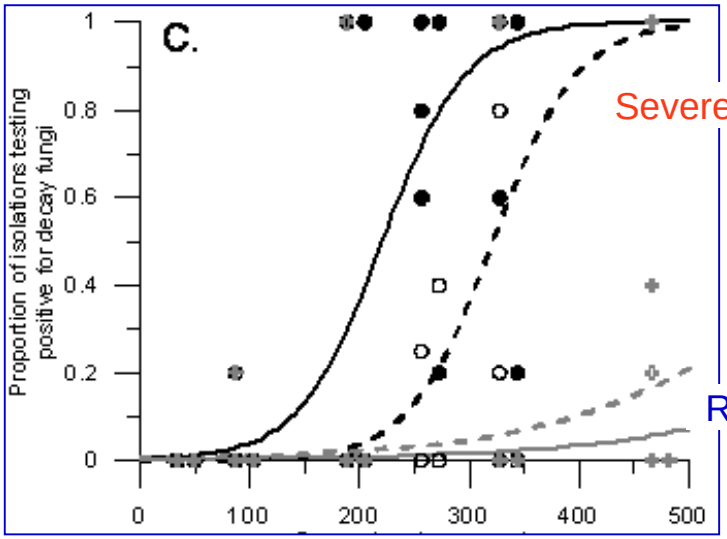
Sapstain



Severed

Rooted

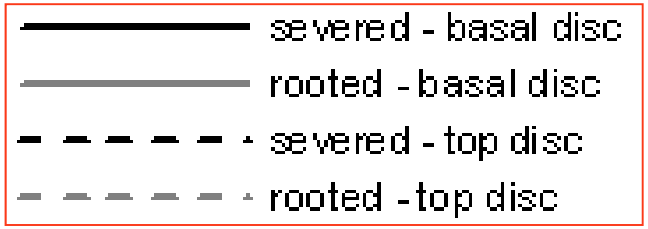
Days after storms



Severed

Rooted

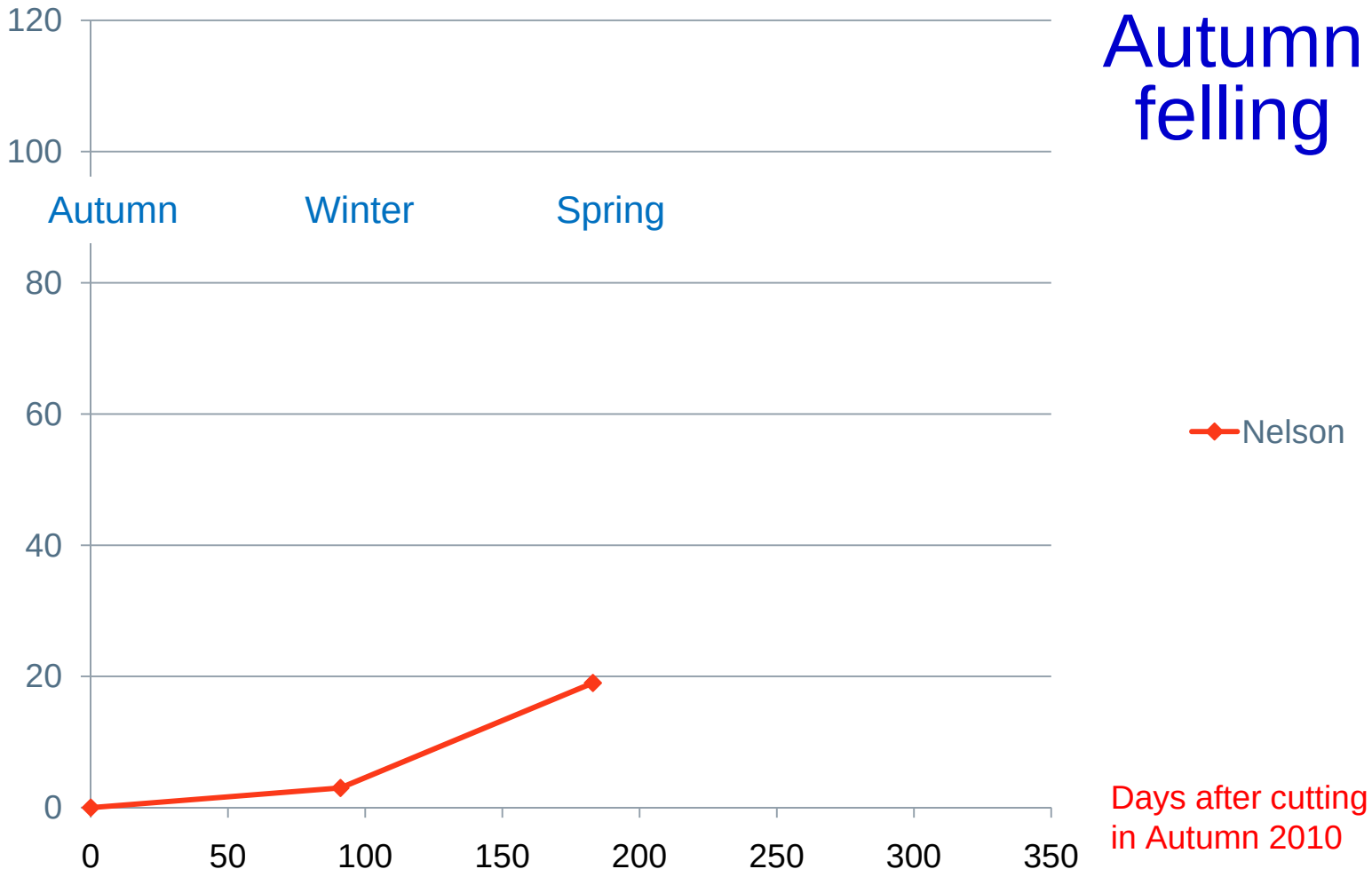
Decay fungi



McCarthy *et al.* (2010): *Forest Ecology and Management 260*: 1456-1466

The story so far…

Mean % disc with sapstain (with standard deviation)



Autumn felling

Additional aspect

Part of James' MSc thesis (South Island, only)

Components:

- Isolate and identify sapstain fungi in wood and from beetles by season and period from felling
- Use DNA primers to determine specific target stain fungi carried by beetles
- Identify stain fungi in billets open to beetle attack or from which they are excluded using cages
- Use GIS to examine effects of management on beetle numbers, potential attack, and possibly sapstain.

Further questions

After a damaging storm:

- Can rate of sapstain development be forecast by monitoring climate conditions? - FBRC (Colleen Carlson et al.)
- Can fungicidal spraying retard the development of sapstain?
  - FBRC
  (Margaret Dick et al.)
- How does sapstain development relate to the National Sapstain Index harvesting guide? Colin Zeff (1999)

Some challenges

- Consistency in sapstain delineation
  - conform to industry criteria
- Effect of tree size
  - variation between sites?
  - study trees versus production logs?
- Effect of rooting
  - variation with location?
- Consistency in moisture content sampling