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## Theme: Diversified Species

**Task No: F30301**
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**Report No. : DS047**

# Douglas-fir 2012-2015 Proposed Permanent Sample Plot Measurement Plan

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# EXECUTIVE SUMMARY

The current Future Forests Research (FFR) Diversified Species Douglas-fir (*Pseudotsuga menziesii*) Permanent Sample Plot (PSP) measurement schedule has not previously been rationalised to ensure it is the most efficient use of resources for collecting Douglas-fir growth data for future FFR projects. This report aims to identify the most cost effective PSP measurement strategy to sample Douglas-fir growth across the widest range of New Zealand genetic, environmental and silvicultural variables, and provide data to support future FFR projects with a focus on growth modelling and model validation.

For each appropriate PSP site available on the Scion PSP database, a description is given in this report outlining the merits for that plot's inclusion in a measurement strategy, and measurement frequencies are recommended. A selection of those PSPs is presented as the recommended measurement schedule from July 2012 to the end of 2015. This sample has been selected for genetic variation by including as many different seed source provenances, families and seedlots as possible. Environmental variables are covered by including all available Land Environments of New Zealand (LENZ) [1] classes, and silvicultural variation is covered by including trials with wide-ranging remaining stocking, as well as all plots with pruned treatments. The recommended measurement schedule is considered to be the most cost effective option to record data for future Douglas-fir modelling and validation studies.

# BACKGROUND

This report catalogues and describes Douglas-fir Permanent Sample Plots (PSPs) and trial sites available for measurement for the FFR Diversified Species theme on the Scion PSP database. It evaluates each trial for its coverage of genetic, environmental and silvicultural variables.

The aim is to design the most cost effective measurement strategy to sample the widest range of these factors in order to best model and understand Douglas-fir growth in the future, and provide data for future FFR projects. Because decisions made from this report affect the availability of future data for research, a long term view of Douglas-fir PSP measurement has been taken to preserve the possibility of future research areas of which Scion or the Diversified Species theme may not yet be aware.

All appropriate Douglas-fir trial series and forest growth plots on the Scion PSP system are described below, and following that a recommended sub-sample of plots is suggested as the most cost effective measurement schedule to cover the widest range of variables for effective future Douglas-fir growth modelling.

# METHODS

The recommended measurement schedule presented in this report consists of a sample of PSPs and trials chosen from available Douglas-fir trial series and forest growth plots on the Scion PSP system measured in the last 8 years, based on the genetic, environmental and silvicultural variables they cover. Information on genetics and silviculture was gathered from the Scion Trial Register, PSP System and in Douglas-fir Cooperative reports. Environmental information was gathered using the location of each plot and the corresponding Land Environments of New Zealand (LENZ) class, identified using the ArcMap Geographic Information System (GIS) [2] and the LENZ GIS data layer [3].

To cover genetic variables, all existing provenance and seed source trials were included in the schedule, covering the full available range of seed source provenances, families and seed lots across a number of locations. Of the other trial types, those PSPs with seed source information recorded were favoured over those without.

Environmental variables have been evaluated using the Level 1 LENZ classification [4]. Level 1 LENZ classes consist of 20 New Zealand environments based on factors likely to affect plant growth. They identify areas of land having similar climate, landform and soil variables [1] regardless of where they occur in New Zealand. Figure 1 is a map of Douglas-fir PSP locations and their relation to different LENZ classes.

Coverage of silvicultural variation was achieved by favouring plots with both low and high remaining stockings. The two existing Douglas-fir pruning trials are included in this report. This covers the full available range of stocking and pruning treatments.

The descriptions below summarise each plot's merits for inclusion in a remeasurement schedule, and give the reason for that plot's recommended measurement frequency.

# PSP AND TRIAL LOCATIONS

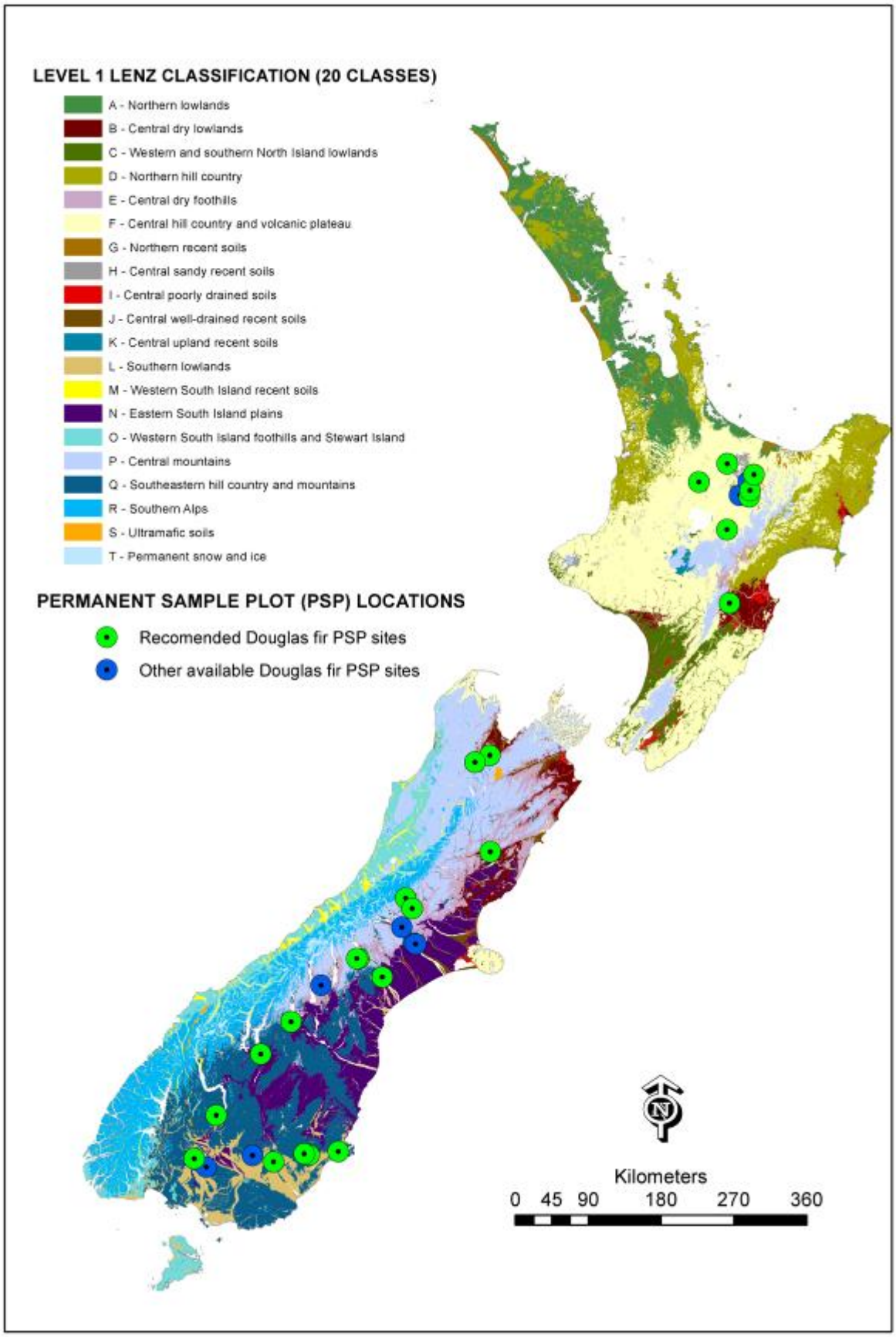


**Figure 1: Currently measured and recommended additional PSPs for the FFR IFS theme over Level 1 LENZ classes of New Zealand[3]**

# DOUGLAS-FIR PSP SITES

## Provenance Trials

FR 209

**Planted:** 1959
**Location:** Kaingaroa Forest, Bay of Plenty
**Number of plots:** 55

**Recommended for remeasurement**

Stockings in this trial range from 145 stems/ha to almost 900 stems/ha. Seed was obtained mainly from Washington, Oregon and California, and each seed origin is known. There is an edge effect on one side of the trial where the neighbouring stand was harvested. This will impact on the suitability of some plots for modelling growth, those plots having a noticeable increase in wind throw mortality. This trial has had six measurements from 1994 to 2011, and provides a data comparison between Douglas-fir provenances when grown in New Zealand's central dry foothills and central plateau (LENZ class F).

This trial is recommended for the remeasurement schedule on a 5-year measurement cycle on account of its age and representation of a number of provenances in an important area for production forests.

FR 244

**Planted:** 1959
**Location:** Kinleith Forest, Waikato
**Number of plots:** 35

**Recommended for remeasurement**

Stockings in this trial range from less than 100 stems/ha to over 600 stems/ha. Seed was obtained mainly from Washington, Oregon and California states, and seed origins are known. This trial has had six measurements to date from 1995 to 2009 and provides a data comparison between Douglas-fir provenances when grown in New Zealand's central dry foothills areas (LENZ class E).

This trial is recommended for the remeasurement schedule on a 5-year measurement cycle on account of its age and low stocking treatments.

FR 249

**Planted:** 1959
**Location:** Gwavas Forest, Hawke's Bay
**Number of plots:** 66

**Recommended for remeasurement**

Stockings in this trial range from 200 stems/ha to 1100 stems/ha. Seed was obtained mainly from Washington, Oregon and California states, and seed origins are known. This trial has had five measurements to date from 1995 to 2011, and provides a data comparison between Douglas-fir provenances when grown in New Zealand's central dry lowland areas (LENZ class B), an environment not well covered by other existing FFR Douglas-fir PSPs.

This trial is recommended for the remeasurement schedule on a 5-year measurement cycle on account of its age and representation of a unique LENZ class.

FR 224

**Planted:** 1959
**Location:** Golden Downs Forest, Nelson Region
**Number of plots:** 101

**Recommended for remeasurement**

Stockings in this trial range from 330 stems/ha to 700 stems/ha. Seed was obtained mainly from Washington, Oregon and California states, and seed origins are known. This trial has had six measurements to date from 1994 to 2008, and provides a data comparison between Douglas-fir provenances when grown in New Zealand's central dry foothills areas (LENZ class E), an environment not well covered by other FFR Douglas-fir PSPs.

This trial is recommended for the remeasurement schedule on a 5-year measurement cycle on account of its age and rare LENZ class.

FR 281

**Planted:** 1996

**Location:** Golden Downs Forest, Nelson Region
**Number of plots:** 6

**Location:** Waipori Forest, Otago
**Number of plots:** 6

**Location:** Blue Mountains Forest, Otago
**Number of plots:** 20

**Recommended for remeasurement**

This trial has a total of 32 plots and stockings range from 550 stems/ha to 1200 stems/ha in Golden downs, 770 stems/ha to 1050 stems/ha in Waipori and from 600 stems/ha to 1400 stems/ha in Blue Mountains. The Golden Downs and Waipori sites have seed from Fort Bragg, Tramway and Ashley (ex Oregon) provenances. The Blue Mountains site has those 3 provenances plus San Mateo, Berteleda, Santa Cruz and two additional families from Fort Bragg. All plots in the Blue Mountains have had one pruning lift. This trial has had four measurements to date, from 2006 to 2011, and provides data from age 10 onwards over a wide range of stockings in central mountains (LENZ class P) and south-eastern hill country and mountains (LENZ class Q). A further replication at Gowan Hills in Otago is still to be established.

This trial series is recommended for the remeasurement schedule, to be measured every year up until 3 years after silviculture when measurements will be reduced to once every 3 years. It is included to cover younger Douglas-fir plantings and contribute to representation of pruning treatments in key Douglas-fir production forest areas.

FR 490/1

**Planted:** 2000
**Location:** A privately owned forest, Canterbury
**Number of plots:** 12

**Recommended for remeasurement**

Stockings in this trial range from 1300 stems/ha to 1700 stems/ha. Seed has been sourced from Tramway, Fort Bragg, Hebo and Eyrewell provenances. This trial has had three measurements to date from 2008 to 2010, and provides a data comparison between Douglas-fir provenances when grown in New Zealand's south-eastern hill country and mountains (LENZ class E), an environment not well covered by other FFR Douglas-fir PSPs.

This trial is recommended for measurement every year up until 3 years after silviculture, when measurements will be reduced to every 3 years. It is included to cover younger Douglas-fir plantings at high stockings and on account of its rare LENZ class.

FR 490/2

**Planted:** 2001
**Location:** A privately owned forest, Southland
**Number of plots:** 6

**Recommended for remeasurement**

Stockings in this trial range from 1200 stems/ha to 1500 stems/ha. Seed was sourced from the Tramway, Hebo and Eyrewell provenances. There are three unmixed plots; one for each provenance, and the remaining three are mixtures of all three seed sources. This trial has had three measurements to date from 2008 to 2010, and provides a data comparison between Douglas-fir provenances when grown in New Zealand's south-eastern hill country and mountains (LENZ class Q).

This trial is recommended for the remeasurement schedule, to be measured every year up until 3 years after silviculture when measurements will be reduced to every 3 years. It is included in the measurement schedule to cover younger Douglas-fir plantings at high stockings and to complement data from FR 490/1.

## Thinning Trials

FR 212

**Planted:** 1983
**Location:** Kaingaroa Forest, Bay of Plenty
**Number of plots:** 23

**Recommended for remeasurement**

Stockings in this trial range from 120 stems/ha to 1800 stems/ha. It has had 14 measurements to date from 1994 to 2010, and provides data comparison for Douglas-fir planted over a range of stockings when grown in the central dry foothills and central plateau (LENZ class F).

This trial is recommended for remeasurement on a 3-year cycle on account of the wide range of stocking treatments.

RO 906

**Planted:** 1969
**Location:** Kaingaroa Forest, Bay of Plenty
**Number of plots:** 8

**Recommended for remeasurement**

Stockings in this trial range from 300 stems/ha to 550 stems/ha. It has had 21 measurements to date from 1979 to 2008, and provides a long term data comparison for Douglas-fir when grown in the central dry foothills or central plateau (LENZ class F).

This trial is recommended for remeasurement on a 5-year cycle on account of the length of time covered by regular measurements, making it suitable for modelling long rotations.

FR 245

**Planted:** 1984
**Location:** Kaingaroa Forest, Bay of Plenty
**Number of plots:** 17

**Recommended for remeasurement**

Stockings in this trial range from 150 stems/ha to 1400 stems/ha. It has had 16 measurements from 1995 to 2010, and provides a data comparison for Douglas-fir when grown in New Zealand's south-eastern hill country and mountains (LENZ class E), an environment not well covered by other FFR Douglas-fir PSPs.

This trial is recommended for the remeasurement on a 3-year cycle on account of its rare LENZ class.

FR 246

**Planted:** 1981
**Location:** Berwick Forest, Otago
**Number of plots:** 17

**Recommended for remeasurement**

Stockings in this trial range from 150 stems/ha to 1700 stems/ha. It has had 13 measurements from 1995 to 2011, and provides a comparison for Douglas-fir planted over a range of stockings when grown in New Zealand's central dry hill country (LENZ class Q).

This trial is recommended for remeasurement on a 3-year measurement cycle on account of the wide range of stocking treatments.

FR 277

**Planted:** 1985
**Location:** Castle Downs Forest, Southland
**Number of plots:** 17

**Recommended for remeasurement**

Stockings in this trial range from 150 stems/ha to 1700 stems/ha. This trial has had 16 measurements to date from 1996 to 2011, and provides a data comparison for Douglas-fir planted over a range of stockings when grown in New Zealand's central dry hill country (LENZ class Q).

This trial is recommended for the remeasurement schedule, to be measured every year up until 3 years after silviculture when measurements will be reduced to every 3 years. It is included in the measurement schedule because of the wide range of stocking treatments on one site.

FR 213

**Planted:** 1984
**Location:** Blue Mountains, Otago
**Number of plots:** 13

**Not recommended for remeasurement**

Stockings in this trial range from 140 stems/ha to 1200 stems/ha. It originally consisted of 17 plots, but four plots have been abandoned due to an incorrect thinning treatment. The remaining plots have had 18 measurements to date from 1994 to 2010, and provide a data comparison for Douglas-fir planted over a range of stockings when grown in New Zealand's central dry hill country (LENZ class Q).

This trial is not recommended for remeasurement as the treatment, region and LENZ class are covered by FR 246.

## Pruning Trials

FR191

**Planted:** 1982
**Location:** Kaingaroa Forest, Bay of Plenty
**Number of plots:** 52

**Recommended for remeasurement**

Stockings in this trial range from 250 stems/ha to 750 stems/ha. Pruned treatments range from 5 m to 10 m and have been scheduled according to various lengths of green crown remaining. This trial has had 14 measurements to date from 1993 to 2011, and provides a long term data comparison for Douglas-fir when grown in the central dry foothills and central plateau (LENZ class F). Douglas-fir pruning trials are rare and provide valuable data for modelling the effects of silviculture.

This trial is recommended for remeasurement schedule on a 3-year cycle to record response to pruning treatments.

FR 206

**Planted:** 1983
**Location:** Ribbonwood Station, South Canterbury
**Number of plots:** 56

**Recommended for remeasurement**

Stockings in this trial range from 300 stems/ha to 1800 stems/ha. All pruned treatments have been pruned to 6 m and scheduled according to varying lengths of green crown remaining. This trial has had 13 measurements to date from 1993 to 2010, and provides a data comparison for Douglas-fir when grown in New Zealand's south-eastern hill country and mountains (LENZ class Q). Douglas-fir pruning trials are rare and provide valuable data for modelling the effects of silviculture.

This trial is recommended for the remeasurement schedule on a 3-year measurement cycle to record the response to pruning treatments.

## Growth Plots

RO 240

**Planted:** 1939
**Location:** Scion Campus, Rotorua, Bay of Plenty
**Number of plots:** 1

**Recommended for remeasurement**

The trees in this plot are thought to have seeded from surrounding planted nursery-bred trees, and therefore growth may be affected by inbreeding. Despite this, the plot is valuable as one of the oldest Douglas-fir plots on the PSP system. This trial is currently stocked at 210 stems per hectare and has had 8 measurements to date from 1958 to 2009. It provides long term data for Douglas-fir when grown on New Zealand's central dry foothills and central plateau (LENZ class F).

This plot is recommended for remeasurement on a 3-year cycle on account of the length of time covered by regular measurements and the cost effective measurement due to its close proximity to the Rotorua Scion office.

CY600

**Planted:** 1987
**Location:** A privately owned forest, Canterbury
**Number of plots:** 3

**Recommended for remeasurement**

Stockings in these plots are around 1100 stems/ha. They have had seven measurements to date from 2000 to 2010, and provide a data comparison for Douglas-fir when grown in New Zealand's south-eastern hill country and mountains (LENZ class E), an environment not well covered by other FFR Douglas-fir PSPs.

These plots are recommended for the remeasurement schedule on a 3-year measurement cycle on account of their rare LENZ class.

CY 210

**Planted:** 1865
**Location:** A privately owned forest, South Canterbury
**Number of plots:** 1

**Recommended for remeasurement**

This plot is currently stocked at 94 stems per hectare and is valuable as it is one of the oldest plots on the PSP system. This trial has had 19 measurements to date from 1956 to 2008 and provides long term data for Douglas-fir grown on New Zealand's eastern South Island plains (LENZ class N), an environment not well covered by other existing FFR Douglas-fir PSPs.

This plot is recommended for the remeasurement schedule on a 5-year measurement cycle on account of the length of time covered by regular measurements and its rare LENZ class.

FR 463

**Planted:** 1911
**Location:** Ross Creek Forest, Otago
**Number of plots:** 1

**Recommended for remeasurement**

This plot is stocked at 460 stems per hectare and is important because it has some of the oldest trees on the PSP system. This trial has had three measurements to date from 2003 to 2008. This plot provides data for Douglas-fir grown on New Zealand's south-eastern hill country and mountains (LENZ class Q).

This plot is recommended for the remeasurement schedule on a 5-year measurement cycle on account of the age of the trees.

FR 298

**Planted:** 1981
**Location:** A privately owned forest, inland Otago
**Number of plots:** 4

**Recommended for remeasurement**

Stockings in these plots range between 633 and 1800 stems per hectare. This trial has had seven measurements to date from 1996 to 2007, and provides data for Douglas-fir grown on New Zealand's eastern South Island plains (LENZ class N), an environment not well covered by other FFR Douglas-fir PSPs.

These plots are recommended for the remeasurement schedule on a 3-year measurement cycle on account of their rare LENZ class.

FR 470

**Planted:** 1981
**Location:** Kaingaroa Forest, Bay of Plenty
**Number of plots:** 3

**Not recommended for remeasurement**

Stockings in these plots range between 620 and 700 stems per hectare. This trial has had three measurements to date from 2003 to 2008, and provides data for Douglas-fir grown on New Zealand's central dry foothills and central plateau (LENZ class F).

These plots are not recommended for the remeasurement as the treatment and location are covered by other trials.

FR 93/4

**Planted:** 1962 - 1996
**Location:** Private land in the Waikato and Bay of Plenty regions
**Number of plots:** 5

**Not recommended for remeasurement**

This trial was established to provide agro-forestry stand information for the 1995 New Zealand Farm Forestry Association conference. The trial has stockings ranging between 75 and 425 stems per hectare. It has had three measurements to date from 2005 to 2009, and provides data for Douglas-fir grown on New Zealand's central dry foothills and central plateau (LENZ class F).

These plots are not recommended for remeasurement as the treatment and location are covered by other trials.

FR 102/1 3/1

**Planted:** 1966
**Location:** A privately owned forest, Southland
**Number of plots:** 1

**Not recommended for remeasurement**

This plot is stocked at 637stems per hectare and has had five measurements to date from 1994 to 2010. This plot provides data for Douglas-fir grown on New Zealand's south-eastern hill country and mountains (LENZ class Q).

This plot is not recommended for the remeasurement as the treatment and location are covered by other trials.

## Altitude Trial

CY 575/3 1

**Planted:** 1965
**Location:** DOC land, Craigieburn, Canterbury high country
**Number of plots:** 5

**Recommended for remeasurement**

These plots are planted over an altitude gradient from 760 m to 960 m, with stockings between 500 and 1200 stems per hectare. This trial has had eight measurements to date from 1983 to 2010, and provides data for Douglas-fir grown on New Zealand's central mountains (LENZ class P), an environment not well covered by other existing FFR Douglas-fir PSPs.

This trial is recommended for the remeasurement schedule on a 3-year measurement cycle on account of its rare LENZ class and the range of altitudes covered on one site.

## Fertiliser Trial

FR 402/1

**Planted:** 1999

**Location:** A private forest in the Canterbury high country
**Number of plots:** 20

**Recommended for remeasurement**

These plots were fertilised with boron at planting and have stockings between 1400 and 1675 stems per hectare. This trial has had five measurements to date from 2000 to 2004, and provides data for Douglas-fir grown with fertiliser on New Zealand's central dry foothills (LENZ class E), an environment not well covered by other existing FFR Douglas-fir PSPs.

This trial is recommended for the remeasurement schedule on a 3-year measurement cycle from 2014 to capture any response to fertiliser, and on account of its rare LENZ class, provided the plots can be re-established after nine years without measurement.

FR 402/2

**Planted:** 1999

**Location:** A high country station in South Canterbury
**Number of plots:** 16

**Recommended for remeasurement**

These plots were fertilised with a boron application at planting and have stockings between 1450 and 1875 stems per hectare. This trial has had four measurements to date from 2001 to 2004, and provides data for Douglas-fir grown with fertiliser on New Zealand's central dry foothills (LENZ class E), an environment not well covered by other existing FFR Douglas-fir PSPs.

This trial is recommended for the remeasurement schedule on a 3-year measurement cycle from 2014 to capture any response to fertiliser, and on account of its rare LENZ class, provided the plots can be re-established after nine years without measurement.

# RECOMMENDED SCHEDULE

Table 1 indicates which PSP sites are to be measured in which period from the 12/13 financial year to the 14/15 financial year. The number of sites measured fluctuates from one site per half year to a maximum of six sites in the first half of 2013.

**Table 1: PSP MEASUREMENT SHEDULE; Douglas-fir PSP measurement scheduling for the FFR Diversified Species Theme from 2012 to 2015 inclusive. Ticks indicate the half year when each site is scheduled for measurement.**

| | Plot ID | Measurement cycle (yrs) | 2012 | 2013 | | 2014 | | 2015 | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Jul-Dec | Jan-Jun | Jul-Dec | Jan-Jun | Jul-Dec | Jan-Jun | Jul-Dec |
| North Island | FR212 | 3 | | ✓ | | | | | |
| | FR 249 | 5 | ✓ | | | | | | |
| | FR191 | 3 | | | | | ✓ | | |
| | FR 209 | 5 | | | | | | | |
| | FR244 | 3 | | | | | ✓ | | |
| | RO 240/0 | 3 | ✓ | | | | | | ✓ |
| | RO 906 | 5 | | ✓ | | | | | |
| South Island | FR 246 | 3 | | | | ✓ | | | |
| | FR 277 | 3 | ✓ | | | | | ✓ | |
| | FR 281/4 | 3 | | | | ✓ | | | |
| | FR 281/7 | 3 | | | | ✓ | | | |
| | FR 281/1 | 3 | | | | | ✓ | | |
| | FR 490/1 | 3 | | ✓ | | | ✓ | | |
| | CY 600 | 3 | | ✓ | | | | | |
| | FR 206 | 3 | | ✓ | | | | | |
| | FR 490/2 | 3 | | | ✓ | | | | |
| | CY210 | 5 | | | | ✓ | | | |
| | FR 463 | 5 | | | ✓ | | | | |
| | FR 224 | 5 | | | ✓ | | | | |
| | CY 575 | 5 | | | | | | | ✓ |
| | FR 245 | 3 | | ✓ | | | | | |
| | FR 298 | 3 | | | ✓ | | | | |
| | FR 402 | 3 | | | ✓ | | | | |

# DISCUSSION

The above measurement schedule is recommended as the most cost-effective PSP measurement strategy to sample data which will provide a solid base for future FFR projects and Douglas-fir modelling and model validation.

This measurement schedule includes some plots in forest areas where Douglas-fir is not currently considered by the forest owner to be the most appropriate species to plant. However, in the long term silvicultural preferences can change so it is important to maintain research capability in those areas and keep Douglas-fir as a potential future option.

The 1959 series of provenance trials will reach 60 years of age during the next decade. FFR would like to thank all associated land owners for keeping these trials to date, and acknowledge that owner's commitment to keeping these trials to age 60. While we are aware it is the forest owner's decision on when harvesting occurs, it will be greatly appreciated if owners consider keeping these trials past this age. Data from such long term trials will be a rare and important future data resource.

Fertiliser trials are not well covered in this schedule. For a thorough assessment of Douglas-fir response to fertiliser nationwide, more trials will need to be established. If there is scope for new Douglas-fir trial establishment, response to fertiliser treatments would be a worthwhile subject to explore.

## Costs

Generally measurements are scheduled intensively at young ages and around silviculture, followed by a drop to 3-year cycles until harvest. To save costs in the recommended schedule, older trials have been given a 5-year measurement cycle. From a modelling perspective this can be justified as the growth curve of older stands will tend to flatten out, not requiring the same number of measurements to capture the shape of the growth curve. The disadvantage is that on more exposed sites a 5-year measurement cycle can cause plot maintenance issues where the condition of tree tags and pegs can deteriorate sufficiently between measurements to decrease measurement efficiency. If maintenance issues are encountered options will be considered, including increasing the measurement frequency back to every three years or using Radio Frequency Identification (RFID) tags to identify trees.

## LENZ Classes

With only six Level 1 LENZ classes sampled out of a possible 20, the portion of classes sampled is small. This is in part due to the limited site types suitable for economic Douglas-fir establishment. This reduces the effectiveness of Douglas-fir modelling, as a wide range of sites provides for stronger growth models. PSPs on LENZ classes other than those already covered will provide valuable data for future modelling.

Because of Swiss Needle Cast disease, warmer sites must be treated with caution in future Douglas-fir growth modelling [5]. It is assumed in this report that ideal LENZ classes are those which have average winter temperatures less than 2.5 degrees [6] and contain more than 2 ha of exotic forestry nationwide according to the Land Cover Database [7]. Within this definition there are 11 LENZ classes ideal for Douglas-fir PSPs, and of those there are five classes not containing existing PSPs. Those are H, J, K, L and O (Appendix A). Douglas-fir PSPs established in these areas would be beneficial and could be achieved by adding additional plots to the recommended measurement schedule.

Warmer LENZ classes which have a higher likelihood of Swiss Needle Cast are still useful from a modelling prospective, to provide a full range of sites and to assess whether future trends continue to follow the measured historical impacts of the disease. This is covered in part by existing recommended plots in class F, but could be added to with new plots in LENZ classes A, D and G (Appendix B). However, to allow analysis of the effects of Swiss Needle Cast, measurements should be combined with disease assessments. The inclusion of disease assessment should be discussed by the TST to decide whether to include them on warmer sites only, on all sites or not to include them at all.

## Industry PSPs

Industry plots have not been considered for this report. Industry data could provide additional resources for future modelling and validation, particularly when in classes not containing existing PSPs. Many industry plots are stored on Scion's PSP system and can be easily assessed for LENZ class with permission from the owners. There may be additional industry PSPs not on the PSP system. These can be added to the pool of available Douglas-fir data if genetic and silvicultural information is supplied with the location.

Any industry plot information supplied can be assessed for coverage of relevant variables, and a summary released once all information is collated. This will provide information on what aspects of the future Douglas-fir PSP measurement strategy can be covered by industry's in-kind data contributions to make for a more cost effective future PSP measurement strategy.

## TST Action Items

Actions for the FFR Diversified Forests TST:

- Decide on establishing additional growth plots to cover LENZ classes not containing any current FFR Douglas-fir PSPs.
- Collate industry Douglas-fir plot descriptions to see how in-kind data contributions could add to future modelling requirements. FFR Diversified Forests members will need to give permission for LENZ class evaluation of their plots on the Scion PSP system. Or, where PSP data are not stored on the Scion PSP system plot information will have to be supplied.
- Consider adding disease assessment to the current measurement schedule for all sites or for warmer sites only.
- Consider establishing fertiliser trials.

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# APPENDICES

## Appendix A – Ideal Douglas-fir modelling LENZ classes not covered by existing FFR Diversified Species Douglas-fir PSPs

To give an indication of the likelihood that a forest covers a suitable class ideal for growth modelling in addition to recommended PSPs, the following descriptions are given. However, to confirm the LENZ class for any given PSP, the NZTM location should be compared with the LENZ Level 1 GIS data layer [3].

Ideal LENZ classes:

H **Central sandy and recent soils**
This class occurs in patches around Mt Tarawera and Mt Taranaki as well as being scattered around the Central and Southern North Island plus the north west coast of the South Island [1].

J **Central well-drained recent soils**
This class occurs along the Wairau, Waimea and Motueka rivers, around Kaikoura and along streams in Canterbury [1].

K **Central upland recent soils**
This class occurs in patches from South Canterbury to Central Otago, inland basins of Canterbury and eastern Otago, inland valleys of Southern Marlborough and the headwaters of rivers in the eastern South Island and Tongariro [1].

L **Southern Lowlands**
This class occurs in patches around Invercargill, the Southland lowlands, on parts of Stewart Island and parts of South Canterbury and coastal Otago [1].

O **Western South Island Foothills and Stewart Island**
This class occurs in Westland, around the edge of Fiordland and on Stewart Island [1].

# Appendix B – Warmer LENZ classes susceptible to Swiss Needle Cast not covered by existing FFR Diversified Species Douglas-fir PSPs

To give an indication of the likelihood that a forest covers a warmer LENZ class, possibly susceptible to Swiss Needle Cast but useful for Douglas-fir growth modelling or quantifying the effects of Swiss Needle Cast, the following descriptions are given. However, to confirm the LENZ class for any given PSP the NZTM location should be compared with the LENZ Level 1 GIS data layer [3].

Useful warmer LENZ classes:

A **Northern Lowlands**
This class occurs from northern Waikato to the north of the North Island, as well as in small patches in coastal Bay of Plenty, East Cape and Mahia peninsula [1].

D **Northern Hill Country**
This class occurs from southern Hawke's Bay to the East Cape, along the Coromandel range and on the Coromandel peninsula, in western coastal Waikato and in patches around Northland [1].

G **Northern Recent Soils**
This class occurs down the West Coast from North Cape to Taranaki and in small scattered patches around East Cape, Coromandel and Waikato [1].