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Eucalyptus nitens
Nelder Growth Data Summary
and
Comparison With Sample Plot Data

Heather McKenzie M.O. Kimberley

Report No. 10 November 1990

Project Record No. 2606

Forest Research Institute
Rotorua
New Zealand

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EXECUTIVE SUMMARY

Growth data collected from age 3 to 11 in a *Eucalyptus nitens* nelder design experiment at Kaingaroa Forest is summarised. Missing values are added by extrapolation. Smoothed curves were fitted through all stockings for each year's measurements (using spline functions) for volume (m^3/ha), basal area (m^2/ha) and mean top height (m). However, the interpolation procedure did not work satisfactorily for survival percentage which was therefore smoothed across both age and stocking (using a logistic regression).

The data was compared with data from 29 sample plots, mainly established in provenance trials with most plots located in the South Island. The nelder appeared to be located on a good site as indicated by height growth and was not abnormal in its basal area growth as far as could be determined.

1 Eucalyptus nitens Cooperative database

1.1 Introduction

There is very limited data on the growth of *E. nitens* available to the Cooperative. In New Zealand the species suffered severe defoliation from tortoise beetle (*Paropsis carybdis*) attack until recently. The experience in Kinleith forests was that mortality occurred and that the species was not a viable option. The experience in the South Island was that the trees remained healthier than in the North Island. However any large scale planting ran the risk of a build up of tortoise beetle with similar ill effects to those noted in the North Island.

Recently a new parasite *Enoggera nassaui* has been successfully established and it is now controlling the pest. Consequently there is increased interest in growing *E. nitens* but there is little data available to assist cooperative members in determining the best management options. This report has been prepared with the data that is available to assist members in their current management decision making. The data includes a nelder design experiment that provides detailed information on the effect of stocking and a range of sample plots, mainly located in provenance trials, that provide a comparison of growth rates at different locations.

The report has been prepared concurrently with the preparation of a volume function for the species so that for this paper the best available function, *E. regnans* volume function (Hayward,1987) was used. The plot data will be reprocessed as soon as possible and if necessary a revised report produced. The *E. regnans* volume function and the new *E. nitens* volume function (Gordon et al,1990) include data from trees grown over a narrower stocking range than that represented by the nelder. The greatest inaccuracy in volume could be expected at the high stockings and for very small trees with either function.

2 Eucalyptus nitens nelder data

2.1 Trial Design

A nelder design experiment was established in 1979 as part of a series of comprehensive eucalypt experiments being planted at that time. The seed was collected at Taggerty in Victoria, Australia. However because of the health problems with *E. nitens* the associated series of plots to investigate various regime options were not included.

Each tree in each arc in the concentric circles of the nelder has a growing space determined by its 8 neighbouring trees. For the purpose of analysing the growth in a meaningful way was the area available to the tree is converted into an equivalent stocking. The equivalent square spacings range from 0.5 to 10.5 m. The stocking shown in Appendix 1 are at age 3 by which time some mortality had occurred in the closest spacings.

2.2 Nelder Measurement

Until recently it was considered unlikely that the species would be planted extensively so the nelder was not measured as intensively as the other eucalypt species nelders were. Alternate arcs (uneven numbered) were measured each year. It was intended that growth of unmeasured arcs would be estimated by extrapolation.

The data was processed with the FRI permanent sample plot system with each arc identified as a 'plot' and given a plot area based on the space occupied by each tree.

Initially all heights and diameters in these arcs were measured. The inner arcs were dropped from the measurement at age 8 and 9 because it was considered all useful data had been collected. Heightened interest in the species led to a demand for more information so that from age 10 all arcs from number 9 out were measured, with only a sample of heights in each arc measured to reduce the work load. At age 11 all arcs were measured. However the heights for arcs 1 to 8 were selected across all eight arcs to provide data for the regression equation that relates volume to tree diameter which is used in the PSP system. This was because of extreme difficulties in seeing the tops of trees.

2.3 Interpolation of data and smoothing of curves

An exercise in interpolation of the data to fill in missing values was undertaken. Although trends were strongly related to the stocking some arcs showed some discrepancies which were smoothed out in with further analysis of the data.

2.3.1 Methods

It was decided not to proceed with a full scale statistical analysis of the data using functions fitted across both stocking and age. This would have masked out yearly perturbations in growth rate which might be of interest. However, some analysis was carried out to assist interpretation of the data. Firstly, although some arcs were measured every year, others (particularly the higher stockings) were measured less frequently. Interpolated values were obtained for these missing measurements. To ensure that interpolated values followed the same trends as measured values, the data was transformed by dividing by the average of those arcs measured every year, before applying linear

interpolation. Secondly, although it was considered undesirable to smooth across ages, there seemed little reason not to smooth out obvious irregularities across stockings. Smoothed curves were therefore fitted through all stockings for each year's measurements (using spline functions). Note that this smoothing was only carried out across stockings, not across ages.

The above procedures were applied to volume (m^3/ha), basal area (m^2/ha) and mean top height (m). However, the interpolation procedure did not work satisfactorily for survival percentage which was therefore smoothed across both age and stocking (using a logistic regression). The second highest stocked arc, which suffered extremely high mortality early in the trial, had measurements completely at variance with all other arcs, and was therefore omitted from the analysis.

2.3.2 Results

Measured values, together with interpolations for missing measurements, are shown in figures 1 to 4 where stocking at age 3 has been labelled for some arcs. The interpolation method appears to have worked well except possibly for some of the very highly stocked arcs which were not measured between ages 3 and 11 years. Values smoothed across stocking are shown in figures 5 to 8 and in Appendix 1.

2.4 Diameter distribution

The average piece size can be calculated from the data as presented however the actual diameter range shows the number of small trees that occur. As the seed available was unimproved the presence of slow growing material is not surprising. Moreover the nelder is unthinned which is an integral feature of the trial design. As a consequence material that would be removed in thinning remains. In Figures 9 to 12 the diameter distributions at age 11 of arcs 9 (4444s/ha), 14 (1111 s/ha), 16 (635 s/ha) and 22 (120 s/ha) are shown. Actual trees in each arc are shown (45 trees in each before mortality occurred) which indicates the proportion of trees at each stocking in each diameter range.

3 Sample Plot data

The sample plot data is shown as volume per hectare, basal area, MTH and stocking against age in Figures 13, 14, 15 and 16 respectively. The plots are identified as most of them are in FRI trials. Timberlands have consented to the inclusion of their data.

3.1 Provenance Trials

At the same time as the *E. nitens* nelder was planted, FRI groups at Rotorua and Christchurch were establishing a series of provenance trials in both islands. These were located at Kaingaroa, Rotoaira, Golden Downs, Fletchers Creek near Reefton, and Longwood Forest. The assessment of the provenances was completed and the areas have been heavily thinned either by Forest Management and Production (South Island FRI) to turn the stands into sawlog producing stands or by Proseed (N.Z. Forestry Corporation) for seed collection in the case of Rotoaira. The stand at Kaingaroa, which is adjacent to the nelder has been thinned to approximately 500 s/ha at age 5. In all cases Victorian provenances have been retained in the thinning because of their superior growth rates.

All areas have had growth plots established under the Cooperative programme except for Kaingaroa. Background details for the plots are as follows

3.1.1 Rotoaira

The plots are identified as ROAIRA1-3. A fourth plot has been established but the data is not available yet. For Rotoaira all past measurements taken as part of the provenance assessment have been included. Therefore there are basal area assessments for age 3.5, age 8, and age 12. The trial was thinned at age 8 to 350 s/ha, and at age 11 to 100 s/ha. At the time of this second thinning the Cooperative obtained sectional measurements for the volume function. Because the growth plots are only now in place there are gaps in the data and as shown in Figure 16 it appears that the stand has been thinned to 100 s/ha at age 8 which is not correct. The corresponding point in Figures 13 and 14 is similarly misleading. The main point to note is that basal area was almost 20 m^2/ha at age 8 with a little over 900 s/ha.

3.1.2 Longwood

The six plots are identified as LGWODS1-6. The 's' in the code is there merely because one author has for several years put s at the end of the forest name. The Longwood provenance trial was planted in 1977. It was thinned in 1985 (age 8) to 100 s/ha. The plots have now received 3 annual measurements from age 10 to 12. The stocking ranges between 100 and 200 s/ha.

3.1.3 Westland

These plots are identified as WESTLD1-4. The trial at Fletchers Creek was thinned in 1981 (age 5). Plots, which were established at that time (dbh only) have been remeasured at age 12 and 13 for the Cooperative and provide data for the oldest E. nitens trees in its database.

3.1.4 Golden Downs

The plots are identified as GLDWNS1-4. The Golden Downs provenance trial was thinned in 1985 (age 7) to 250 s/ha. The growth plots have been measured at age 10 and 11. Plot stocking is between 100 and 250 s/ha. They form the group of plots with the highest MTH over that age interval on Figure 15.

3.2 Longwood Forest Experiment

In 1983 the Forest Service staff in Southland established 6 plots in a one hectare stand of *E. nitens* (New South Wales provenance) planted in 1978 at Happy Valley, Longwood Forest. The object was to test the effects of three different early thinning regimes with the thinning timed for when the plots had reached either 5 or 10 PMH (predominant mean height). The plots are 0.04 hectare and each treatment has been replicated. The schedule of thinning is summarised as follows

	STOCKING (S/HA)					
Treatment	Age 5 (MTH=6.1)	After Thinning	Age 6 (MTH=7.6)	After Thinning	Age 7 (MTH=10.1)	After Thinning
1	1160	1000	1000		1000	500
2	1160		1160	1000	1000	500
3	1320		1320		1320	500

The plots have been identified as HAPVAY1-6. In Figure 16 (stocking) these plots are the group of plots that commence at age 5 with stocking between 1000 and 1400 s/ha, some thinned at age 6 to 1000 s/ha and all dropped to 500 s/ha at age 7. The plots can be located on Figure 14 (basal area) with relatively high basal area at age 10, when they were last measured and in Figure 15 (MTH) as the series of lines from age 5 to 10 falling in the low to mid range of the limited data over that age range.

3.3 Happy Valley

This plot (HAPVLYA) has been established for the cooperative in the area adjacent to the thinning trial. It is also NSW provenance.

3.4 Oreti Plantings

Plots have been established in a stand of E.nitens originally intended as nurse species for an *Acacia melanoxylon* trial and in a shelter belt planted with trees raised from seed collected at Glentunnel. They are identified as ORETI(1-3) and ORETIS(1-2) respectively. The measurement at time of establishment is included as well as the winter measurement for the plots in the stand.

4 Discussion

The nelder trial is compared to the plots in terms of height and basal area growth in order to determine how the nelder compares with the growth of *E. nitens* elsewhere.

4.1 Height

The height growth of the nelder arcs as represented by the Mean Top Height is about 26m at age 11 except for the most outer arcs. The MTH for the 93 s/ha is 21.3m, for 120 s/ha 23.6 and 155 s/ha 25.0 m. Many of the sample plots have been thinned to stockings near 100 s/ha but initially they were at higher stockings so it appears that the site that the nelder occupies is a good site for *E. nitens* on the basis of the limited data available. Note that the height growth in the nelder tapered off at age 8 when there were dead tops noted frequently on the field sheets which was assumed to be the result of Paropsis attack. Height growth appears to be improving in the last years measurement. The improvement is assumed to be as a result of the pest being controlled by *Enoggera*.

4.2 Basal Area

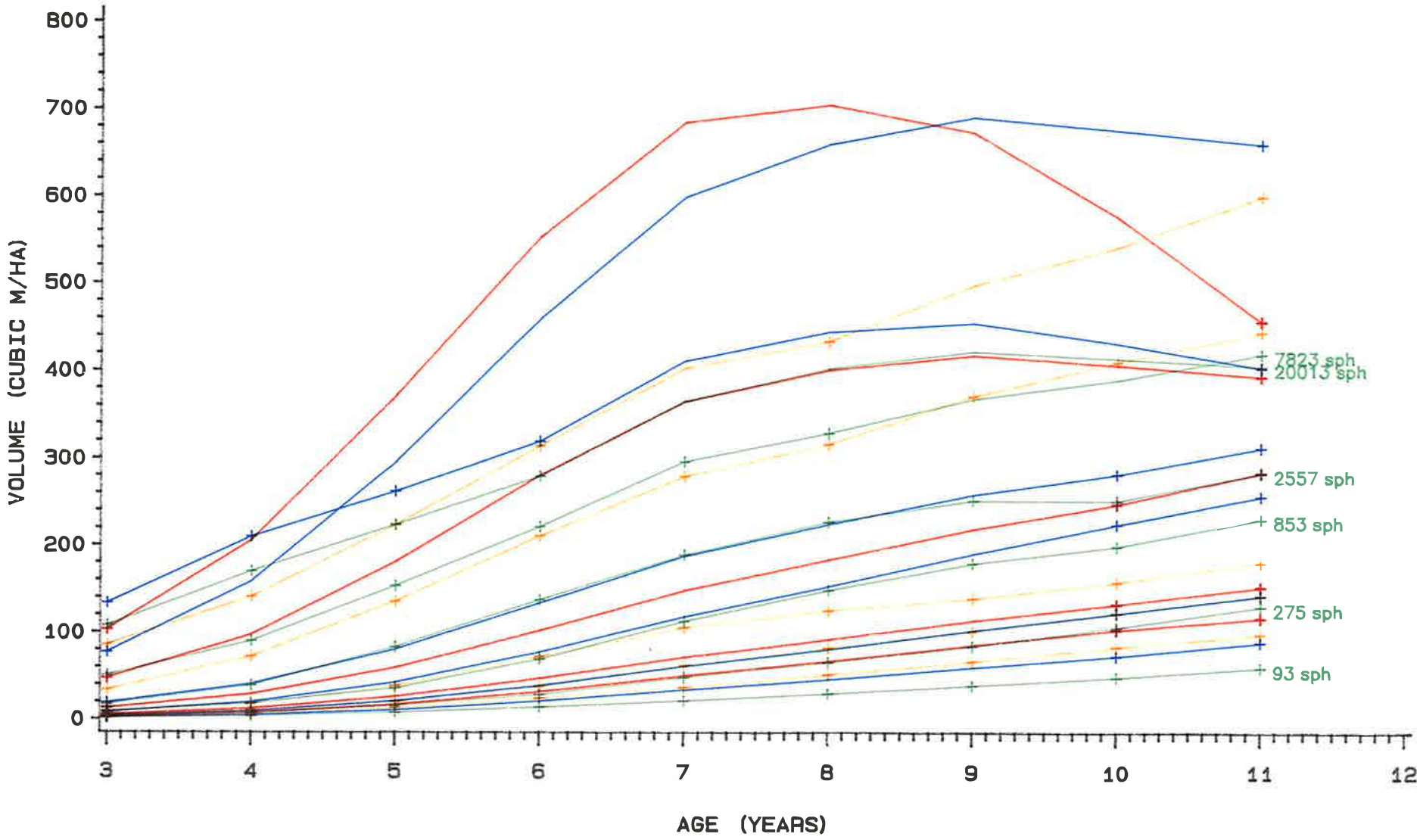
The basal area of the Rotoaira plots at 766-900 s/ha both at age 8 ranges from 17.5-20.5 m^2/ha compared with 16-17 m for a similar range of stocking in the nelder. All other sample data is from thinned plots.
It is possible to compare several thinned sample plots at age 11 with the nelder at the same stockings. At age 11 the basal area for 120, 155, 204 275 s/ha in the nelder is 9.1, 10.9 12.7 14.5 m^2/ha respectively. At the same age at Longwood the two plots with 100s/ha average 6.7m^2/ha, the 150 s/ha plots average 10.6m^2/ha and the 200 s/ha plots average 11.8 m^2/ha. At Golden Downs (one plot each) the corresponding figures are 100 s/ha:8.4 m^2/ha, 150 s/ha:13.0 m^2/ha, 200 s/ha:16.1 m^2/ha, 250 s/ha:17.3 m^2/ha. All four plots at Fletchers Creek are 100 s/ha averaging 8.4 m^2/ha.

The trees in the nelder have had more growing space from time of establishment and will have deeper crowns than the trees in plots thinned to the same stocking. Thus a bigger basal area in the nelder could be expected compared to any thinned sample plots with the same stocking. However because the sample plots have been thinned genetically superior trees will have been selected with better growth rates. This will tend to raise the basal area compared with the unthinned nelder arcs. Consequently the data will only indicate if the nelder is very unusual in its growth. The data does suggest that the trees on the Golden Downs and Rotoaira sites are growing better but that the nelder data is not aberrant.

5 List of Figures

Fig 1: NITENS NELDER TRIAL

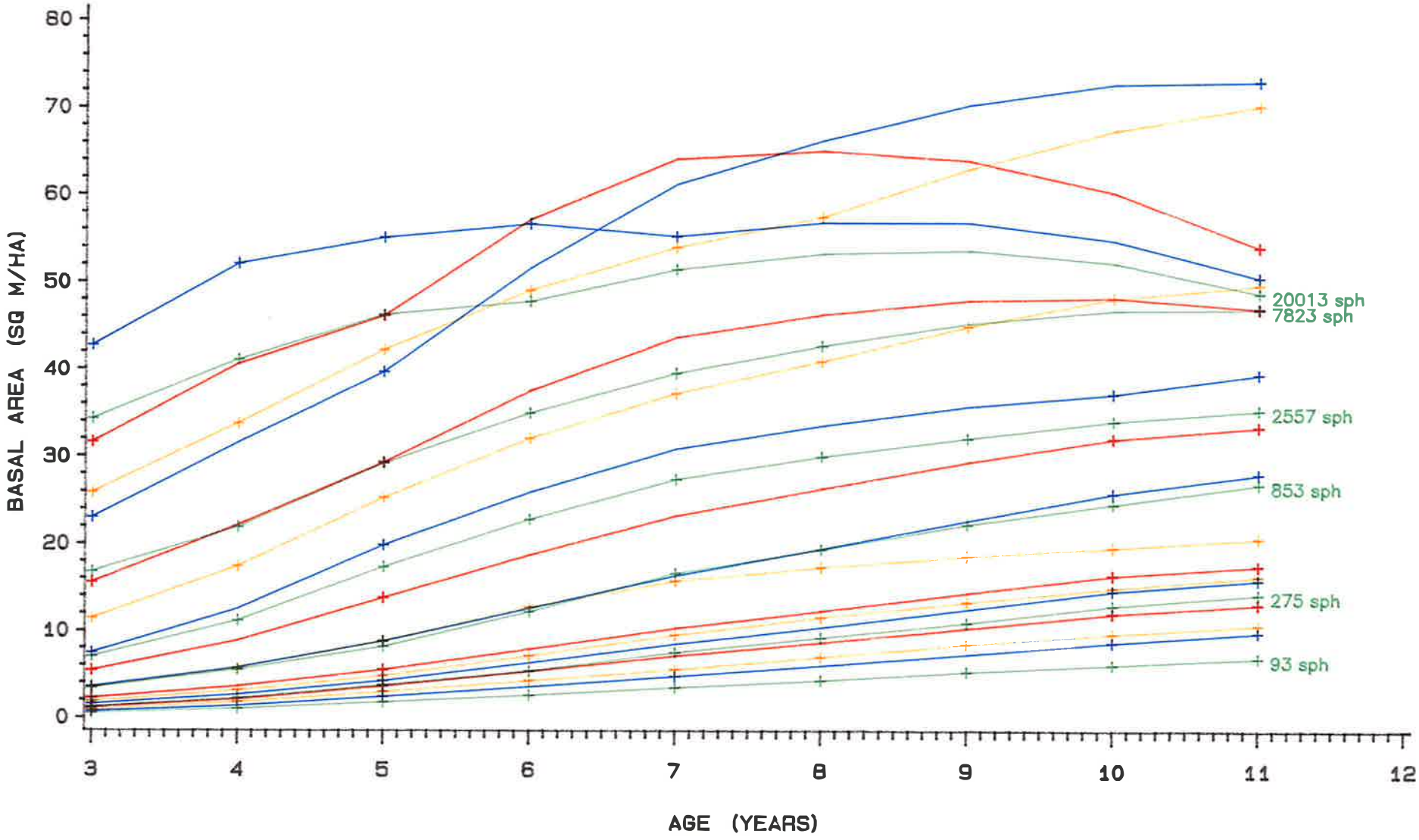
VOLUME



ACTUAL MEASUREMENTS (+) AND INTERPOLATED LINES

Fig 2: NITENS NELDER TRIAL

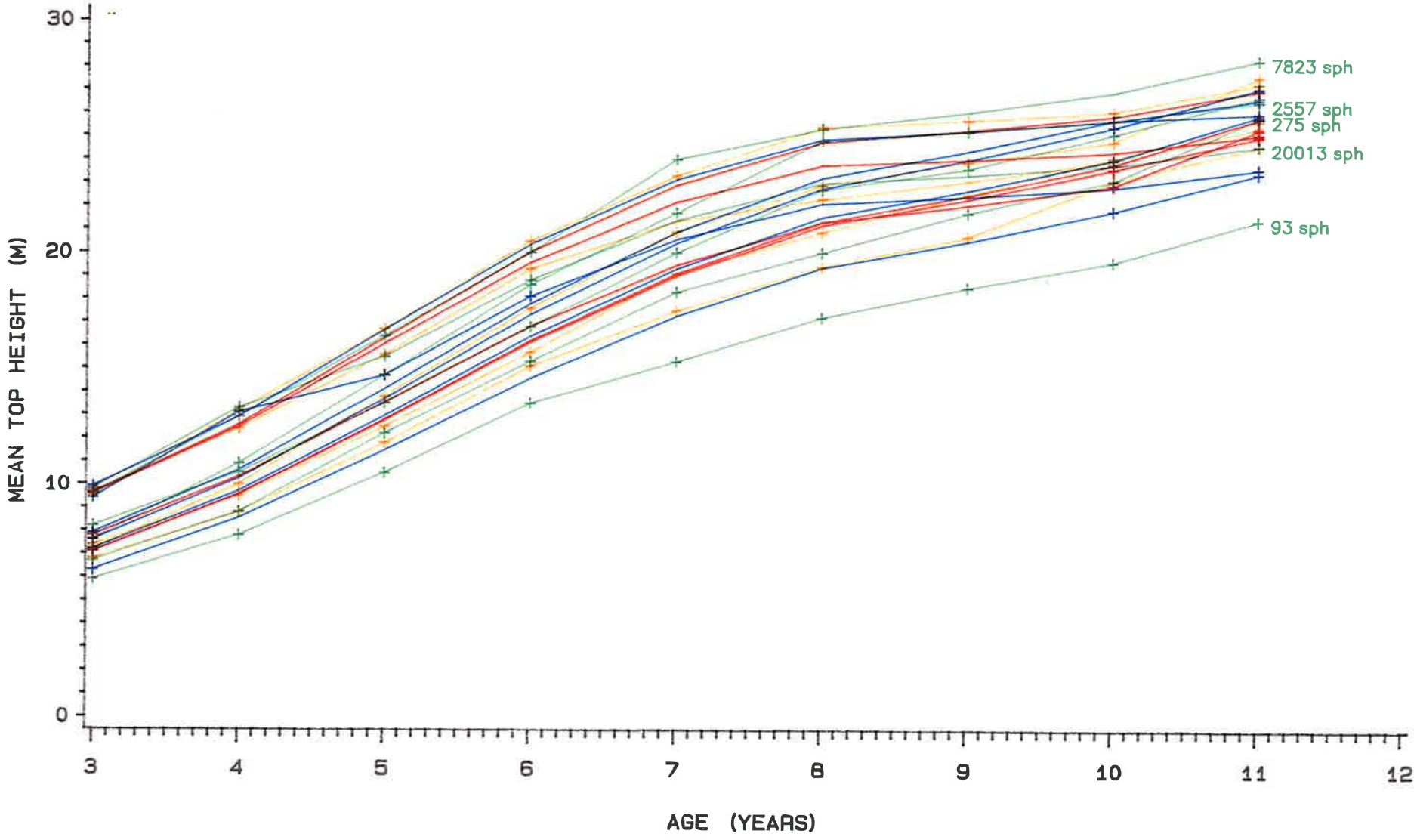
BASAL AREA



ACTUAL MEASUREMENTS (+) AND INTERPOLATED LINES

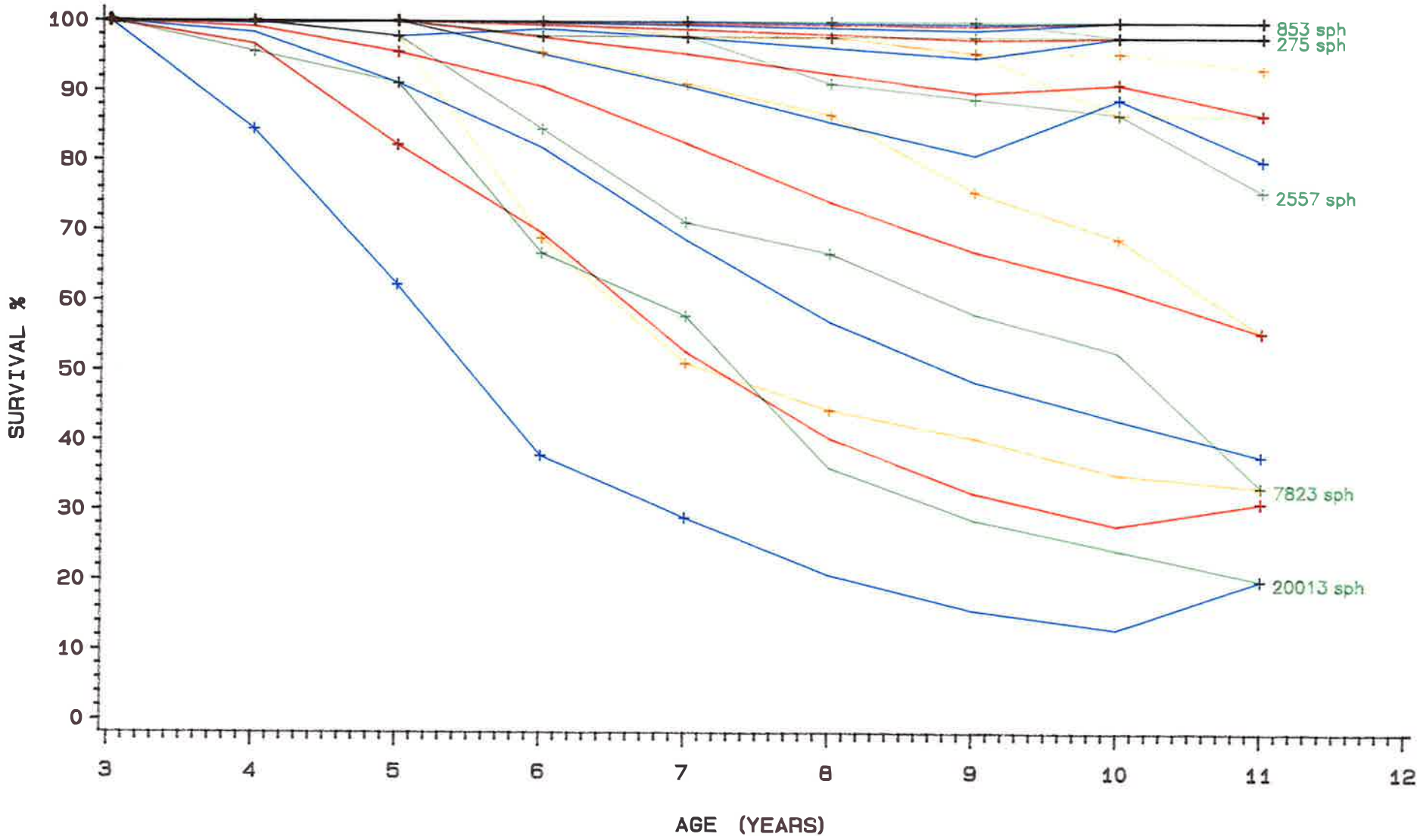
Fig 3: NITENS NELDER TRIAL

MEAN TOP HEIGHT



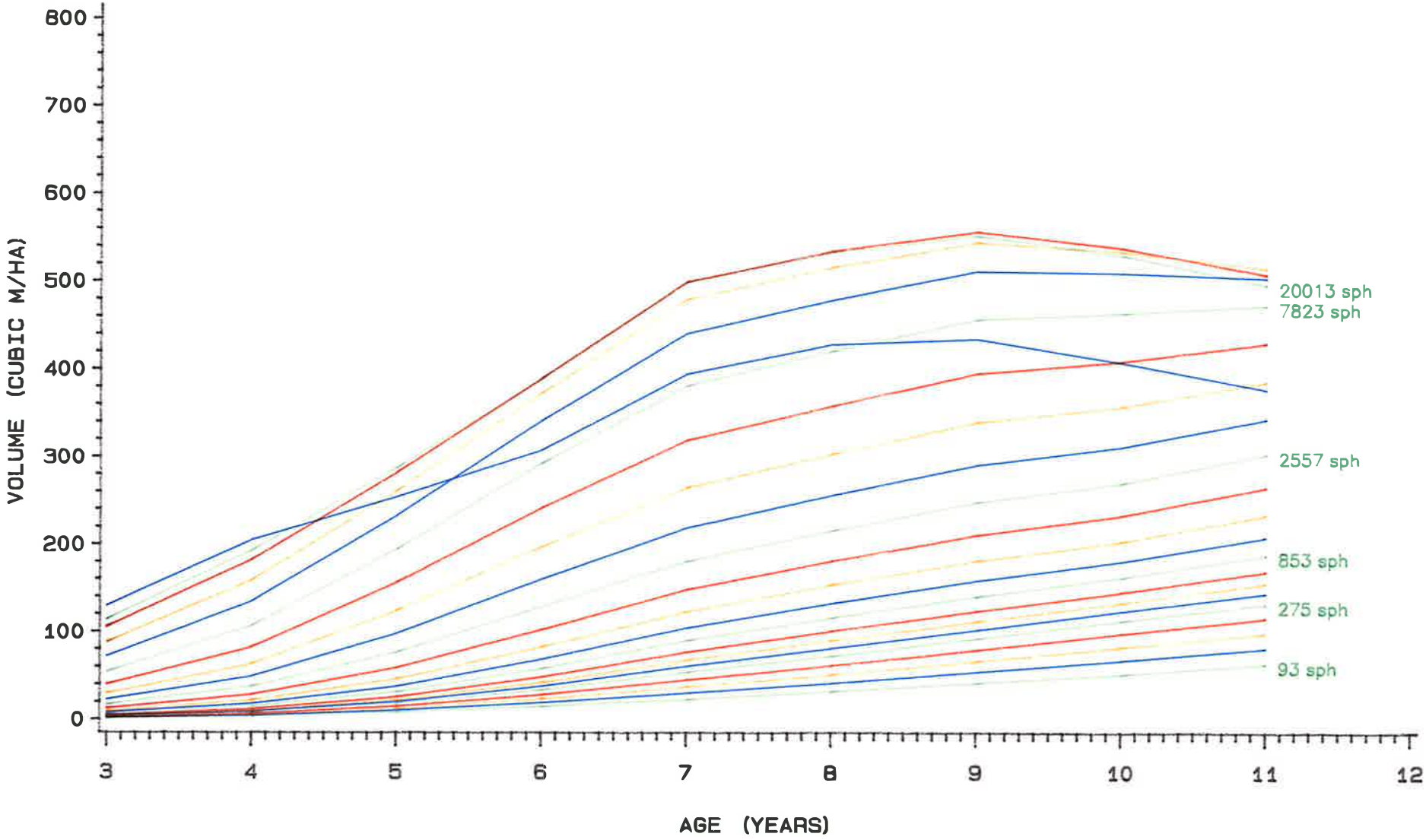
ACTUAL MEASUREMENTS (+) AND INTERPOLATED LINES

Fig 4: NITENS NELDER TRIAL



ACTUAL MEASUREMENTS (+) AND INTERPOLATED LINES

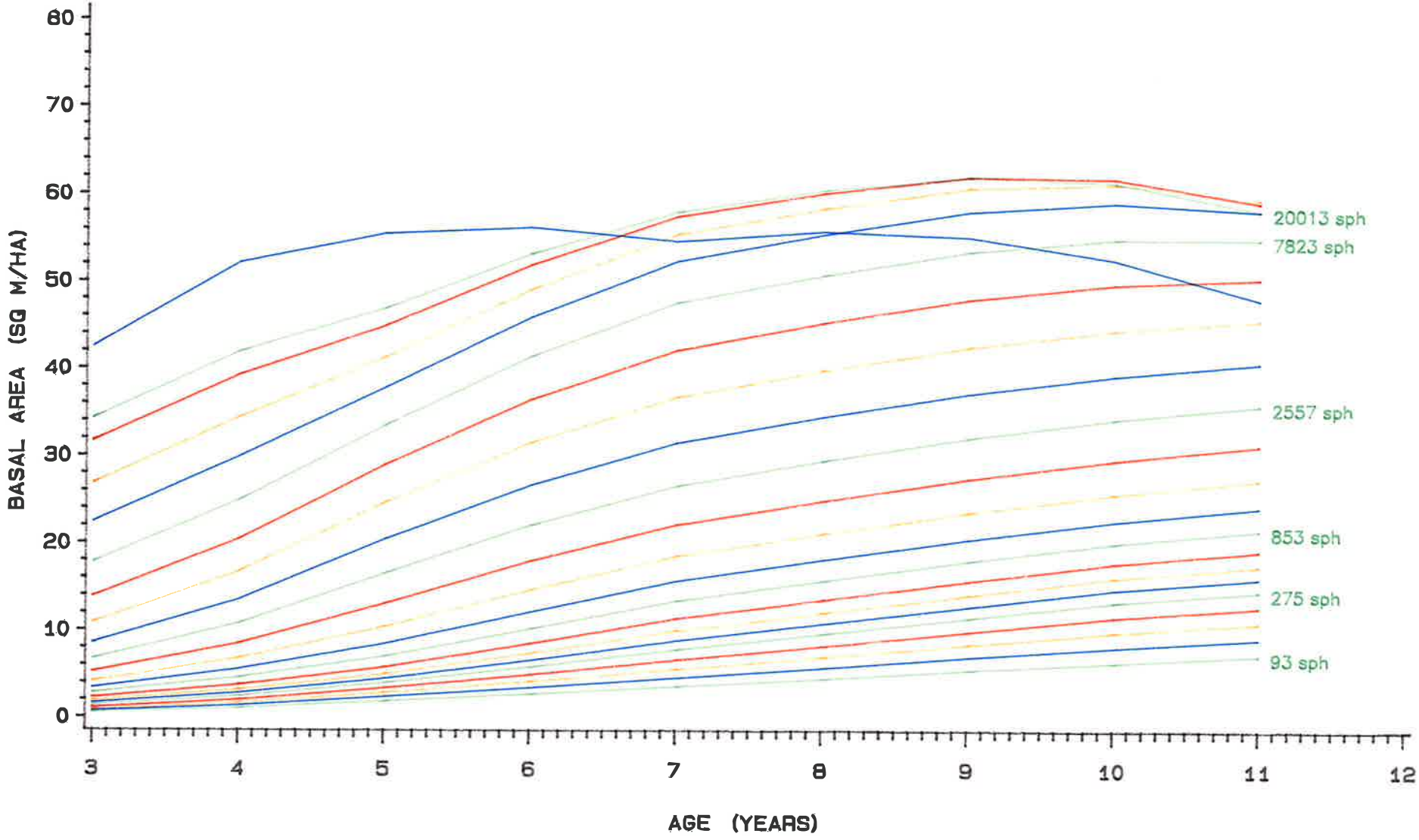
Fig 5: NITENS NELDER TRIAL



SMOOTHED VALUES

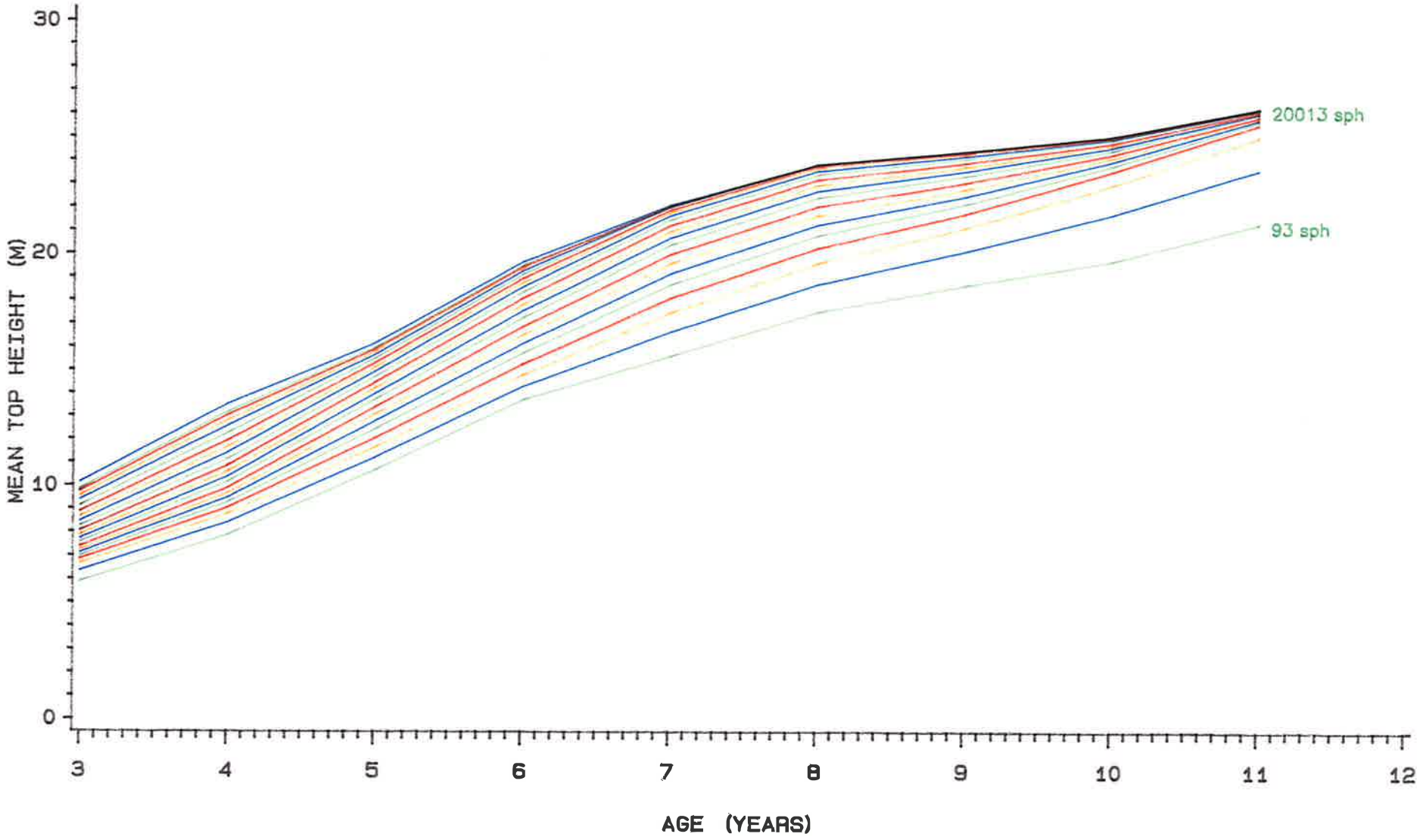
Fig 6: NITENS NELDER TRIAL

BASAL AREA



SMOOTHED VALUES

Fig 7: NITENS NELDER TRIAL



SMOOTHED VALUES

Fig 8: NITENS NELDER TRIAL

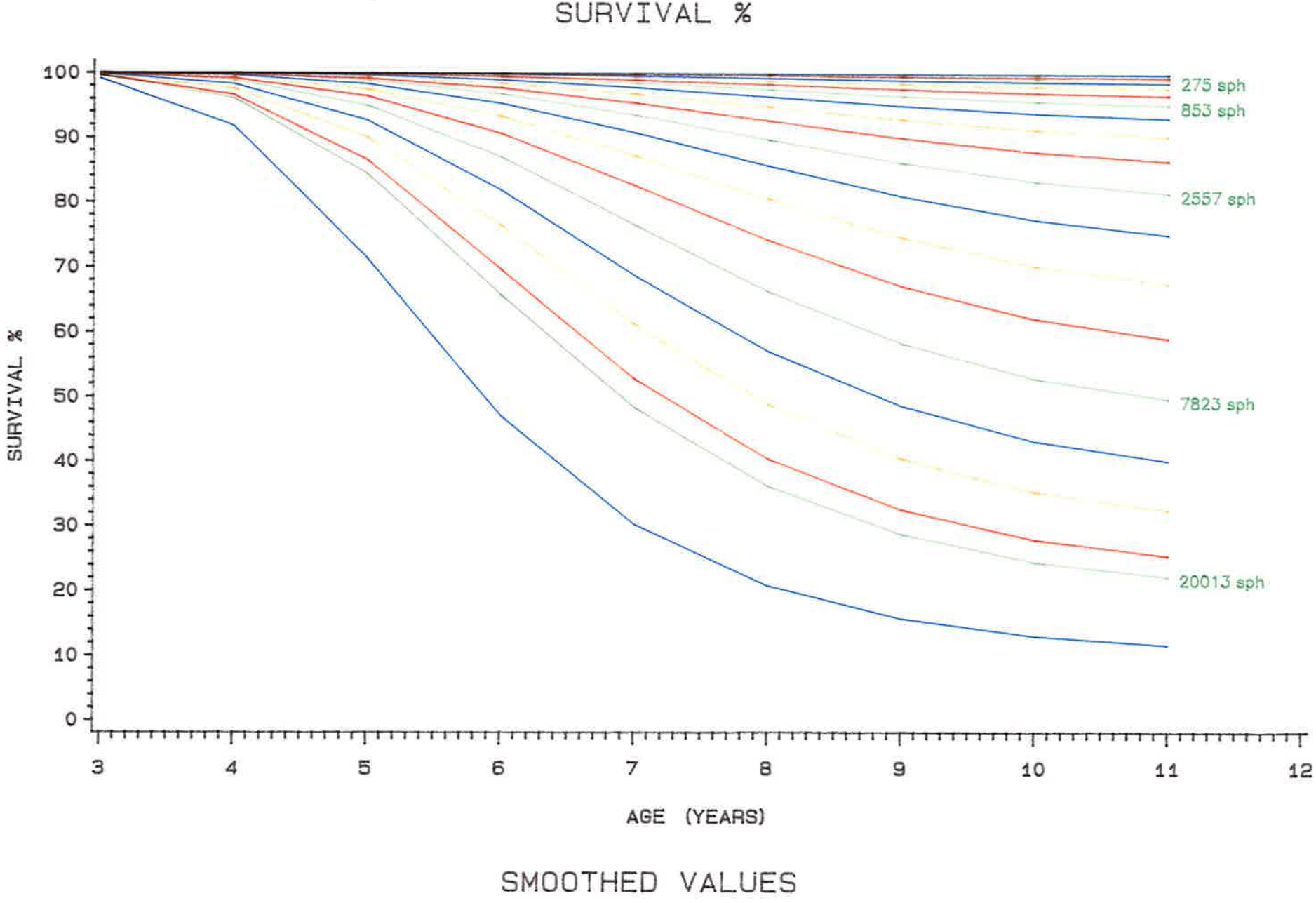


Fig 9: NITENS NELDER

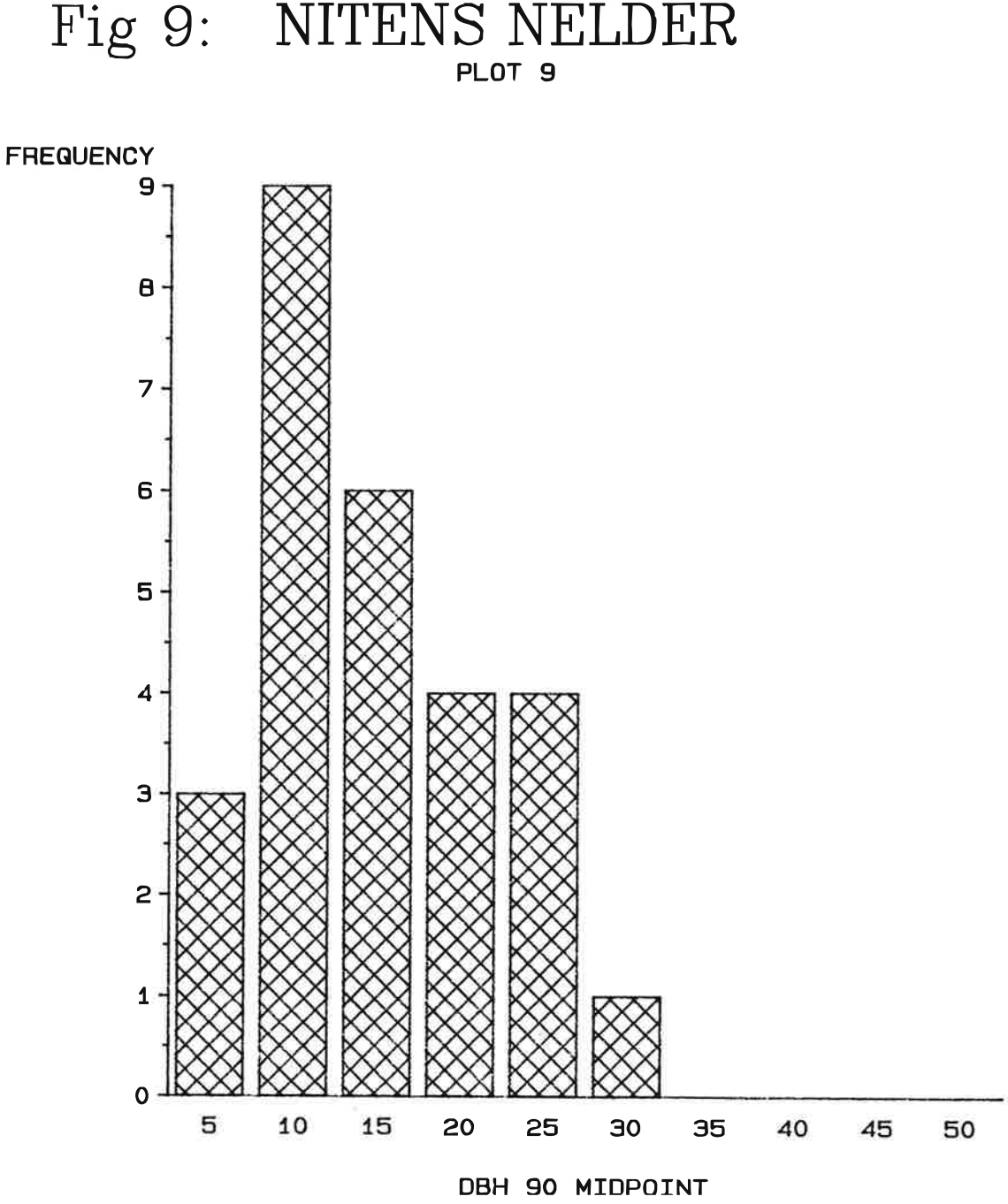


Fig 10: NITENS NELDER

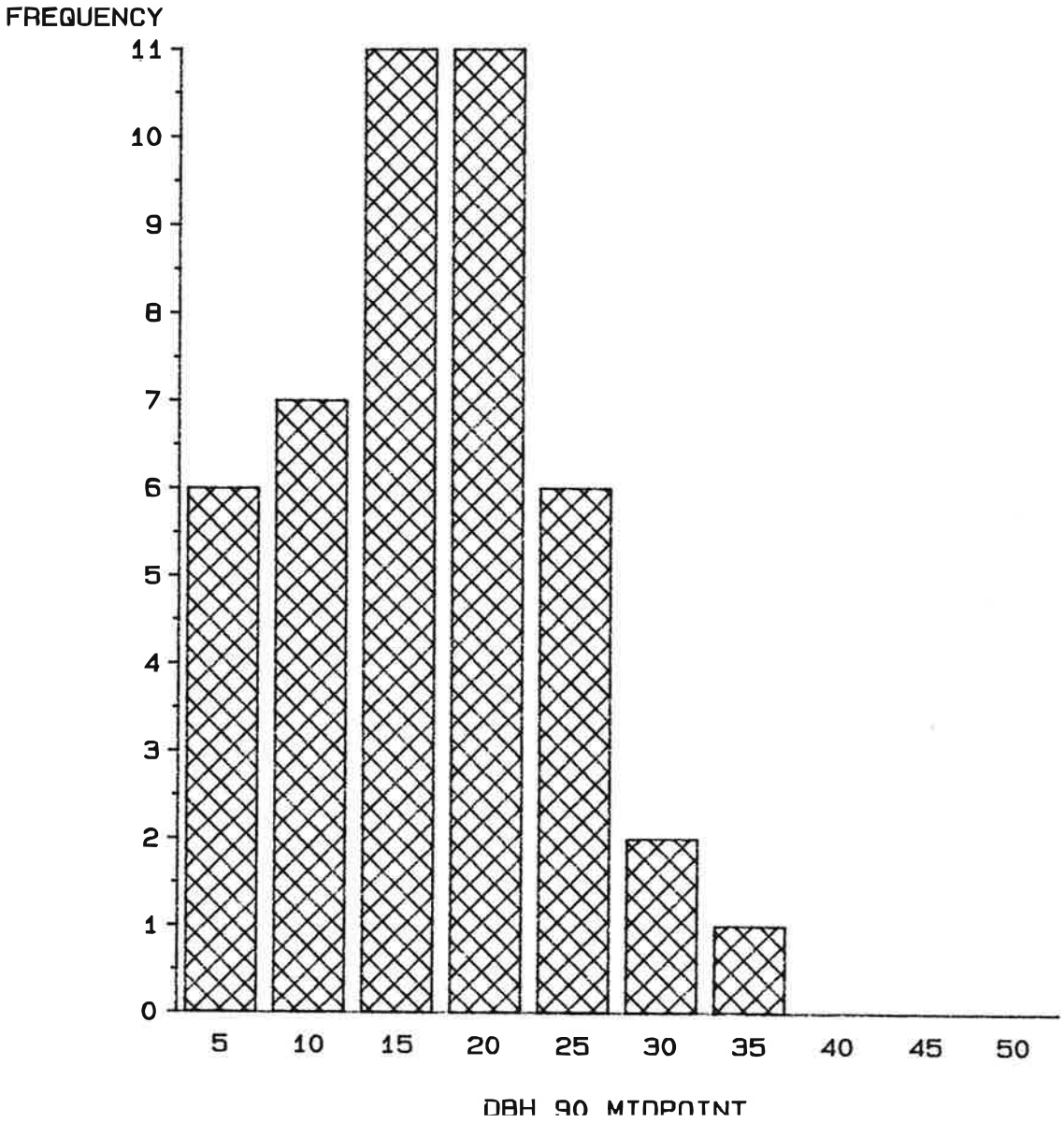


Fig 11: NITENS NELDER

PLOT 16

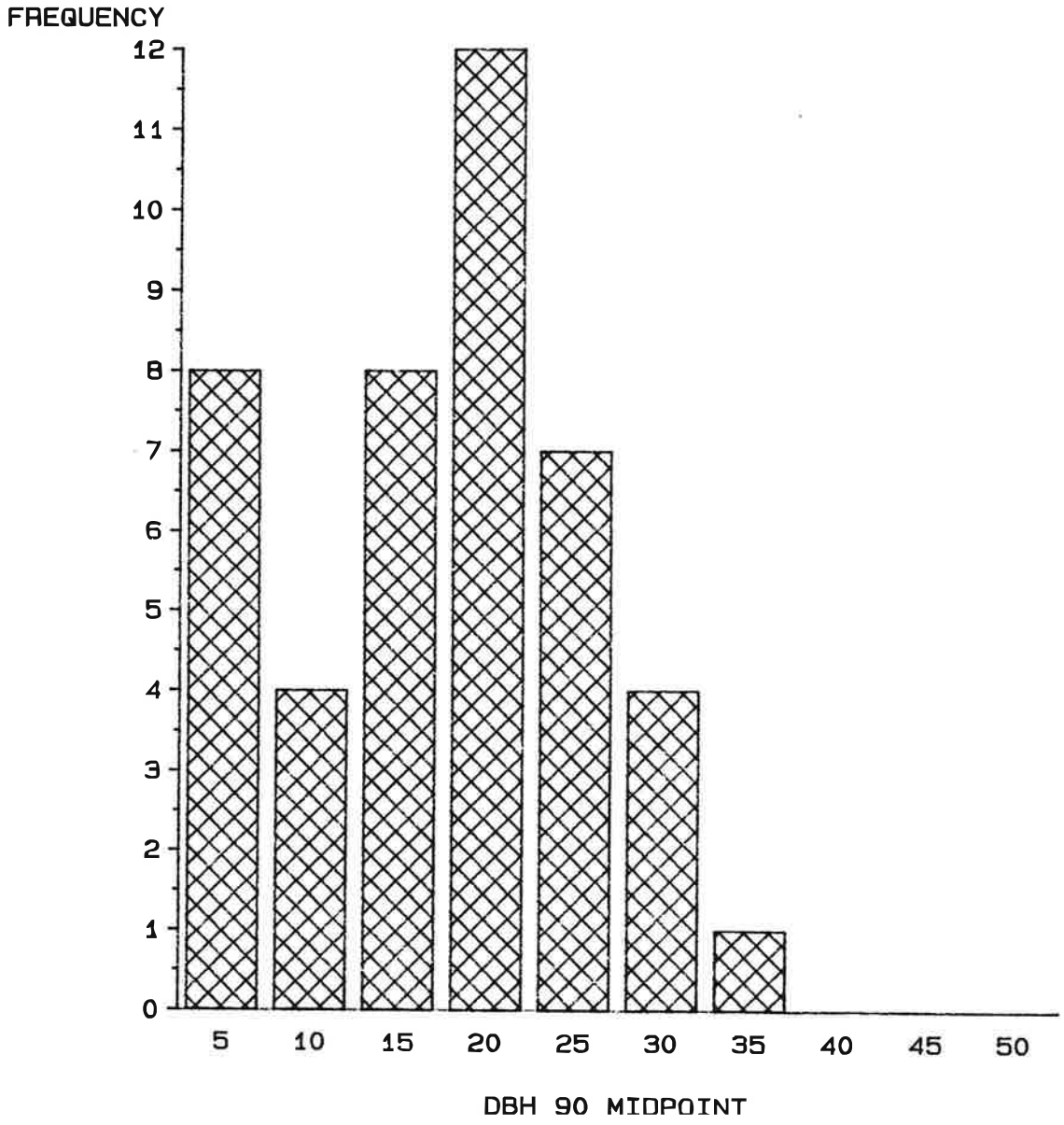


Fig 12: NITENS NELDER

PLOT 22

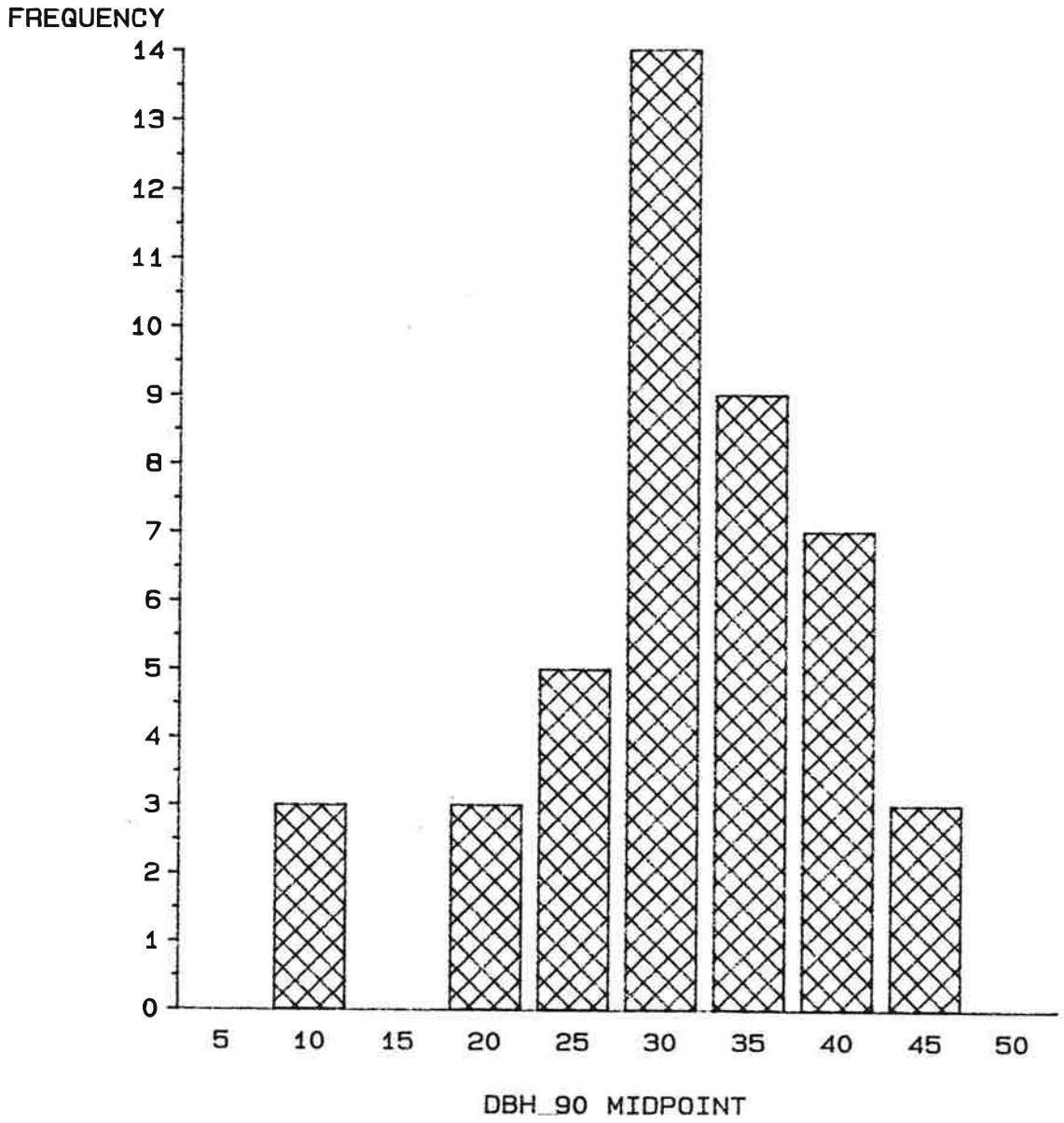


Fig 13: NITENS SAMPLE PLOTS

VOLUME (HAYWARD REGNANS FUNCTION)

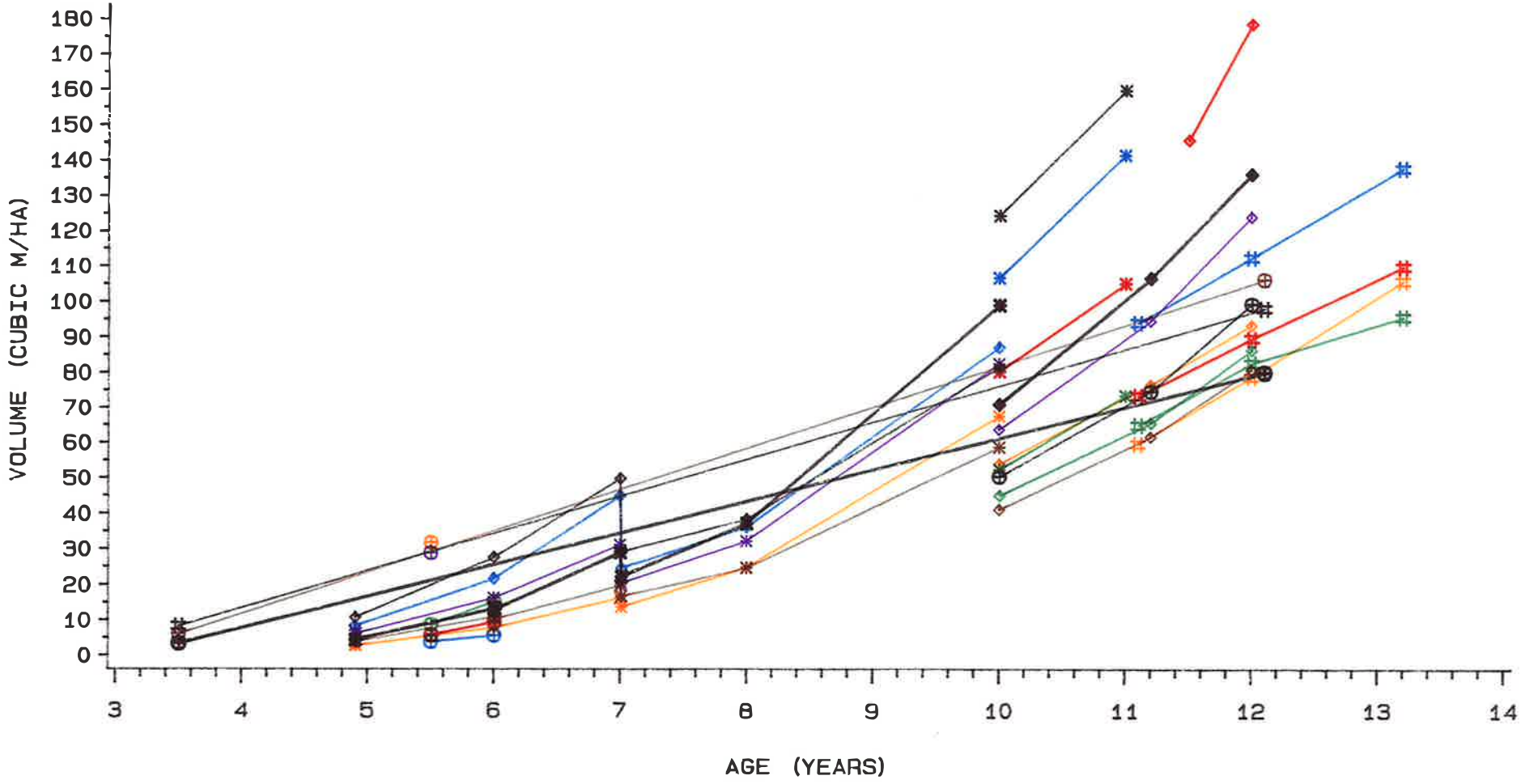


Fig 14: NITENS SAMPLE PLOTS

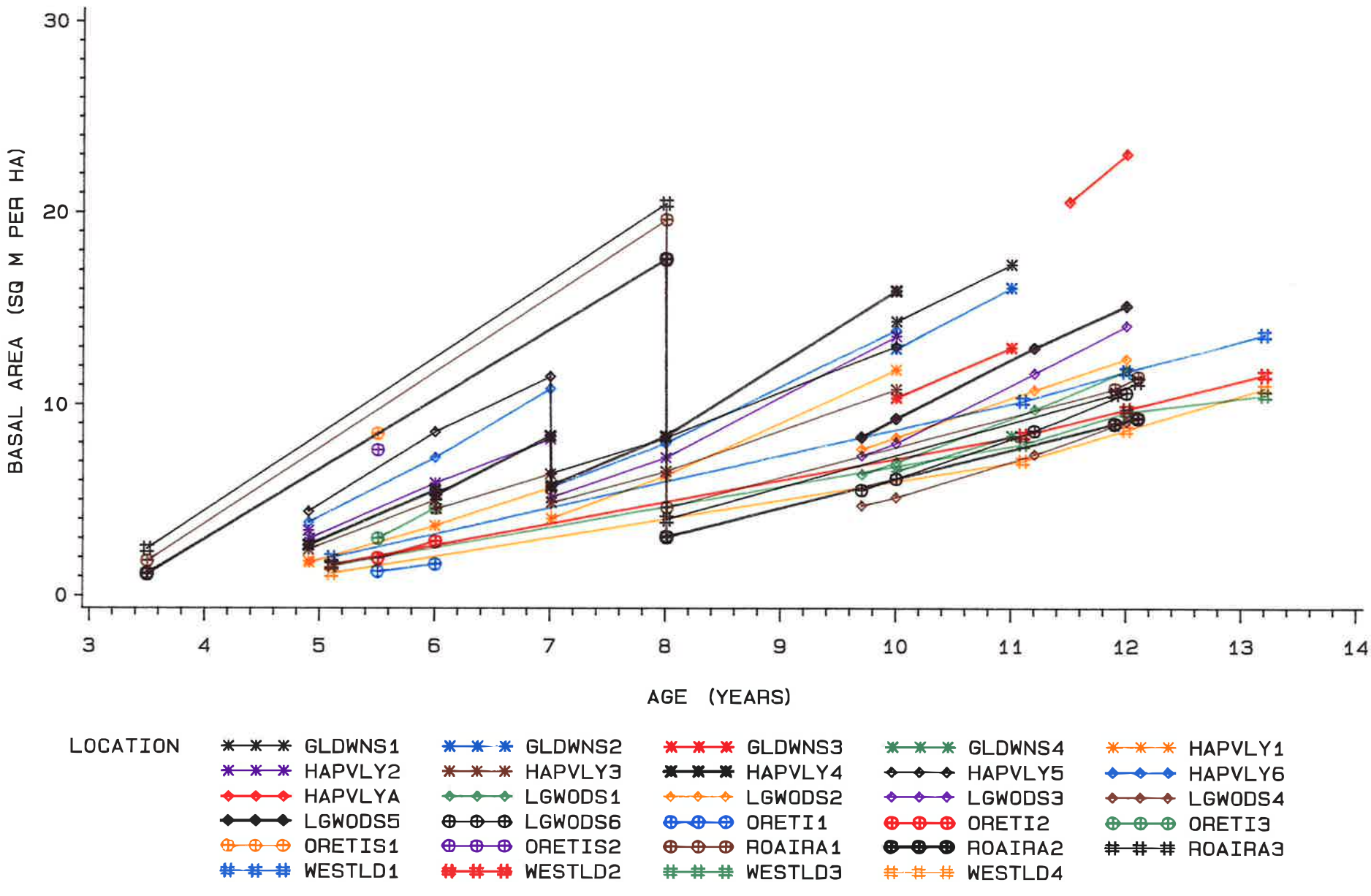


Fig 15: NITENS SAMPLE PLOTS

MEAN TOP HEIGHT

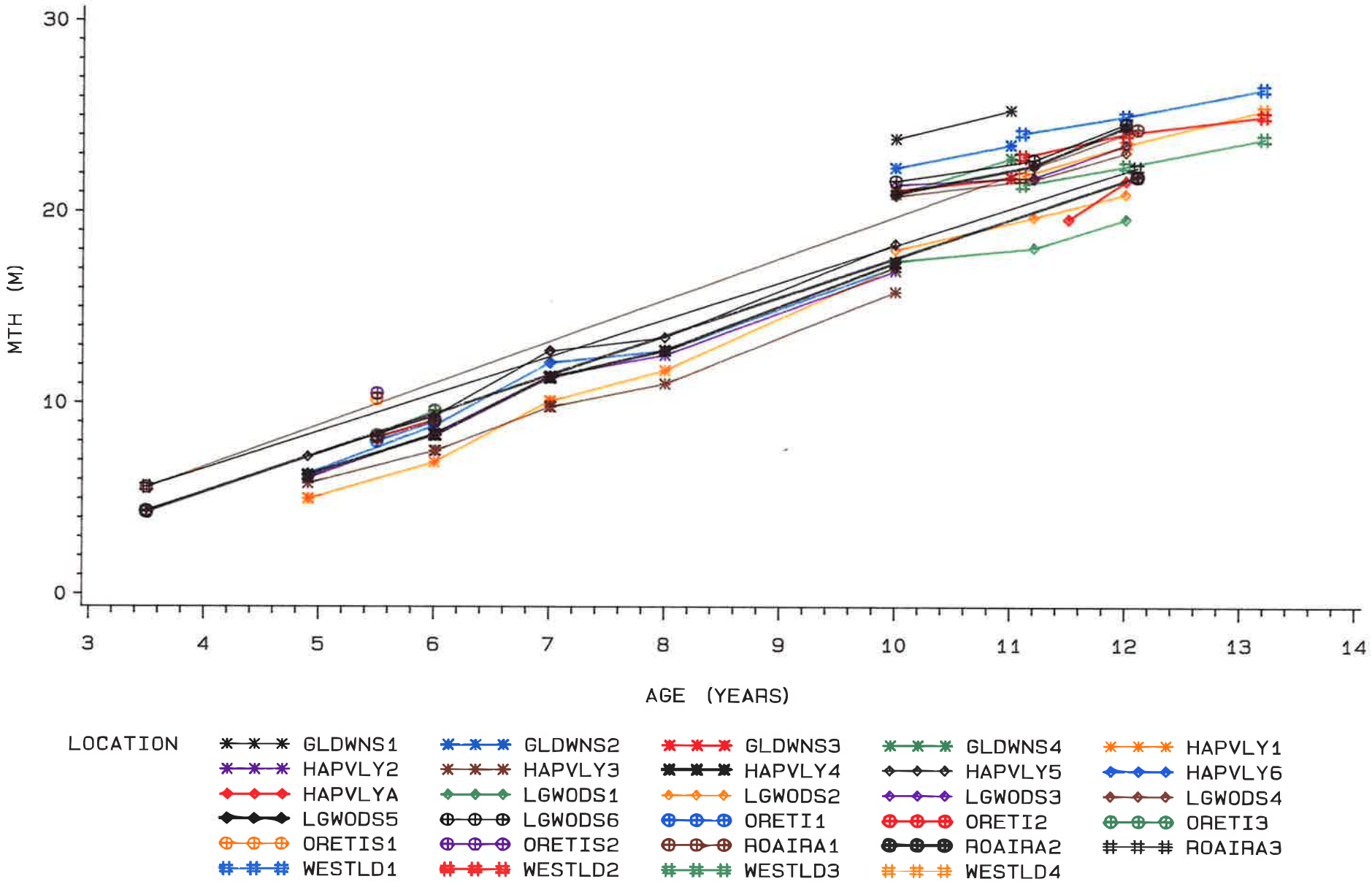
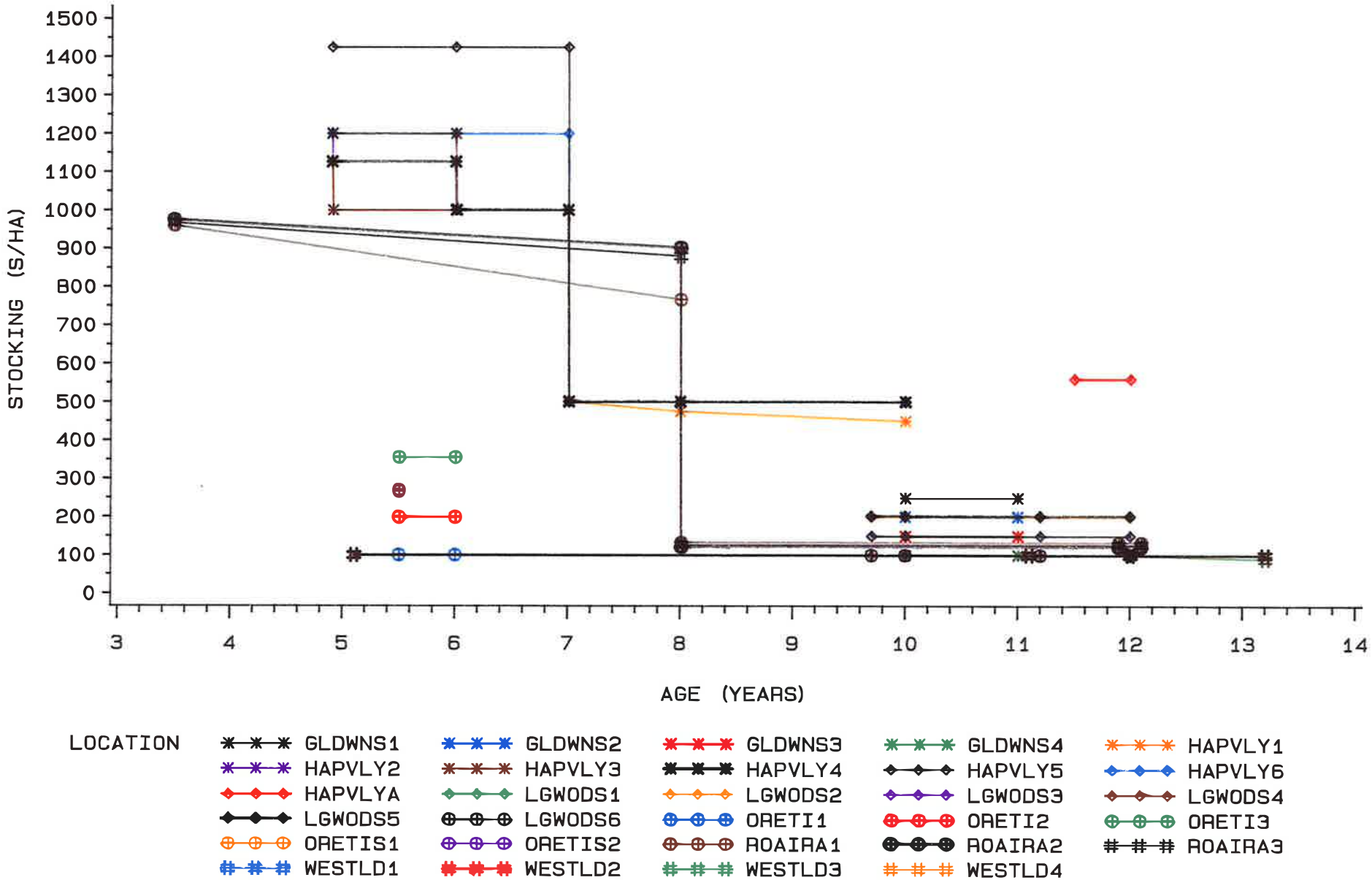


Fig 16: NITENS SAMPLE PLOTS

STOCKING



6 References

Hayward W.,1987 Volume and Taper of *Eucalyptus regnans* grown in the central North Island of New Zealand. *New Zealand Journal of Forestry Science* 17(1):109-20.

Gordon A., Hay E., and Milne P. 1990 A Volume and Taper Equation for New Zealand Grown *Eucalyptus nitens*. *Management of Eucalypts Cooperative Report No. 9.*

Appendix 1: Smoothed Data for Nitens Nelder

Basal area

stocking (age 3)	Arc number	Age								
		3	4	5	6	7	8	9	10	11
93	23	0.5	1.0	1.8	2.7	3.6	4.5	5.5	6.3	7.2
120	22	0.7	1.3	2.4	3.4	4.6	5.7	7.0	8.1	9.1
155	21	0.9	1.7	2.9	4.2	5.6	7.0	8.4	9.8	10.9
204	20	1.1	2.0	3.4	4.9	6.6	8.3	9.9	11.6	12.7
275	19	1.3	2.4	3.9	5.7	7.8	9.6	11.4	13.2	14.5
364	18	1.6	2.8	4.4	6.5	8.8	10.8	12.7	14.7	16.0
481	17	1.9	3.2	5.0	7.4	10.0	12.0	14.1	16.1	17.5
635	16	2.3	3.7	5.8	8.5	11.4	13.6	15.7	17.7	19.2
853	15	2.8	4.5	6.9	10.1	13.4	15.7	17.9	20.0	21.5
1111	14	3.4	5.5	8.4	12.1	15.6	18.1	20.4	22.5	24.1
1456	13	4.2	6.8	10.4	14.6	18.5	21.1	23.6	25.7	27.4
1923	12	5.2	8.5	13.0	17.9	22.1	24.9	27.4	29.6	31.2
2557	11	6.7	10.7	16.4	22.0	26.5	29.4	32.0	34.2	35.8
3383	10	8.5	13.5	20.4	26.6	31.5	34.5	37.1	39.2	40.6
4455	9	10.9	16.7	24.6	31.5	36.7	39.8	42.5	44.4	45.6
5861	8	13.9	20.4	28.9	36.4	42.1	45.3	48.0	49.7	50.4
7823	7	17.7	24.9	33.4	41.3	47.5	50.7	53.4	54.9	54.8
10480	6	22.4	29.8	37.7	45.8	52.3	55.4	58.0	59.0	58.1
13447	5	26.9	34.4	41.3	49.1	55.5	58.4	60.8	61.2	59.4
17414	4	31.7	39.2	44.9	51.9	57.5	60.1	62.0	61.8	59.1
20013	3	34.3	41.9	46.8	53.1	57.9	60.4	61.9	61.3	58.0
35718	1	42.5	52.1	55.5	56.2	54.6	55.8	55.1	52.5	47.9

Volume

stocking (age 3)	Arc number	Age								
		3	4	5	6	7	8	9	10	11
93	23	1	3	8	15	23	32	42	51	63
120	22	2	5	11	19	30	42	54	67	81
155	21	2	6	13	24	38	52	67	83	99
204	20	3	7	16	29	46	62	80	98	116
275	19	3	8	18	33	54	72	92	112	131
364	18	4	9	20	38	61	81	102	123	144
481	17	5	11	23	43	68	90	112	133	155
635	16	5	12	26	49	77	101	124	145	169
853	15	6	15	31	58	90	116	140	161	187
1111	14	8	18	38	69	104	132	158	180	208
1456	13	10	22	47	83	123	154	181	204	234
1923	12	13	29	59	102	148	181	211	233	265
2557	11	17	37	76	128	180	215	248	269	302
3383	10	23	49	98	160	219	256	290	311	343
4455	9	30	64	124	197	265	304	340	358	386
5861	8	40	82	156	242	319	358	395	409	429
7823	7	54	106	194	292	381	420	456	463	472
10480	6	72	134	232	341	440	478	511	509	503
13447	5	88	159	261	373	480	516	544	534	515
17414	4	106	182	282	389	499	534	557	538	508
20013	3	114	192	287	389	498	532	551	529	495
35718	1	129	205	254	307	394	428	434	407	376

Mean top height

stocking (age 3)	Arc number	Age								
		3	4	5	6	7	8	9	10	11
93	23	5.9	7.9	10.6	13.7	15.6	17.5	18.6	19.7	21.3
120	22	6.4	8.4	11.2	14.3	16.6	18.7	20.1	21.7	23.6
155	21	6.7	8.8	11.6	14.8	17.5	19.6	21.1	23	25
204	20	6.9	9	12	15.2	18.1	20.2	21.7	23.5	25.6
275	19	7	9.3	12.4	15.7	18.6	20.8	22.1	23.8	25.7
364	18	7.1	9.5	12.7	16.1	19.1	21.2	22.5	23.9	25.7
481	17	7.3	9.7	13.1	16.5	19.6	21.6	22.8	24.1	25.8
635	16	7.4	9.9	13.4	16.9	20	22	23	24.3	25.9
853	15	7.6	10.1	13.7	17.2	20.3	22.4	23.3	24.4	26
1111	14	7.7	10.4	13.9	17.5	20.7	22.7	23.5	24.6	26
1456	13	7.9	10.6	14.2	17.8	20.9	22.9	23.7	24.7	26.1
1923	12	8.1	10.8	14.4	18.1	21.2	23.2	23.9	24.8	26.1
2557	11	8.3	11.1	14.7	18.3	21.4	23.4	24.1	24.8	26.1
3383	10	8.5	11.4	14.9	18.5	21.6	23.5	24.2	24.9	26.2
4455	9	8.7	11.7	15.1	18.7	21.8	23.7	24.3	25	26.2
5861	8	8.9	11.9	15.3	18.9	21.9	23.7	24.3	25	26.2
7823	7	9.1	12.2	15.5	19.1	21.9	23.8	24.4	25	26.2
10480	6	9.4	12.6	15.6	19.2	22	23.8	24.4	25	26.2
13447	5	9.6	12.8	15.8	19.3	22	23.8	24.4	25	26.2
17414	4	9.8	13	15.9	19.4	22	23.8	24.4	25	26.2
20013	3	9.8	13.1	15.9	19.5	22	23.8	24.4	25	26.2
35718	1	10.1	13.5	16.1	19.6	22.1	23.8	24.4	25	26.2

Stocking

stocking (age 3)	Arc number	Age								
		3	4	5	6	7	8	9	10	11
93	23	93	93	93	93	93	93	93	93	93
120	22	120	120	120	120	120	120	120	120	120
155	21	155	155	155	155	155	155	154	154	154
204	20	204	204	204	204	203	203	203	203	202
275	19	275	275	275	275	274	273	273	272	272
364	18	364	364	364	363	362	361	360	358	358
481	17	481	481	480	479	477	475	472	470	469
635	16	635	635	634	632	628	623	619	615	612
853	15	853	852	851	846	839	830	821	814	809
1111	14	1111	1110	1106	1098	1085	1069	1053	1040	1031
1456	13	1456	1454	1448	1433	1409	1379	1351	1327	1311
1923	12	1923	1919	1907	1879	1834	1780	1728	1686	1658
2557	11	2556	2550	2526	2472	2388	2290	2196	2122	2074
3383	10	3382	3370	3324	3222	3069	2894	2733	2609	2530
4455	9	4452	4430	4344	4157	3883	3583	3319	3122	3000
5861	8	5856	5813	5653	5313	4837	4343	3928	3632	3454
7823	7	7813	7730	7423	6796	5971	5174	4546	4120	3871
10480	6	10461	10298	9710	8573	7195	5976	5086	4512	4188
13447	5	13414	13125	12111	10271	8226	6567	5434	4736	4354
17414	4	17353	16833	15074	12134	9198	7037	5663	4853	4421
20013	3	19929	19216	16866	13141	9652	7219	5728	4869	4415
35718	1	35398	32793	25492	16813	10796	7425	5614	4646	4155

1 VOLUME (Cubic metres)

Stocking (age 3)	Arc No	Age (years)								
		3	4	5	6	7	8	9	10	11
93	23	2	4	9	15	23	31	40	48	58
120	22	2	5	11	20	30	40	53	63	75
155	21	3	6	14	24	37	49	66	77	91
204	20	4	8	16	29	44	59	79	91	106
275	19	4	9	19	34	52	69	91	104	120
364	18	5	11	22	38	59	78	101	115	132
481	17	6	12	25	44	67	87	111	125	144
635	16	7	15	28	50	76	97	122	137	157
853	15	9	18	34	59	89	112	137	152	174
1111	14	11	21	41	70	103	128	155	170	193
1456	13	13	26	50	85	121	148	177	192	217
1923	12	17	33	63	104	145	174	206	220	246
2557	11	22	43	80	129	175	206	242	254	280
3383	10	29	55	102	159	211	244	284	293	318
4455	9	37	70	128	195	254	288	332	336	359
5861	8	49	90	159	236	303	338	388	384	401
7823	7	65	114	196	283	359	394	449	435	442
10480	6	84	143	233	328	414	447	506	479	476
13447	5	102	168	262	359	451	483	543	505	492
17414	4	122	194	284	377	472	503	561	513	491
20013	3	132	205	291	378	474	504	559	508	482
35718	1	154	226	270	314	394	424	457	409	382

Volumes computed using FRI volume table no 256 (*E. nitens* NZ 1990).

2 MAI (Cubic metres per annum)

Stocking (age 3)	Arc No	Age (years)								
		3	4	5	6	7	8	9	10	11
93	23	0.7	1.0	1.8	2.5	3.3	3.9	4.4	4.8	5.3
120	22	0.7	1.3	2.2	3.3	4.3	5.0	5.9	6.3	6.8
155	21	1.0	1.5	2.8	4.0	5.3	6.1	7.3	7.7	8.3
204	20	1.3	2.0	3.2	4.8	6.3	7.4	8.8	9.1	9.6
275	19	1.3	2.3	3.8	5.7	7.4	8.6	10.1	10.4	10.9
364	18	1.7	2.8	4.4	6.3	8.4	9.8	11.2	11.5	12.0
481	17	2.0	3.0	5.0	7.3	9.6	10.9	12.3	12.5	13.1
635	16	2.3	3.8	5.6	8.3	10.9	12.1	13.6	13.7	14.3
853	15	3.0	4.5	6.8	9.8	12.7	14.0	15.2	15.2	15.8
1111	14	3.7	5.3	8.2	11.7	14.7	16.0	17.2	17.0	17.5
1456	13	4.3	6.5	10.0	14.2	17.3	18.5	19.7	19.2	19.7
1923	12	5.7	8.3	12.6	17.3	20.7	21.8	22.9	22.0	22.4
2557	11	7.3	10.8	16.0	21.5	25.0	25.8	26.9	25.4	25.5
3383	10	9.7	13.8	20.4	26.5	30.1	30.5	31.6	29.3	28.9
4455	9	12.3	17.5	25.6	32.5	36.3	36.0	36.9	33.6	32.6
5861	8	16.3	22.5	31.8	39.3	43.3	42.3	43.1	38.4	36.5
7823	7	21.7	28.5	39.2	47.2	51.3	49.3	49.9	43.5	40.2
10480	6	28.0	35.8	46.6	54.7	59.1	55.9	56.2	47.9	43.3
13447	5	34.0	42.0	52.4	59.8	64.4	60.4	60.3	50.5	44.7
17414	4	40.7	48.5	56.8	62.8	67.4	62.9	62.3	51.3	44.6
20013	3	44.0	51.3	58.2	63.0	67.7	63.0	62.1	50.8	43.8
35718	1	51.3	56.5	54.0	52.3	56.3	53.0	50.8	40.9	34.7

Volumes computed using FRI volume table no 256 (*E. nitens* NZ 1990).

unsmoothed ↓

3 CAI (Cubic metres per annum)

Stocking (age 3)	Arc arc	Age (years)									
		3	4	5	6	7	8	9	10	11	12
93	23		2.0	5.0	6.0	8.0	8.0	9.0	8.0	10.0	5
120	22		3.0	6.0	9.0	10.0	10.0	13.0	10.0	12.0	14
155	21		3.0	8.0	10.0	13.0	12.0	17.0	11.0	14.0	12
204	20		4.0	8.0	13.0	15.0	15.0	20.0	12.0	15.0	12
275	19		5.0	10.0	15.0	18.0	17.0	22.0	13.0	16.0	10
364	18		6.0	11.0	16.0	21.0	19.0	23.0	14.0	17.0	10
481	17		6.0	13.0	19.0	23.0	20.0	24.0	14.0	19.0	6
635	16		8.0	13.0	22.0	26.0	21.0	25.0	15.0	20.0	9
853	15		9.0	16.0	25.0	30.0	23.0	25.0	15.0	22.0	14
1111	14		10.0	20.0	29.0	33.0	25.0	27.0	15.0	23.0	15
1456	13		13.0	24.0	35.0	36.0	27.0	29.0	15.0	25.0	2
1923	12		16.0	30.0	41.0	41.0	29.0	32.0	14.0	26.0	10
2557	11		21.0	37.0	49.0	46.0	31.0	36.0	12.0	26.0	0
3383	10		26.0	47.0	57.0	52.0	33.0	40.0	9.0	25.0	13
4455	9		33.0	58.0	67.0	59.0	34.0	44.0	4.0	23.0	36
5861	8		41.0	69.0	77.0	67.0	35.0	50.0	-4.0	17.0	37
7823	7		49.0	82.0	87.0	76.0	35.0	55.0	-14.0	7.0	64
10480	6		59.0	90.0	95.0	86.0	33.0	59.0	-27.0	-3.0	13
13447	5		66.0	94.0	97.0	92.0	32.0	60.0	-38.0	-13.0	-8
17414	4		72.0	90.0	93.0	95.0	31.0	58.0	-48.0	-22.0	-61
20013	3		73.0	86.0	87.0	96.0	30.0	55.0	-51.0	-26.0	-26
35718	1		72.0	44.0	44.0	80.0	30.0	33.0	-48.0	-27.0	-49

Volumes computed using FRI volume table no 256 (*E. nitens* NZ 1990).

↑

exaggeration