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SECOND ORCHARD SURVEY RESULTS

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FRI/INDUSTRY RESEARCH COOPERATIVES

EXECUTIVE SUMMARY

Up to the end of 1988, some 37 000 hectares of *Pinus radiata* stands have been established nationwide with "second orchard" seedlots (mostly of "268" series origin) by co-operative members. Of this, 24 000 hectares, or 67% has been planted in the Central North Island region alone. Some 82% this material is currently less than three years old, with 67% estimated to have a quality rating of GF 16. Very little higher quality seedlots have been planted.

Although the extreme ranges of site quality do not appear to be covered in most regions, forest sites typical of each of these regions are well represented in the survey. Initial stockings range from 500 to 2000 stems per hectare with 67% of the total area planted at stockings less than 1000 sph.

The current experimental database is also described. Although comprehensive at a nationwide level, the database is inadequate for modifying/developing and validating future regional growth models.

Opportunity therefore exists to plan for a co-ordinated database for the second orchard clonal series with further establishment on a nationwide basis.

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1.0 INTRODUCTION

Over the past forty years, efforts to genetically improve radiata pine have been successfully undertaken. Early seed orchards have provided seed of up to GF 16 quality rating, versus ratings of up to GF 1 to GF 7 for unimproved and climbing select seedlots (see Vincent, 1987). Material from the 'second orchard' clonal series of the 'Growth and Form' breed, with quality ratings ranging from GF 15 to GF 25+, has exhibited clear superiority in growth and yield to all other seedlots currently available (Shelbourne *et al* 1986, King *et al* 1987, Wilcox *et al* 1988). However, since this material has been available commercially since 1984 only, it is poorly represented in existing growth model databases, and is not represented by current regional growth models. The use of these models to predict growth performance is likely both to underestimate growth and yield of this material, and possibly to incorrectly simulate the actual patterns of growth performance.

Thus in November 1987 the Stand Growth Modelling Co-operative Technical Committee agreed to investigate the use of the second orchard clonal series with the eventual aim of developing a database for constructing future growth models incorporating genetic gains.

This report covers the results from a survey of all co-operative members of the use of second orchard material.

2.0 METHODOLOGY

A questionnaire approach (Appendix 1) was used to obtain the following information from co-operative members:

region - as defined by the applicable growth model
site index - based on existing stands of unimproved *P.radiata*
seedlot number (if available)
year of planting

Regional boundaries were defined using existing regional growth model boundaries.

Site index was used to obtain an approximate estimate of site quality, thus allowing an indication of the coverage of site quality as well as a judgment of the typicality of any given site for a particular region. Likewise, seedlot numbers were used to obtain a 'Growth and Form' (GF) rating; hence ranking the genetic quality of tree stocks. Initial stocking information was collected to ensure any future (experimental) use is feasible for prescribed silvicultural treatments, e.g., initial stockings are not too low to allow a high final stocking comparison. Year of planting was incorporated to evaluate distribution of planting over time as well as an estimate of 'lead time' (if any) which may be gained from establishing experiments and/or growth plots in these stands.

Results were obtained between January and October 1988 and subsequently tabulated and graphed with appropriate GF rating estimates attached.

3.0 RESULTS AND DISCUSSION

3.1 Regional Analysis

A total of 36 984 hectares have been planted in second orchard material throughout New Zealand by Co-operative members (Appendix 2). Figure 1 shows the distribution of this material by region and owner.

The vast majority of second orchard seedlots have been planted in the Central North Island (CNI) region - some 24 687 ha or 66.8% of the total area (up to and including 1988). Other regions with sizeable quantities include the Auckland Clays (ACM) and Hawkes Bay (HBM) areas with 11.2% and 6.3% respectively. The remaining regions have about 3% or 1100 ha each.

The dominance of the Central North Island in terms of area is largely resultant from New Zealand Forest Service policy: when limited quantities of the seedlots

first became available, they were allocated to the higher fertility Central North Island sites where greater genetic gains were expected. However, as supplies of second orchard seed have increased, this material has spread over a wider range of regions and owners in more recent years.

3.2 Within-Region Analysis

3.2.1 Distribution by Seedlot and Site Quality

In all regions the seedlot quality predominantly ranged between GF 16 and GF 19 (Appendix 3) although considerable areas of the Central North Island were planted with quantities of GF 15 material, mostly originating from Tasman's Te Teko seed orchard. Small areas in some of the regions have also been established with higher quality control-pollinated material. Some 67% of all seedlots were rated at GF 16 alone, representing a rather narrow quality range for every region. It should be noted however that the GF ratings are "guesstimates" only, as the exact parentage and pollen contamination levels for earlier seedlots are not known (G.Vincent, pers comm).

Over the next five years, seedlots with quality ratings of up to GF 26 will increase in availability (G.R. Johnson, pers. comm.), hence seedlots currently in the ground will be of lower average quality compared to future seedlots. Therefore any co-ordinated sampling strategy will also need to consider adequate representation of future genetic material.

Seedlot distribution tended to be restricted to the more representative sites in most regions, with the extreme ranges of site indices not usually covered. For example, although the Hawkes Bay model possesses a range of site indices from 20 to 38.5 metres (mean 29.8) (M.Lawrence, pers comm), the site index range for the second orchard material is effectively restricted to between 28 and 33 m.

An exception is the Central North Island region: the range of site indices are reasonably well covered, particularly at the mid to upper range of site quality (Figure 2).

Because the range of estimated site indices (based on unimproved *P. radiata*) may underestimate the true situation, additional areas may need to be represented in further growth plots and/or an experimental database. It may also be necessary to ensure adequate coverage of sites with similar site indices but varying basal area response.

3.2.2 Age of Second Orchard Material

Some 30 500 ha, or 82 %, of second orchard-derived stands have been planted during the past two planting seasons (Appendix 4). Regions such as Auckland Clays, Canterbury, Golden Downs and Southland have very little or no areas planted before 1987 with such seedlots. The Central North Island is the sole region to have large amounts of area planted across a range of sites prior to 1987. The two remaining regions, Hawkes Bay and Sands, have small areas planted prior to 1987 only, and these tend to be restricted to a narrow range of site indices.

Most stands are not yet ready for pruning or thinning, hence there is an opportunity to plan and implement a nationwide growth and yield database for this genetic material covering a range of silvicultural treatments. Furthermore, the earlier plantings provide some opportunity to gain additional 'lead time' in predicting changes in growth and yield from using second orchard material.

3.2.3 Initial Stocking

Data was collected on initial stocking to ensure silvicultural alternatives could be included in any resultant database (e.g., high final stockings, high selection ratios). Results show some 24 400 ha, or 66 % of area nationwide is planted at stockings less than 1000 sph. On a regional basis, higher initial stockings tend to be used in the Auckland Sands and Southland regions, with substantial areas in the Central North Island planted at similarly high levels. Stocking levels tend to be spread across site quality within regions (Appendix 5). Opportunity therefore exists to vary a database across a range of both initial and final stockings on a spectrum of site qualities within regions.

3.2.4 Distribution of Site Quality by Tenure

For the majority of regions only NZ Timberlands has stands covering the range of site indices. Exceptions are the two southern-most regions, Canterbury and Southland where local afforestation agencies cover the higher end of the site index range. In the other regions, organisations such as ERNZFP Ltd, Tasman Forestry Ltd and Carter Holt Harvey Ltd tend to be represented on a more limited range of site indices with overlap of site indices among owners is common. Although these organisations tend to be concentrated in the Central North Island region (along with NZ Timberlands Ltd), management practices tend to differ, thus a spread of plots tenure owners may be necessary.

4.0 **Experimental Database**

This section outlines the potential (FRI) experimental database, in terms of both existing trials containing growth and yield plots, and trials which can potentially provide growth information.

4.1 **Existing Database**

Table 1 provides a list of existing FRI trials containing growth and yield plots. They tend to be young, with the majority of trials established during 1987-88 using higher quality control-pollinated seedlots.

These trials cover a wide range of final stockings, with the exception of the 1979 trials (Genetic Gain series) which were restricted to one silvicultural regime. However growth and yield data is currently limited to the 1979 series and the second orchard growth plots in Northland (FR 59 & 60) - which do not contain any climbing-select control seedlots. Although experimental coverage is nationwide, within-region spread is restricted to 2-3 sites per region (with the exception of Westland which is not represented), some of which are silvicultural trials only (i.e., can not provide genetic gain information).

4.2 **Potential Additions**

A number of trials also suitable for providing growth and yield data have been established by various FRI research fields in recent years (Table 2).

The majority of these experiments have been established in the Central North Island region with limited coverage of other regions. Some opportunity exists to impose variable silviculture in a number of these trials, e.g., the '100 hectare' trial consists of large blocks of seedlings and cuttings of both '268' and '870' (long internode breed) origin which have yet to receive silviculture, hence differential treatments could be imposed. Furthermore, both this trial and the initial spacing trial contain cuttings from 2-3 year old ortets which could provide data to quantify differences for this plant type.

TABLE 1 - Existing FRI Second Orchard Database

Location	Trial Number	Yr Planted	GF Rating	# Plots	Final Stocking	Purpose
Weiti	FR 60	1982	17	12	100 - 400	Final stocking trial
Moerewa	FR 59	1981	12	6	300	Growth plots
Mamaranui	FR 54	1988	22	18*	100 - 500	Genetic gain/silviculture trial
Woodhill	FR 7	1987	19	18	100 - 500	Genetic gain/silviculture trial
Tauhara	FR 8	1987	19	18	100 - 500	Genetic gain/silviculture trial
Kaingarua	FR 9	1987	19	12	100 - 500	Genetic gain/silviculture trial
Kaingarua	RO 2103/3	1979	14, 19	10	300	Genetic gain trial
Kaingarua	FR 85	1989	16, 18, 22, 25	36	250 - 600	Genetic gain/silviculture trial
Kawerau	FR 84/1	1989	16, 25	27	250 - 600	Genetic gain/silviculture trial
Tikokino	FR 57	1988	16, 19	24*	100 - 600	Genetic gain/silviculture trial
Tikokino	FR 77	1989	16 - 23	30	200 - 400	Genetic gain/silviculture trial
Glengarry	FR 10	1987	19	12	100 - 500	Genetic gain/silviculture trial
Gwavas	FR 78	1989	16 - 23	30	200 - 400	Genetic gain/silviculture trial
Golden Downs	NN 530/2	1979	14, 18	12	300	Genetic Gain trial
Golden Downs	FR 86	1989	16, 23	8	250, 600	Genetic gain/silviculture trial
Wairau Valley	FR 11	1987	19	12	100 - 500	Genetic gain/silviculture trial
Eyrewell	FR 55	1988	22	22*	100 - 500	Final stocking trial
Dalethorpe	FR 56	1988	12	18*	100 - 500	Genetic gain/silviculture trial
Otago Coast	FR 12	1987	19	12	100 - 500	Genetic gain/silviculture trial
Dean	SD 682	1979	14, 18	12	300	Genetic gain trial

* - includes cuttings from 2-3 year-old ortets of '268' origin (GF 16).

TABLE 2- Potential Additions to the FRI Second Orchard Database

Trial	Sites	Year Planted	Comments
Cpt. 327 Genetic Gain RO 1897	Kaingaroa	1984	Genetic gain & final stocking comparisons possible
'100 Hectare' Trial RO 2000/1	Lismore, Kaingaroa, Karioi, Tokomaru Bay	1984-85	Genetic gain and silvicultural comparisons possible
'268' Factorial Trials RO 2052	Rerewhakaitu Taylor's Block	1985	Genetic gain data & monitoring plots possible
Cuttings Initial Spacing Trial RO 2005	Valley Rd (Ngongotaha)	1984	Initial and final stocking comparisons for '268' cuttings and seedlings

An experimental database consisting of current trials (section 4.1) and the potential additions outlined above can provide a large amount of growth and yield data on a nationwide basis. From a regional perspective however, the database would still be rather limited (with the possible exception of the Central North Island) and probably inadequate for future growth model development and validation. A database suitable for modelling growth and yield of second orchard radiata pine on a regional basis would require good coverage of site quality and silvicultural regimes. This can be achieved in an efficient manner using a co-ordinated data collection strategy consisting of use of both sample plots and designed experiments to obtain the necessary information.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Second orchard seedlots have been planted in every region in New Zealand with the exception of Westland. Area planted varies between regions, with some 67% of total area in the Central North Island alone. Typical forestry sites tend to be covered throughout the country however, although the extreme ranges of site quality lack representation on a regional basis. The vast majority of this material is less than three years old, thus is yet to receive silviculture. Seedlot quality is generally GF 16 with very little representation of the higher quality material.

The majority of the FRI experimental trials are similar in age, although higher in quality, and have been extended to provide some coverage of cuttings. The resulting database will however be limited on a regional basis, and will require expansion to meet future growth modelling needs.

Opportunity therefore exists to plan and establish trials to produce a nationwide database. Data could come from both monitoring-type sample plots and a range of experimental trials which could be established on a co-ordinated basis. Further data may also be obtained in the future using retrospective sampling (Wilcox, 1987).

Consideration should also be given to extending coverage of site qualities within each region, as well as coverage of the increasingly improved control pollinated seedlots.

ACKNOWLEDGEMENTS

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APPENDIX 1 '268' QUESTIONNAIRE

STAND GROWTH MODELLING CO-OPERATIVE**QUESTIONNAIRE - USE OF GENETICALLY IMPROVED "268" OR "2ND ORCHARD" MATERIAL****INTRODUCTION**

Seed of the '268' or '2nd orchard' type material is becoming available throughout New Zealand. Results from early trials indicate this material is superior in growth performance to all other seedlots currently available. However, the growth modelling database is relatively small for this breed, and there is a need to quantify the use of the '268' material.

The objectives of this questionnaire are to evaluate:

- (a) the area already stocked with "268"/"2nd orchard" material, and
- (b) the area which will be planted in 1988 with material of that breed.

The need for this questionnaire was identified at a Stand Growth Modelling Co-operative meeting, 25 November 1987. Following identification of areas planted using this material, a series of growth plots may be established at a later date to provide an adequate data base for modelling purposes.

The assistance of co-operative members is much appreciated.

OUTLINE

The questionnaire is arranged in tabular format. Several points should be noted:

- 1. Forest managers should be certain of genetic identity (for the purposes of this questionnaire) of tree stock. Inclusion of seedlot number is encouraged.
- 2. A list of "268" and other "2nd orchard" derivatives is included.
- 3. FRI trials should not be included. FRI will collate this information on these.

The questionnaire is divided into two sections. Please complete as much as you are able in both sections and return to the Co-operative Manager, FRI.

B - FUTURE PLANTING

This should include both restocking and establishment of new plantations. Projected planting levels for 1987 would be welcomed.

Year Planted	Seedlot No.	Region ¹	Forest	Site Index	Area (ha)	Stocking (ha)

NOTES:

1. "Region" should be defined according to the applicable growth model e.g., Tarawera forest.
2. Please indicate approximately site index (if known) and range of site index if sites are available.

"268"/"2ND ORCHARD" SEEDLOTS UP TO 1987

Year of Seed	Seedlot Number	General Description
1984	2/3/84/10	Kaingaroa collection, General 268 seedlot
	2/3/84/53	Kaingaroa collection, Top 25 268 special collection
1985	2/6/85/06	Kaingaroa collection, General 268 seedlot
	2/6/85/05	Kaingaroa collection, Top 16 268
1986	2/5/86/21	Kaingaroa collection, "875" breed
	2/6/86/27	Kaingaroa collection, General 268 seedlot
	2/6/86/29	Kaingaroa collection, Top 16 268
	6/6/86/47	Amberly collection C.P. (control pollinated) 268 Rank 17-72 x Top 25 (Top 16 O.P. equivalent-grade 19)
	6/6/86/54	Amberly C.P. Top 16 x 25 268 plus 5 Top 850. GF 21
1987	2/3/87/33	Kaingaroa collection, 875
	2/3/87/34	Kaingaroa collection, 268 General seedlot
	2/3/87/35	Kaingaroa collection, 268 Top 16
	6/6/87/20	Amberly C.P. Top 16 x 850 55 GF 25 (low wood density)
	6/6/87/21	Amberly C.P. BCD 268 X TOP 16 268

APPENDIX 2 TOTAL AREA BY REGION AND OWNER

		AREA
		SUM
REGION	OWNER	
ACM	CHHN NZFP TLDN	452.30 2063.00 1612.80
ASM	NZFP TLDN	54.30 1388.30
CGM	SPB TLDS	28.00 981.70
GDM	BAIG TLDS	845.00 1317.60
HBM	CHHC TASM TLDN	680.00 72.00 1567.30
KGM	BPF NZFP OLS TASM TLDC TLDN	210.00 3418.50 1294.90 5642.25 13923.70 198.50
SGM	DCC TLDS	396.00 838.60

Total for all Regions _____ 36 984.00

NB - Footnotes listed over page

FOOTNOTES**Regions**

ACM - Auckland Clays
ASM - Auckland Sands
CGM - Canterbury
GDM - Golden Downs
HBM - Hawkes Bay
KGM - Central North Island
SGM - Southland

Owners

BAIG - Baigents Forests
BPF - BP Forests Ltd
CHHC - Carter Holt Harvey Ltd Central Region
CHHN - Carter Holt Harvey Ltd Northern Region
DCC - Dunedin City Council
NZFP - Elders Resources N.Z. Forest Products Forests Ltd
OLS - P.F. Olsens Ltd
SPB - Selwyn Plantation Board
TASM - Tasman Forestry Ltd
TLDC - NZ Timberlands Ltd Central Region
TLDN - NZ Timberlands Ltd Northern Region
TLDS - NZ Timberlands Ltd Southern Region

APPENDIX 3 - REGIONAL TOTALS BY GF RATING AND SITE INDEX

Footnotes

GF_SCORE - Growth and Form rating

SI - Site Index

Auckland Clays

		AREA

		SUM
GF_SCORE	SI	
16	27	34.20
	28	109.60
	29	766.30
	30	2543.00
	32	412.00
17	27	26.60
	32	5.00
19	29	26.40
22	30	15.00

Auckland Sands

		AREA
		SUM
GF_SCORE	SI	
15	25 26	54.30 29.20
16	18 22 25 26 27 28	72.10 36.60 50.00 361.50 38.00 618.90
17	29	27.00
19	28 29	86.00 69.00

Canterbury

		AREA
		SUM
GF_SCORE	SI	
16	21	339.00
	22	345.00
	23	26.50
	24	92.00
	25	142.40
17	25	3.30
19	18	1.50
22	24	60.00

Hawkes Bay

		AREA
		SUM
GF_SCORE	SI	
15	28	28.00
	29	120.00
	31	72.00
	32	250.00
	33	70.00
16	19	39.20
	24	10.00
	28	519.90
	29	331.00
	30	407.90
	31	318.00
	32	73.40
17	28	48.00
	32	3.90
22	28	28.00

Golden Downs

		AREA
		SUM
GF_SCORE	SI	
16	26	45.70
	27	321.50
	28	1200.40
19	25	8.00
	27	15.50
	28	7.50

Central North Island

		AREA
		SUM
GF_SCORE	SI	
15	25	580.00
	28	26.00
	29	8.00
	30	6539.40
	31	609.20
	32	476.30
	33	1011.80
	34	92.60
	35	219.40
16	20	19.00
	23	56.40
	24	2097.20
	25	60.00
	26	1115.62
	27	931.10
	28	791.93
	29	1087.15
	30	1878.45
	31	409.10
	32	4407.00
	33	1308.24
	34	349.60
	35	33.15
17	28	16.70
	32	9.70
19	26	113.08
	29	73.05
	30	332.17
	32	27.81
	33	8.70

Southland

		AREA

		SUM
GF_SCORE	SI	
16	20	64.00
	21	826.10
	24	1.50
	25	300.00
17	24	11.00
19	25	10.00
22	25	22.00

APPENDIX 4 REGIONAL TOTALS BY AGE AND SITE INDEX

Footnotes

Age	Year of Planting
-1	1989
0	1988
1	1987
2	1986
3	1985
4	1984

Auckland Clays

		AREA
		SUM
AGE	SI	
-1	30	190.00
0	29 30 32	633.30 2210.00 134.00
1	28 29 30 32	70.00 159.40 348.00 278.00
2	27 28 32	26.60 39.60 5.00
3	27	34.20

Auckland Sands

		AREA
		SUM
AGE	SI	
0	25	50.00
	26	120.00
	28	337.00
1	26	29.20
	27	38.00
	28	256.00
	29	69.00
2	18	72.10
	22	36.60
	26	146.20
	28	111.90
	29	27.00
3	26	95.30
9	25	54.30

Canterbury

		AREA
		SUM
AGE	SI	
0	21	339.00
	22	304.00
	23	24.80
	24	152.00
1	22	41.00
	23	1.70
	25	139.00
2	18	1.50
	25	3.40
3	25	3.30

Golden Downs

		AREA
		SUM
AGE	SI	
0	28	649.00
1	25	8.00
	26	45.70
	27	337.00
	28	558.90

Hawkes Bay

		AREA
		SUM
AGE	SI	
0	28	230.00
	29	211.00
	31	72.00
	32	250.00
	33	70.00
1	24	10.00
	28	54.00
	29	240.00
	30	41.00
	31	318.00
2	28	201.90
	30	61.30
	32	77.30
3	19	39.20
	28	138.00
	30	305.60

Central North Island

		AREA
		SUM
AGE	SI	
0	25	580.00
	26	254.30
	28	109.13
	29	322.10
	30	7606.42
	31	210.00
	32	2952.11
	33	1102.34
	34	102.70
	35	33.15
1	20	19.00
	23	56.40
	24	1232.80
	25	60.00
	26	881.80
	27	636.60
	28	287.50
	29	846.10
	30	494.70
	31	199.10
	32	1118.10
	33	522.10
	34	101.10
	35	85.60
2	24	374.90
	26	92.60
	27	115.70
	28	25.20
	30	189.40
	31	514.20
	32	604.20
	33	175.50
	34	67.50

Central North Island (Cont'd)

		AREA
		SUM
AGE	SI	
3	24	489.50
	27	178.80
	28	412.80
	30	450.70
	31	95.00
	32	246.40
	33	424.60
	34	145.80
	35	76.10
4	30	8.80
	33	104.20
	34	25.10
	35	57.70

Southland

		AREA
		SUM
AGE	SI	
0	20	64.00
	25	332.00
1	21	826.10
	24	1.50
3	24	11.00

APPENDIX 5 REGIONAL TOTALS BY SITE INDEX AND STOCKING

Footnotes

Code	Stocking
1	< 800 sph
2	801 - 1000 sph
3	1001 - 1200 sph
4	> 1200 sph

Auckland Clays

		AREA
		SUM
STOCKING	SI	
1	28	70.00
	29	643.00
	30	773.00
	32	5.00
2	29	123.30
	30	1975.00
	32	134.00
3	27	26.60
	28	39.60
	29	26.40
	32	278.00
4	27	34.20

Auckland Sands

		AREA
		SUM
STOCKING	SI	
2	18 26	48.90 70.00
3	25 26 27 28 29	54.30 24.90 38.00 593.00 96.00
4	18 22 25 26 28	23.20 36.60 50.00 295.80 111.90

Canterbury

		AREA
		SUM
STOCKING	SI	
1	25	3.40
2	21 22 24 25	339.00 345.00 152.00 139.00
3	18 23 25	1.50 26.50 3.30

Golden Downs

		AREA
		SUM
STOCKING	SI	
1	25 26 27 28	8.00 45.70 337.00 95.90
2	28	969.40
3	28	142.60

Hawkes Bay

		AREA
		SUM
STOCKING	SI	
1	24 28 30 31 32	10.00 202.00 41.00 318.00 3.90
2	28 29 30 31 32 33	283.90 211.00 61.30 72.00 323.40 70.00
3	19 29	39.20 240.00
4	28 30	138.00 305.60

Central North Island

		AREA
		SUM
STOCKING	SI	
1	28	83.13
	29	322.10
	30	736.05
	31	1.80
	33	157.50
	34	90.00
2	25	580.00
	27	574.40
	28	131.70
	29	305.10
	30	6903.67
	31	666.60
	32	3835.00
	33	1268.14
	34	67.50
	35	33.15
3	20	19.00
	23	56.40
	24	2097.20
	25	60.00
	26	974.40
	27	356.70
	28	593.80
	29	541.00
	30	1093.10
	31	349.90
	32	915.90
	33	473.00
	34	284.70
	35	207.10
4	26	254.30
	28	26.00
	30	17.20
	32	169.91
	33	430.10
	35	12.30

Southland

		AREA
		SUM
STOCKING	SI	
1	21	199.00
2	24 25	11.00 20.00
3	20 21 24 25	64.00 627.10 1.50 300.00
4	25	12.00