Trees —————— DBH > 10 cm
Height
Stem Height
No. of individuals

Shrubs and saplings ———— $2.5 < DBH > 10$ cm
Height
No. of individuals

Herbs and
Seedlings
$1\,m^2$

Ground cover
No. of individuals

$9\,m^2$

$100\,m^2$

Figure 11 - Diagram of nested squares for vegetation sampling in Machadinho d'Oeste
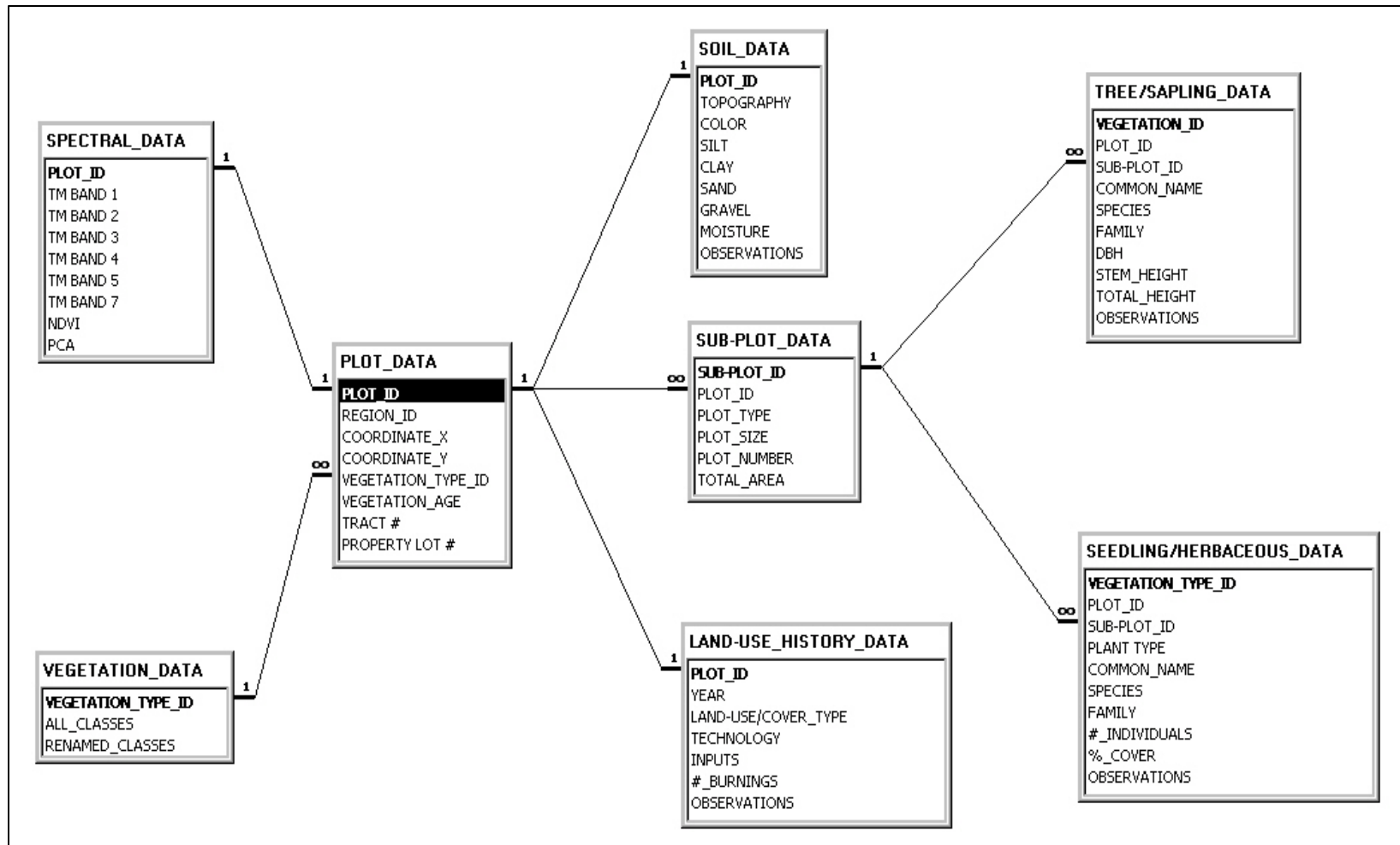and Vale do Anari.

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SPECTRAL_DATA
- **PLOT_ID**
- TM BAND 1
- TM BAND 2
- TM BAND 3
- TM BAND 4
- TM BAND 5
- TM BAND 7
- NDVI
- PCA

SOIL_DATA
- **PLOT_ID**
- TOPOGRAPHY
- COLOR
- SILT
- CLAY
- SAND
- GRAVEL
- MOISTURE
- OBSERVATIONS

TREE/SAPLING_DATA
- **VEGETATION_ID**
- PLOT_ID
- SUB-PLOT_ID
- COMMON_NAME
- SPECIES
- FAMILY
- DBH
- STEM_HEIGHT
- TOTAL_HEIGHT
- OBSERVATIONS

PLOT_DATA
- **PLOT_ID**
- REGION_ID
- COORDINATE_X
- COORDINATE_Y
- VEGETATION_TYPE_ID
- VEGETATION_AGE
- TRACT #
- PROPERTY LOT #

SUB-PLOT_DATA
- **SUB-PLOT_ID**
- PLOT_ID
- PLOT_TYPE
- PLOT_SIZE
- PLOT_NUMBER
- TOTAL_AREA

VEGETATION_DATA
- **VEGETATION_TYPE_ID**
- ALL_CLASSES
- RENAMED_CLASSES

LAND-USE_HISTORY_DATA
- **PLOT_ID**
- YEAR
- LAND-USE/COVER_TYPE
- TECHNOLOGY
- INPUTS
- #_BURNINGS
- OBSERVATIONS

SEEDLING/HERBACEOUS_DATA
- **VEGETATION_TYPE_ID**
- PLOT_ID
- SUB-PLOT_ID
- PLANT TYPE
- COMMON_NAME
- SPECIES
- FAMILY
- #_INDIVIDUALS
- %_COVER
- OBSERVATIONS

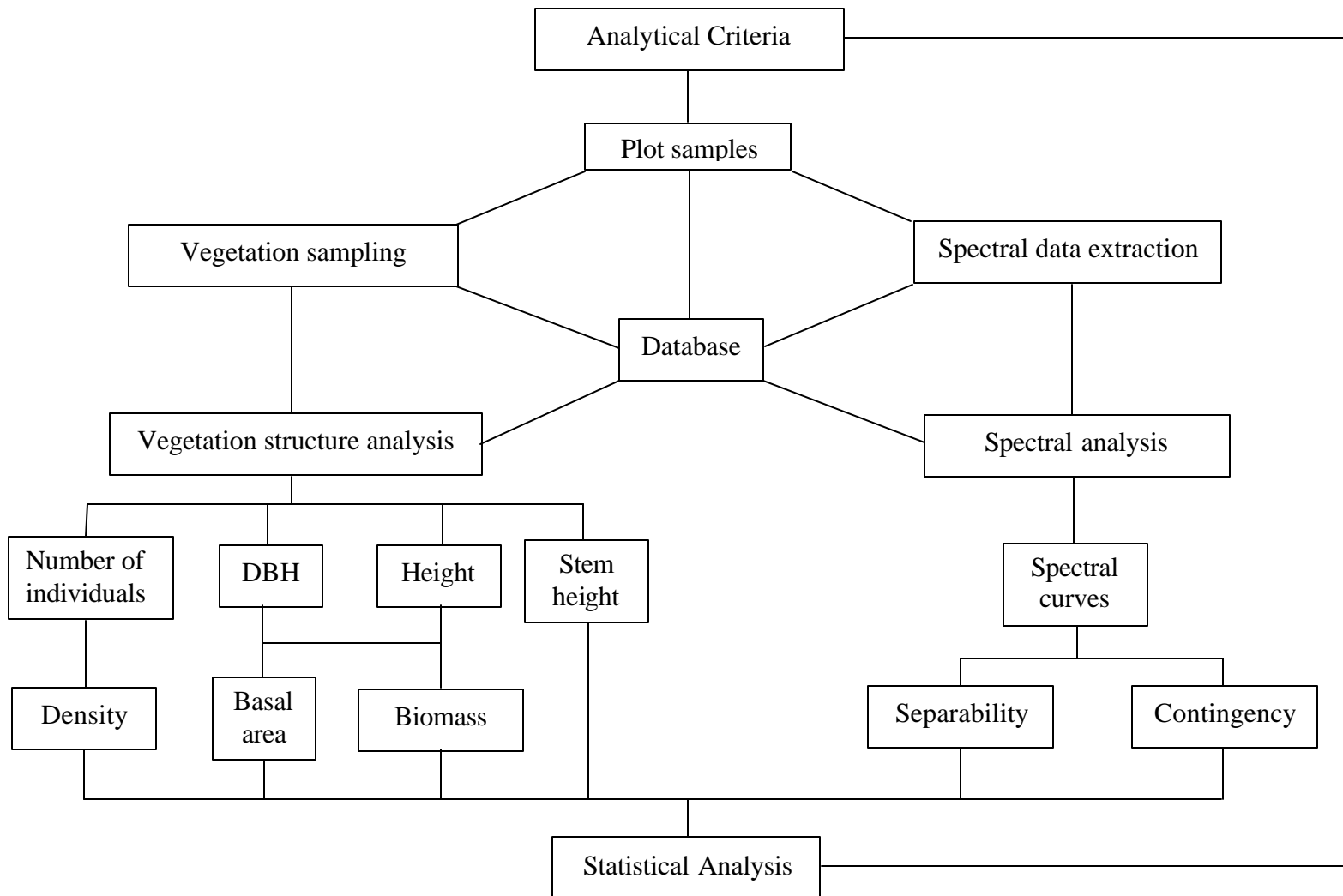Figure 12 - Relationships between vegetation database tables for Machadinho d'Oeste and Vale do Anari.

Figure 13 - Integration of vegetation structure and spectral data analysis for Machadinho d'Oeste and Vale do Anari.

Initial Secondary Succession (SS1)

8m

5m

30m

1- Embauba/ *Cecropia sp* (Cecropiaceae)
2- Breu/ *Protium sp* (Burseraceae)
3- Abiurana/ *Lucuma lasiocarpa* (Sapotaceae)
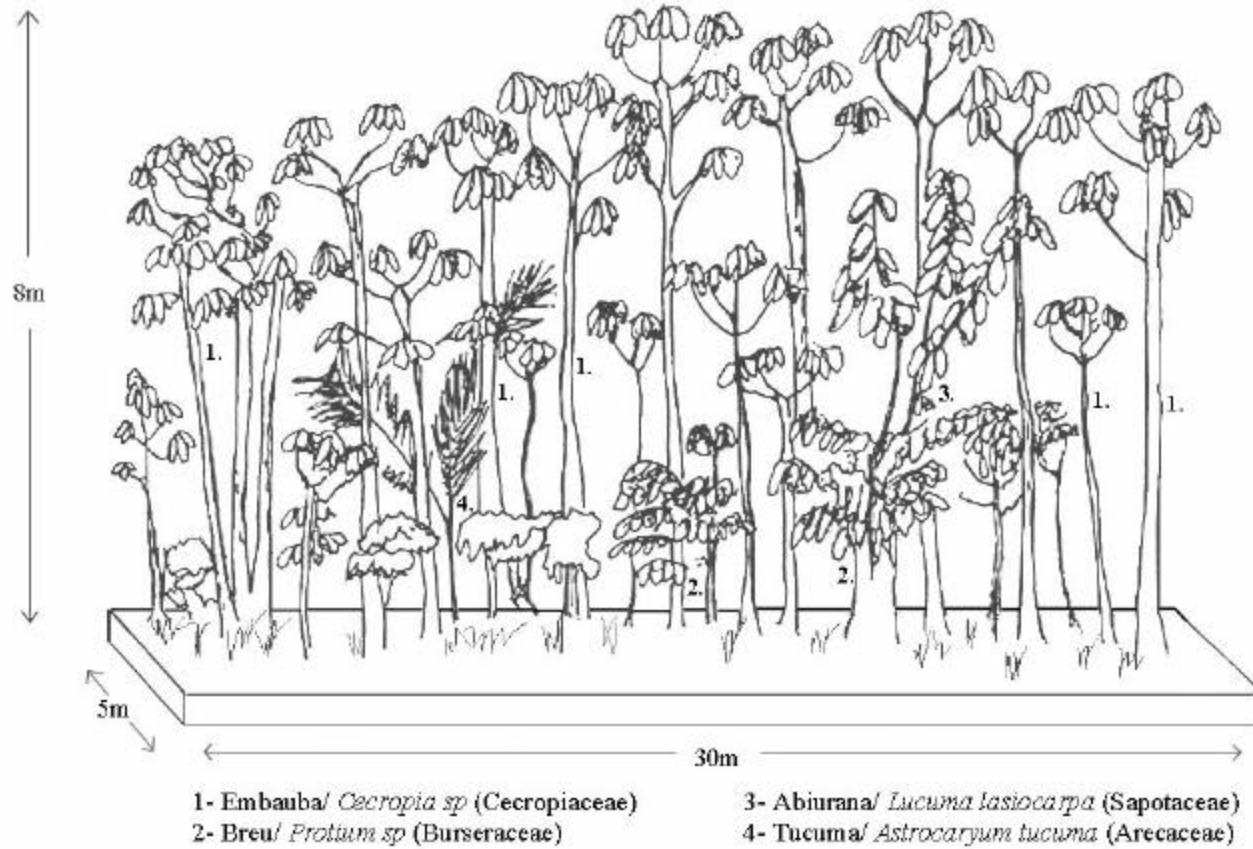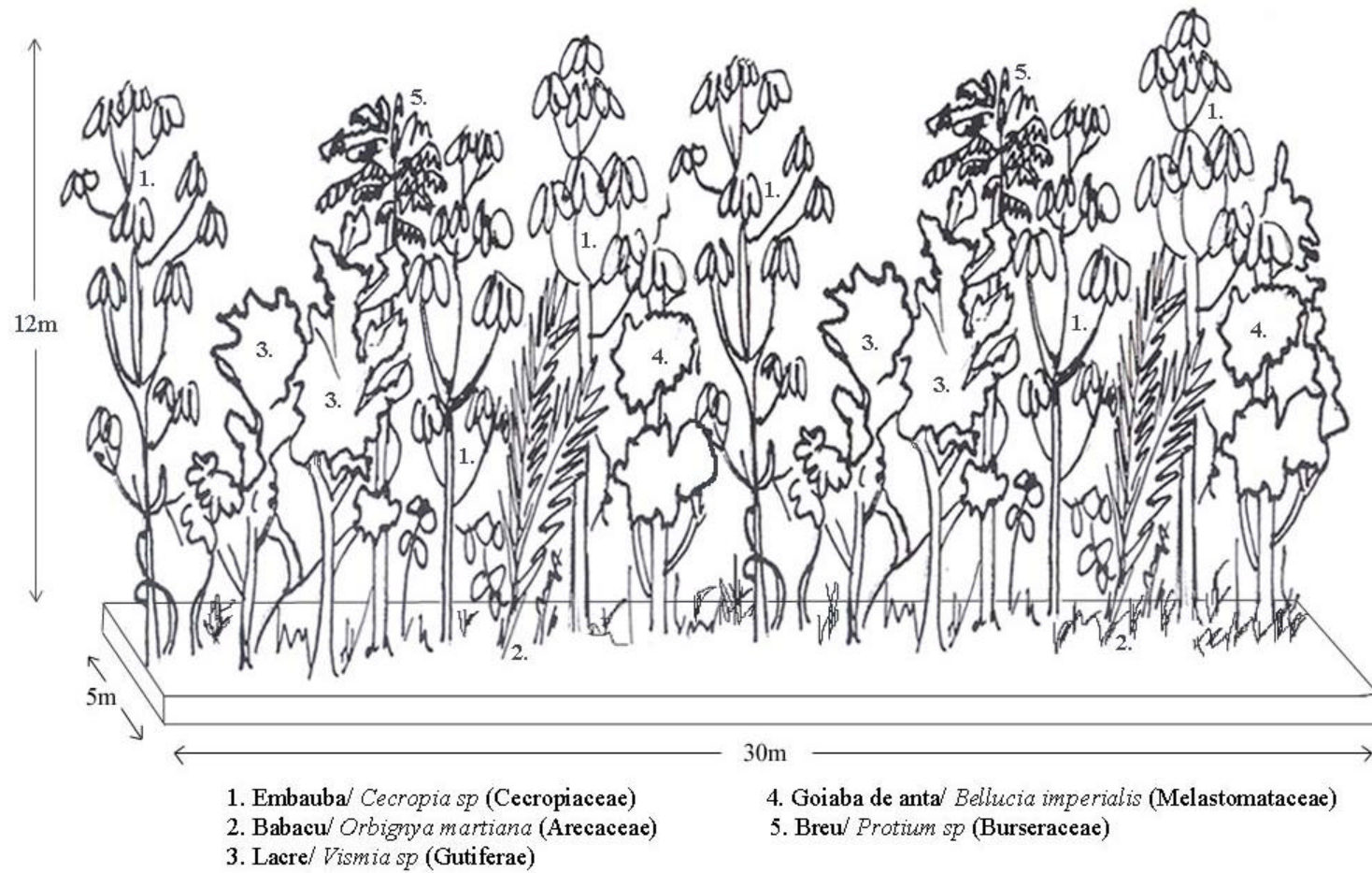4- Tucuma/ *Astrocaryum tucuma* (Arecaceae)

Figure 14 - Vegetation profile of an initial secondary succession stand in Machadinho d'Oeste and Vale do Anari.

Table 5 - Vegetation structural variables for initial secondary succession stands in Machadinho d'Oeste and Vale do Anari.

	Mean	S.D.	Min.	Max.
Density of trees (individuals/ha)	266.7	231.9	33.3	533.3
Density of saplings (individuals/ha)	7460.3	2022.1	4074.1	10000.0
Density of saplings / density of trees	88.8	110.7	7.6	300.0
DBH of trees (cm)	11.4	0.8	10.0	12.4
DBH of saplings (cm)	4.3	0.3	3.7	4.6
Basal area of trees (m^2/ha)	2.7	1.3	0.0	4.0
Basal area of saplings (m^2/ha)	5.1	1.3	2.4	6.3
Total basal area (m^2/ha)	7.8	2.1	4.6	9.8
Percent tree contribution to total basal area	33.5	15.6	0.0	47.7
Percent sapling contribution to total basal area	66.5	15.6	52.3	100. 0
Total height of trees (m)	7.8	1.4	5.5	9.6
Total height of saplings (m)	4.8	0.5	4.3	5.8
Stem height of trees (m)	5.4	1.4	3.5	7.0
Biomass of trees (t/ha)	28.3	14.2	0.0	38.0
Biomass of saplings (t/ha)	0.9	0.1	0.7	1.1
Total biomass (t/ha)	29.2	14.3	0.9	39.1

Intermediate Secondary Succession (SS2)

Figure 15 - Vegetation profile of an intermediate secondary succession stand in Machadinho d'Oeste and Vale do Anari.

1. Embauba/ *Cecropia sp* (Cecropiaceae)
2. Babacu/ *Orbignya martiana* (Arecaceae)
3. Lacre/ *Vismia sp* (Gutiferae)

4. Goiaba de anta/ *Bellucia imperialis* (Melastomataceae)
5. Breu/ *Protium sp* (Burseraceae)

Table 6 - Vegetation structural variables for intermediate secondary succession stands in Machadinho d'Oeste and Vale do Anari.

	Mean	S.D.	Min.	Max.
Density of trees (individuals/ha)	763.3	283.0	300.0	1233.3
Density of saplings (individuals/ha)	4814.8	1719.5	1481.5	7037.0
Density of saplings / density of trees	7.8	5.2	1.2	19.7
DBH of trees (cm)	13.8	1.2	12.1	15.3
DBH of saplings (cm)	4.7	0.6	4.0	5.7
Basal area of trees (m^2/ha)	5.0	0.8	3.9	6.2
Basal area of saplings (m^2/ha)	6.4	1.6	4.7	9.5
Total basal area (m^2/ha)	11.5	1.8	9.4	15.7
Percent tree contribution to total basal area	44.4	7.3	33.9	55.2
Percent sapling contribution to total basal area	55.6	7.3	33.9	55.2
Total height of trees (m)	10.1	0.6	8.7	10.7
Total height of saplings (m)	5.1	0.4	4.4	5.6
Stem height of trees (m)	6.6	0.9	5.2	8.0
Biomass of trees (t/ha)	63.6	13.4	44.6	80.7
Biomass of saplings (t/ha)	1.1	0.2	0.9	1.5
Total biomass (t/ha)	64.7	13.4	45.7	82.2

Advanced Secondary Succession (SS3)

16m

5m

30m

1- Embauba/ *Cecropia sp* (Cecropiaceae)
2- Goiaba de anta/ *Bellucia imperialis* (Melastomataceae)
3- Babacu/ *Orbignya Martiana* (Arcaceae)
4- Lacre/ *Vismia sp* (Gutiferae)
5- Breu/ *Protium sp* (Burseraceae)
6- Abiurana/ *Lucuma lasiocarpa* (Sapotaceae)
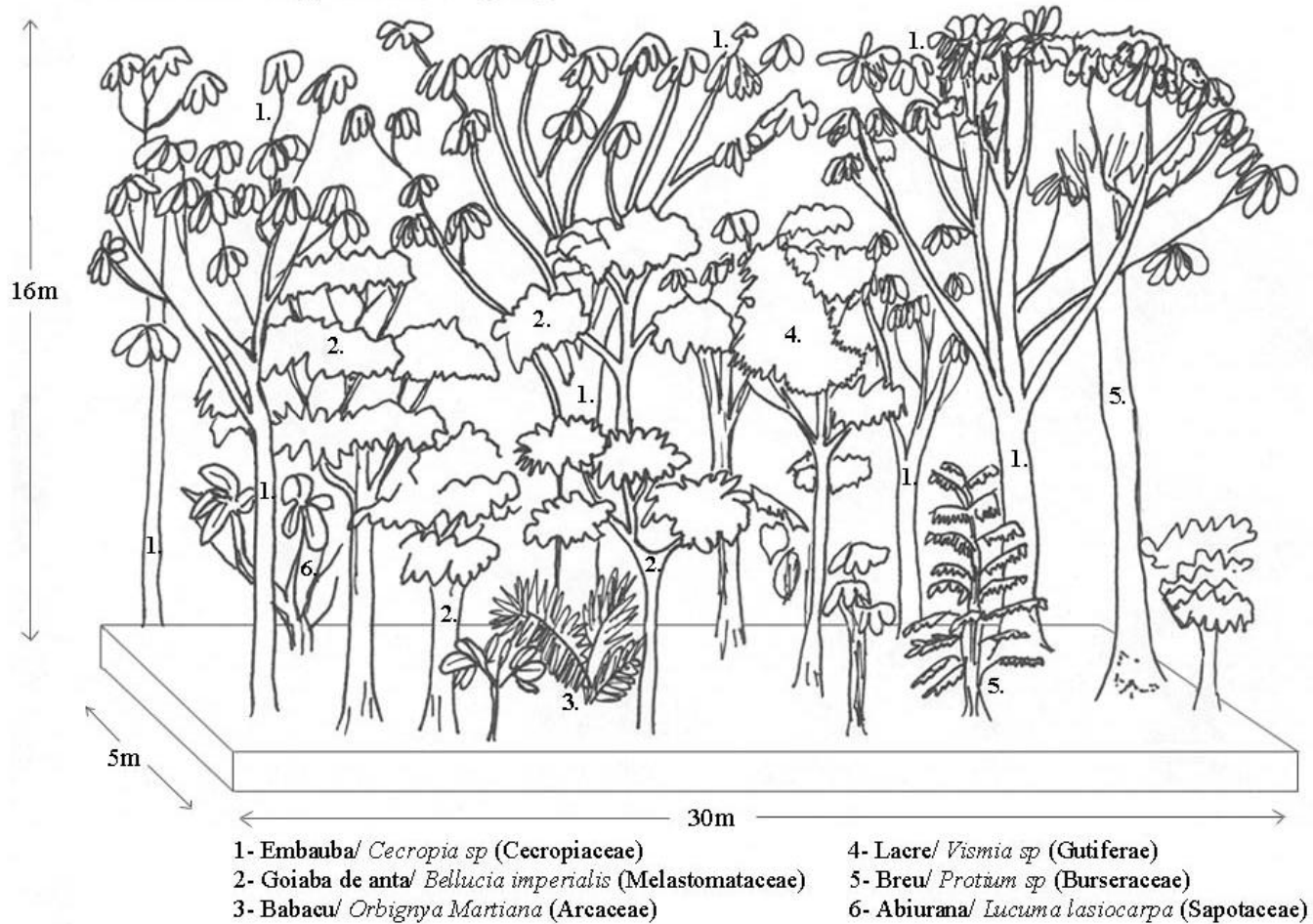
Figure 16 - Vegetation profile of an advanced secondary succession stand in Machadinho d'Oeste and Vale do Anari.

Table 7 - Vegetation structural variables for advanced secondary succession stands in Machadinho d'Oeste and Vale do Anari.

	Mean	S.D.	Min.	Max.
Density of trees (individuals/ha)	920.8	276.0	666.7	1333.3
Density of saplings (individuals/ha)	3750.0	1392.0	2222.2	6666.7
Density of saplings / density of trees	4.5	2.4	1. 7	9.1
DBH of trees (cm)	17.1	1.1	15.2	18.6
DBH of saplings (cm)	5.0	0.7	3. 9	6.1
Basal area of trees (m^2/ha)	6.9	1.5	4.5	9.1
Basal area of saplings (m^2/ha)	6.7	2.2	3.8	10.8
Total basal area (m^2/ha)	13.6	2.9	8.9	17.4
Percent tree contribution to total basal area	51.1	9.0	37.9	64.2
Percent sapling contribution to total basal area	48.9	9.0	35.8	62.1
Total height of trees (m)	13.0	1.1	11.3	14.8
Total height of saplings (m)	5.7	0.8	4.4	6.9
Stem height of trees (m)	9.8	1.9	7.6	12.9
Biomass of trees (t/ha)	124.1	20.8	94.5	151.3
Biomass of saplings (t/ha)	1.3	0.3	0.8	1.7
Total biomass (t/ha)	125.4	20.7	95.7	152.4

Open Tropical Forest

20m

10m

30m

1-Itaubarana/ *Heisteria sp* (Olacaceae)
2-Matamata/ *Eschweilera sp* (Lecythidaceae)
3-Jatoba/ *Hymenaea sp* (Caesalpiniaceae)
4-Itauba/ *Mesilaurus itauba* (Lauraceae)
5-Guariuba/ *Clarisia racemosa* (Moraceae)

6-Roxinho/ *Peltogyne paniculata* (Caesalpiniaceae)
7-Babacu/ *Orbignya martiana* (Arecaceae)
8-Acai/ *Euterpe oleraceae* (Arecaceae)
9-Louro/ *Acrodiclidium brasiliense* (Lauraceae)
10-Massaranduba/ *Manilkara huberi* (Sapotaceae)

Figure 17 - Vegetation profile of a tropical open forest stand in Machadinho d'Oeste and Vale do Anari.

Table 8 - Vegetation structural variables for tropical open forest stands in Machadinho d'Oeste and Vale do Anari.

	Mean	S.D.	Min.	Max.
Density of trees (individuals/ha)	772.1	449.6	466. 7	1766. 7
Density of saplings (individuals/ha)	2407.4	1296.3	1481.5	5185.2
Density of saplings / density of trees	3.2	0.7	2.0	4.3
DBH of trees (cm)	22.8	3.2	19.4	28.5
DBH of saplings (cm)	4.5	0.7	3.5	5.8
Basal area of trees (m^2/ha)	12.5	4.3	8.3	21.3
Basal area of saplings (m^2/ha)	5.5	2.4	2.6	9.7
Total basal area (m^2/ha)	18.0	5.0	11.2	26.8
Percent tree contribution to total basal area	69.4	10.7	55.8	82.8
Percent sapling contribution to total basal area	30.6	10.7	55.8	82.8
Total height of trees (m)	15.2	1.4	14.2	18.1
Total height of saplings (m)	5.8	0.5	5.0	6.3
Stem height of trees (m)	10.7	1.3	9.7	13.6
Biomass of trees (t/ha)	268.1	104.8	176.5	481.9
Biomass of saplings (t/ha)	1.1	0.3	0.7	1.6
Total biomass (t/ha)	269.2	104.8	177.6	483.0

Vegetation Classes (1=SS1; 2=SS2; 3=SS3; 4=Forest)
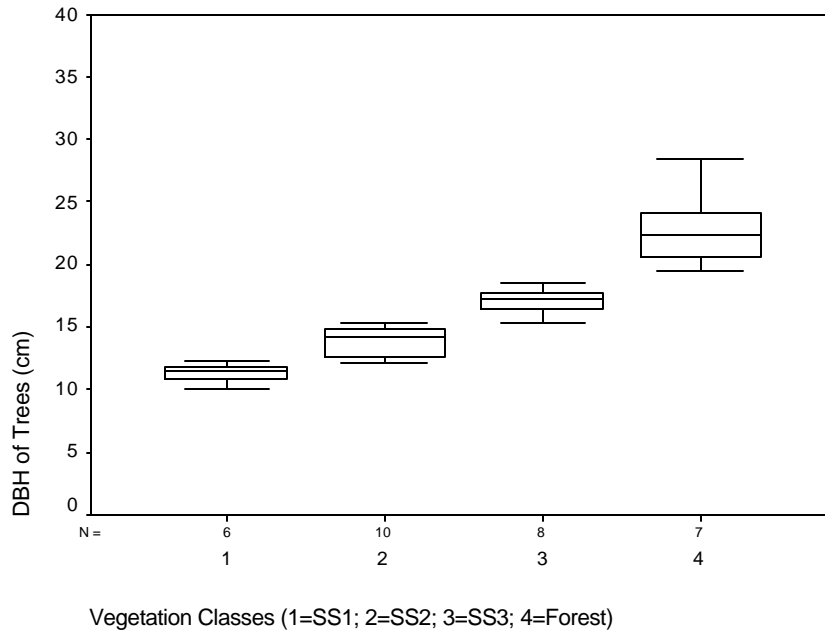
Figure 18 - Distribution of DBH of trees within vegetation classes sampled in

Machadinho d'Oeste and Vale do Anari.

Vegetation Classes (1=SS1; 2=SS2; 3=SS3; 4=Forest)
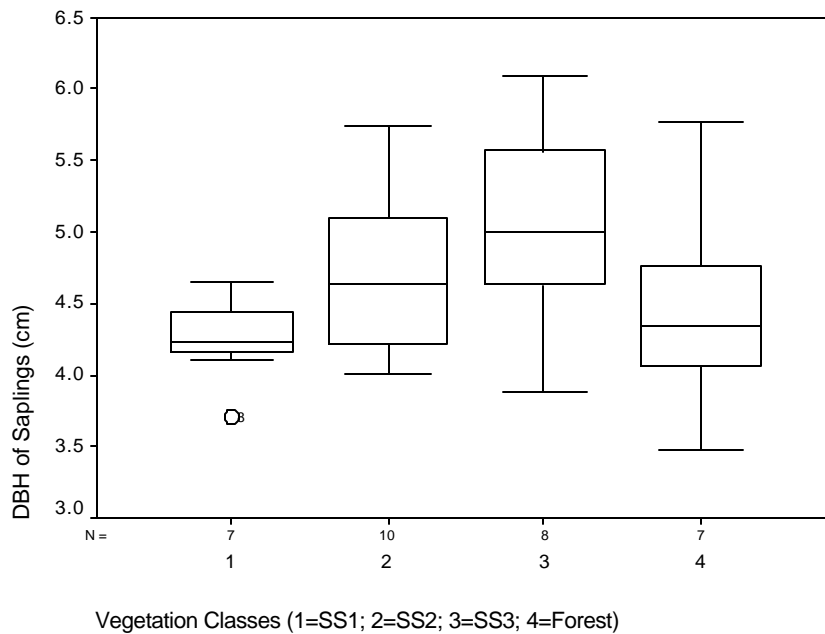
Figure 19 - Distribution of DBH of saplings within vegetation classes sampled in

Machadinho d'Oeste and Vale do Anari.

Table 9 - Analysis of variance (ANOVA) for vegetation structural variables sampled in Machadinho d'Oeste and Vale do Anari.

		Sum of Squares	df	Mean Square	F	Sig.
Density of trees (individuals/ha)	Between Groups	1590306.48	3	530102.16	5.23	0.006
	Within Groups	2736146.60	27	101338.76		
Density of saplings (individuals/ha)	Between Groups	97164561.17	3	32388187.06	12.13	0.000
	Within Groups	74791871.49	28	2671138.27		
Density of saplings / density of trees	Between Groups	33691.26	3	11230.42	4.93	0.007
	Within Groups	61549.15	27	2279.60		
DHB of trees (cm)	Between Groups	510.36	3	170.12	52.13	0.000
	Within Groups	88.11	27	3.26		
DBH of saplings (cm)	Between Groups	2.59	3	0.86	2.39	0.090
	Within Groups	10.12	28	0.36		
Basal area of trees (m^2/ha)	Between Groups	373.88	3	124.63	24.36	0.000
	Within Groups	143.25	28	5.12		
Basal area of saplings (m^2/ha)	Between Groups	13.82	3	4.61	1.27	0.305
	Within Groups	101.82	28	3.64		
Total basal area (m^2/ha)	Between Groups	389.11	3	129.70	13.72	0.000
	Within Groups	264.63	28	9.45		
Percent tree contribution to total basal area	Between Groups	4831.07	3	1610.36	14.17	0.000
	Within Groups	3181.83	28	113.64		
Percent sapling contribution to total basal area	Between Groups	4831.07	3	1610.36	14.17	0.000
	Within Groups	3181.83	28	113.64		
Total height of trees (m)	Between Groups	218.51	3	72.84	59.44	0.000
	Within Groups	33.08	27	1.23		
Total height of saplings (m)	Between Groups	5.00	3	1.67	5.25	0.005
	Within Groups	8.89	28	0.32		
Stem height of trees (m)	Between Groups	135.47	3	45.16	22.67	0.000
	Within Groups	53.77	27	1.99		
Biomass of trees (t/ha)	Between Groups	243799.89	3	81266.63	31.68	0.000
	Within Groups	71837.89	28	2565.64		
Biomass of saplings (t/ha)	Between Groups	0.42	3	0.14	2.48	0.082
	Within Groups	1.58	28	0.06		
Total biomass (t/ha)	Between Groups	243937.55	3	81312.52	31.75	0.000
	Within Groups	71704.42	28	2560.87		

Note: df = degrees of freedom; F = F test of significance; Sig. = Significance
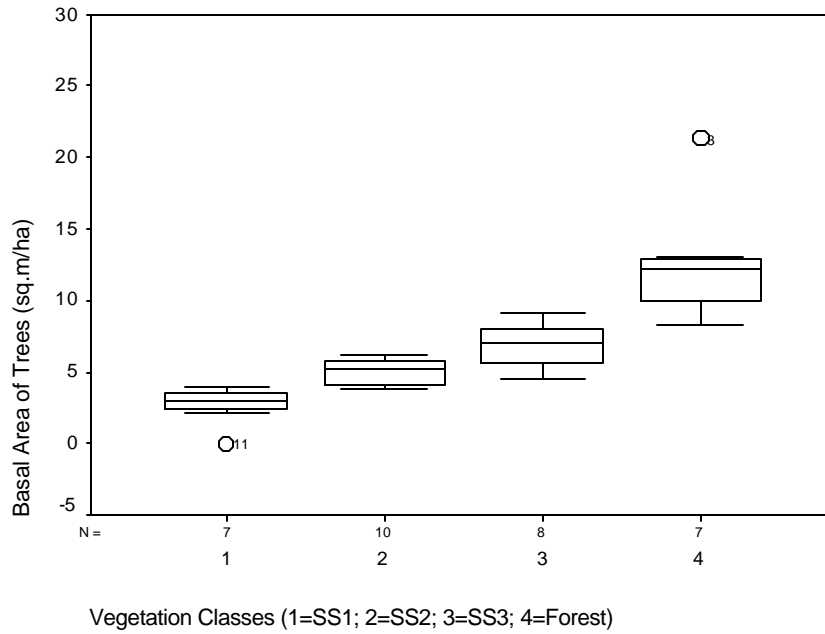
Figure 20 - Distribution of basal area of trees within vegetation classes sampled in
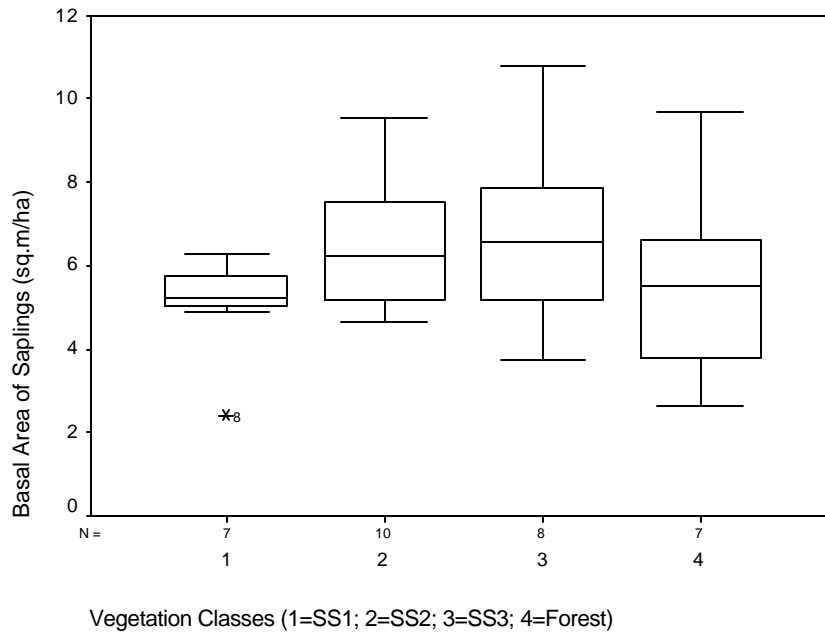
Machadinho d'Oeste and Vale do Anari.

Figure 21 - Distribution of basal area of saplings within vegetation classes sampled in
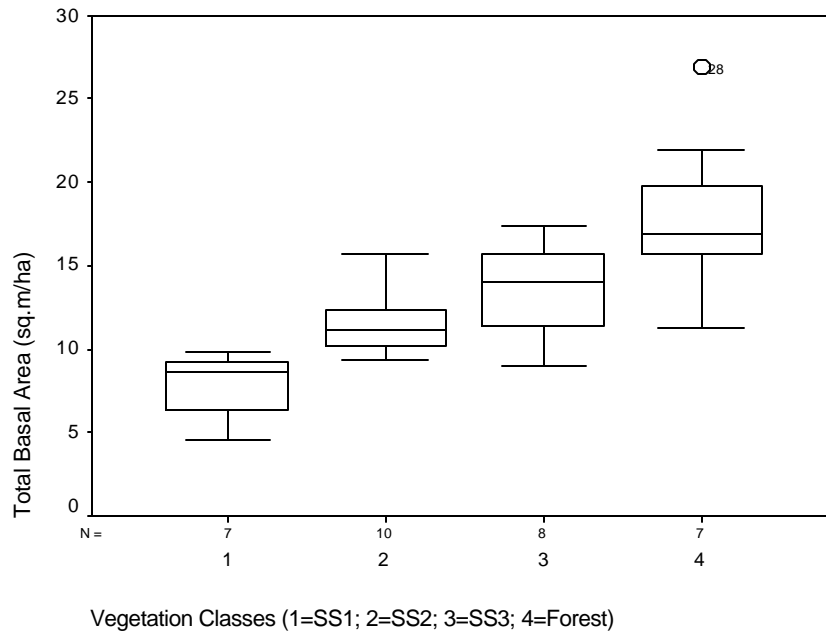
Machadinho d'Oeste and Vale do Anari.

Figure 22 - Distribution of total basal area within vegetation classes sampled in
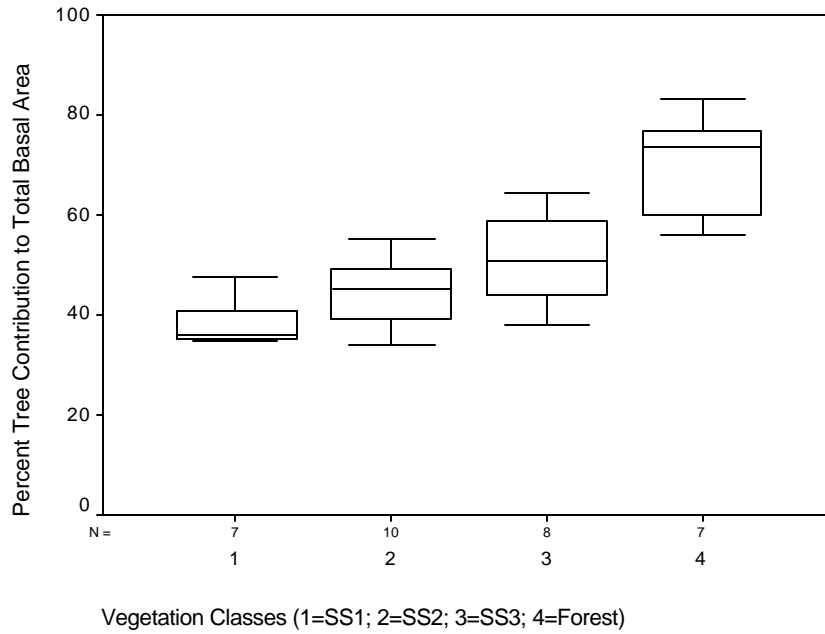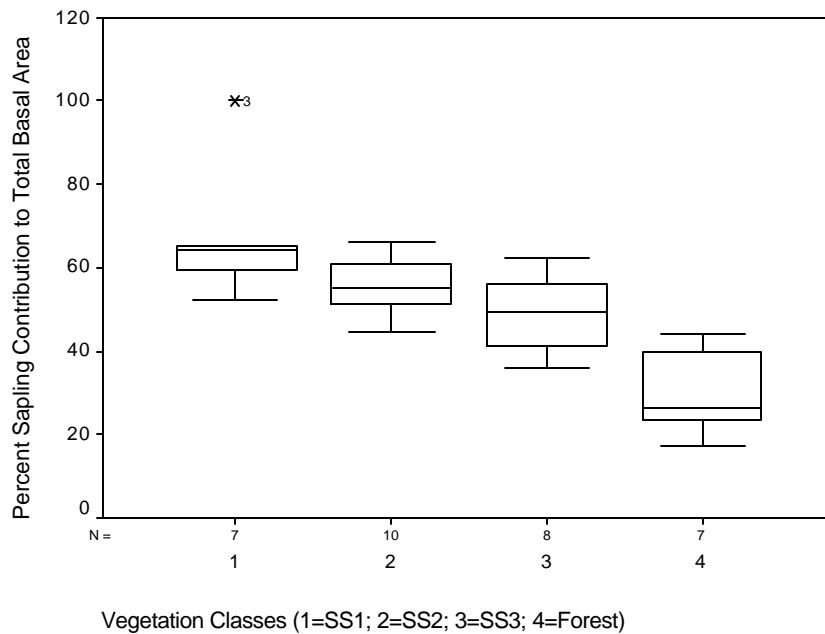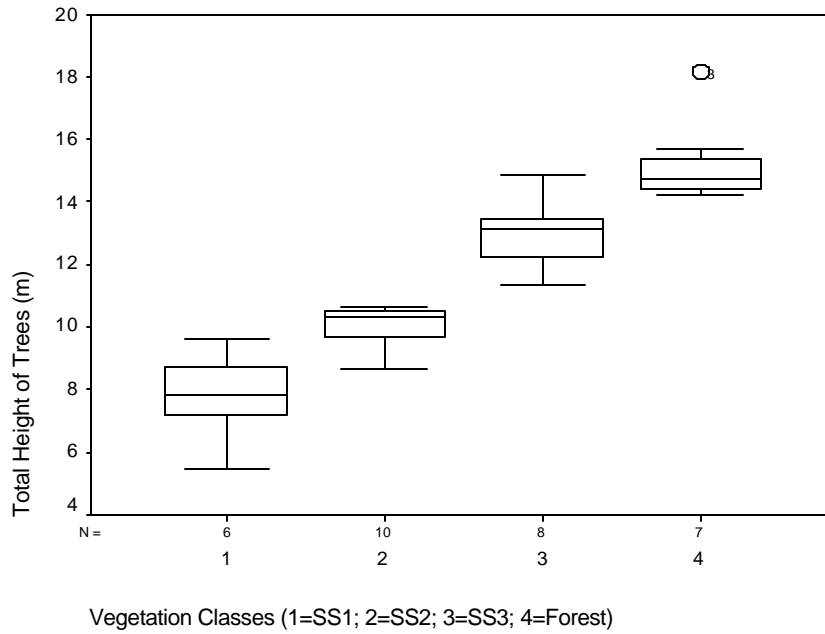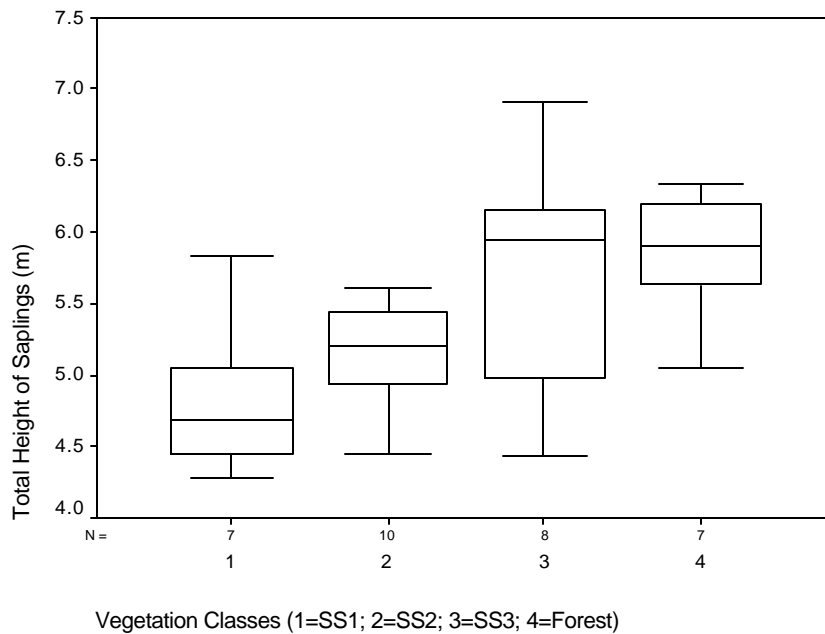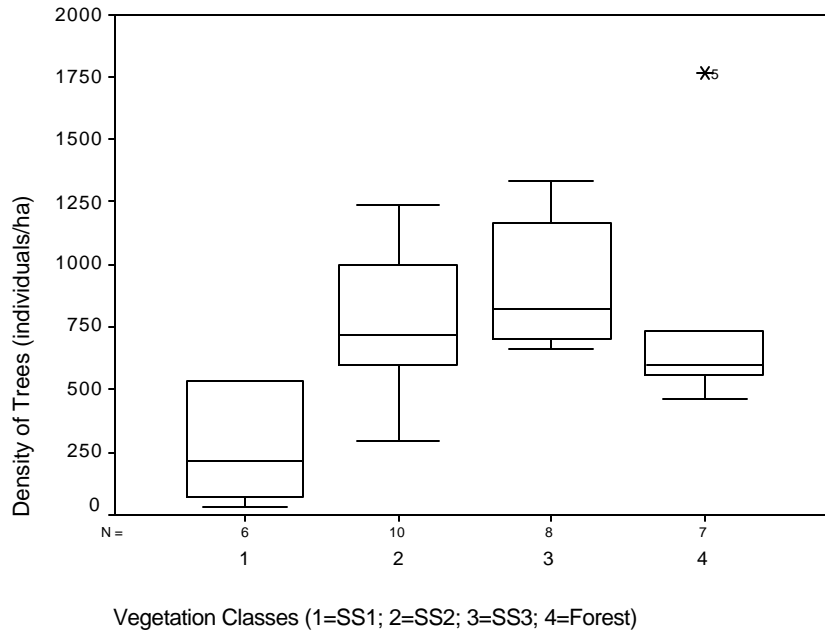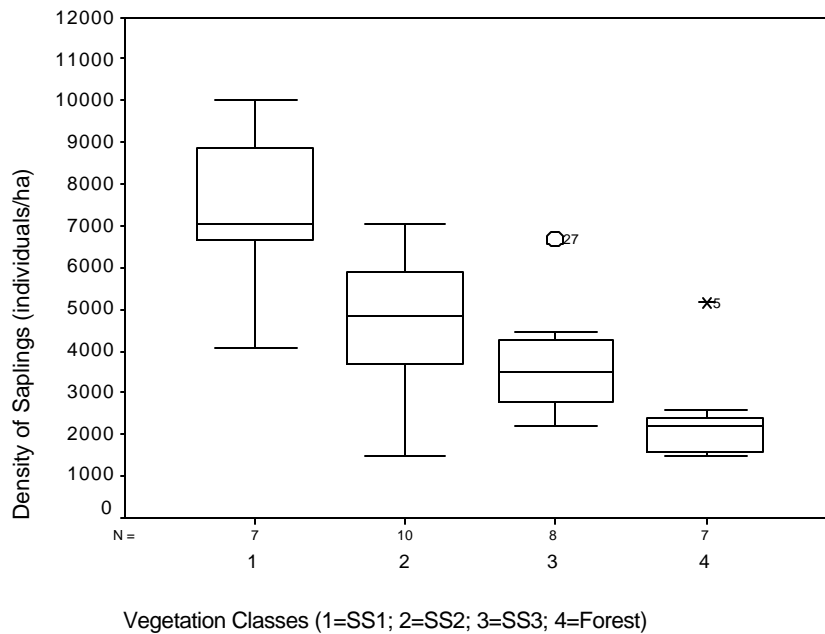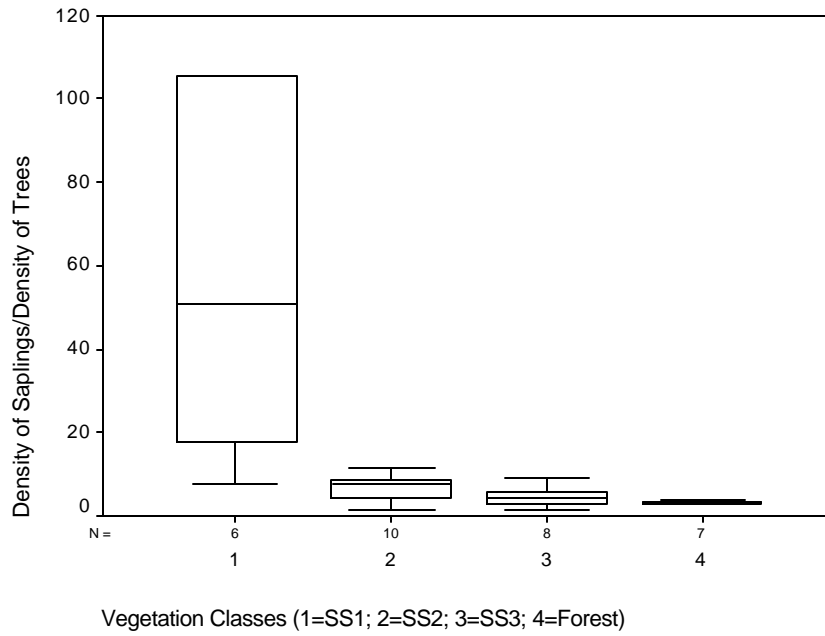
Machadinho d'Oeste and Vale do Anari.

Figure 23 - Distribution of percentage tree contribution to total basal area within

vegetation classes sampled in Machadinho d'Oeste and Vale do Anari.

Figure 24 - Distribution of percentage sapling contribution to total basal area within

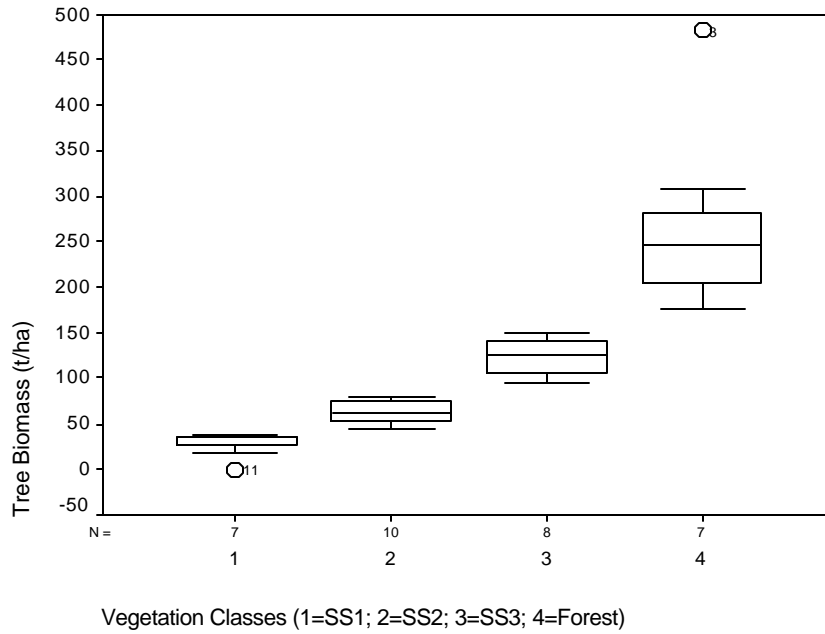vegetation classes sampled in Machadinho d'Oeste and Vale do Anari.

Figure 25 - Distribution of total height of trees within vegetation classes sampled in
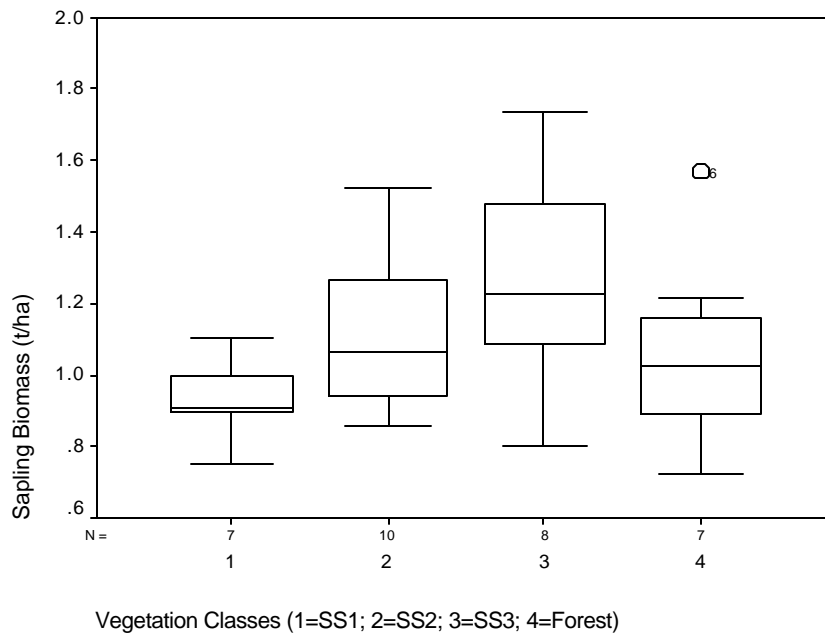
Machadinho d'Oeste and Vale do Anari.

Figure 26 - Distribution of total height of saplings within vegetation classes sampled in

Machadinho d'Oeste and Vale do Anari.

Figure 27 - Distribution of density of trees within vegetation classes sampled in

Machadinho d'Oeste and Vale do Anari.

Figure 28 - Distribution of density of saplings within vegetation classes sampled in

Machadinho d'Oeste and Vale do Anari.

Figure 29 - Distribution of ratio between density of trees and saplings within vegetation

classes sampled in Machadinho d'Oeste and Vale do Anari.

Figure 30 - Distribution of biomass of trees within vegetation classes sampled in

Machadinho d'Oeste and Vale do Anari.

Figure 31 - Distribution of biomass of saplings within vegetation classes sampled in
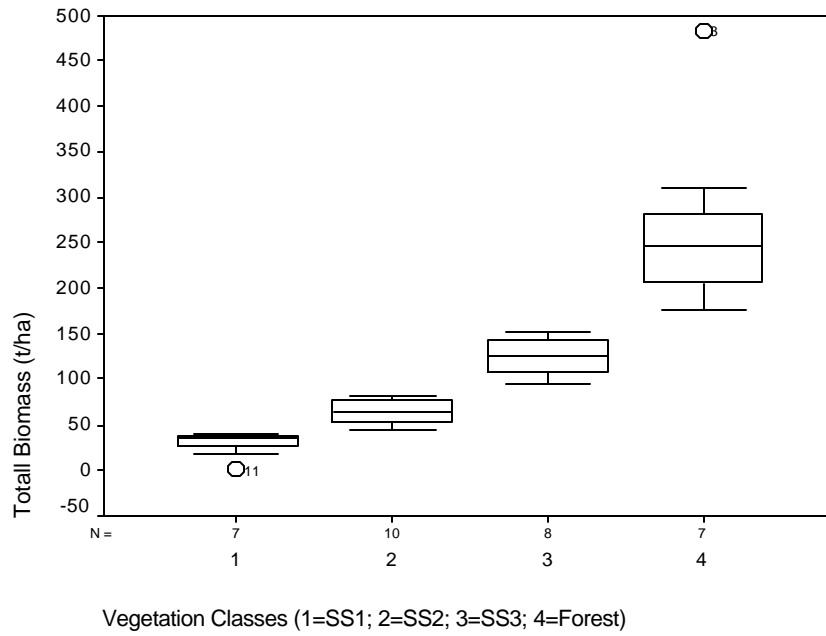
Machadinho d'Oeste and Vale do Anari.

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Figure 32 - Distribution of total biomass within vegetation classes sampled in
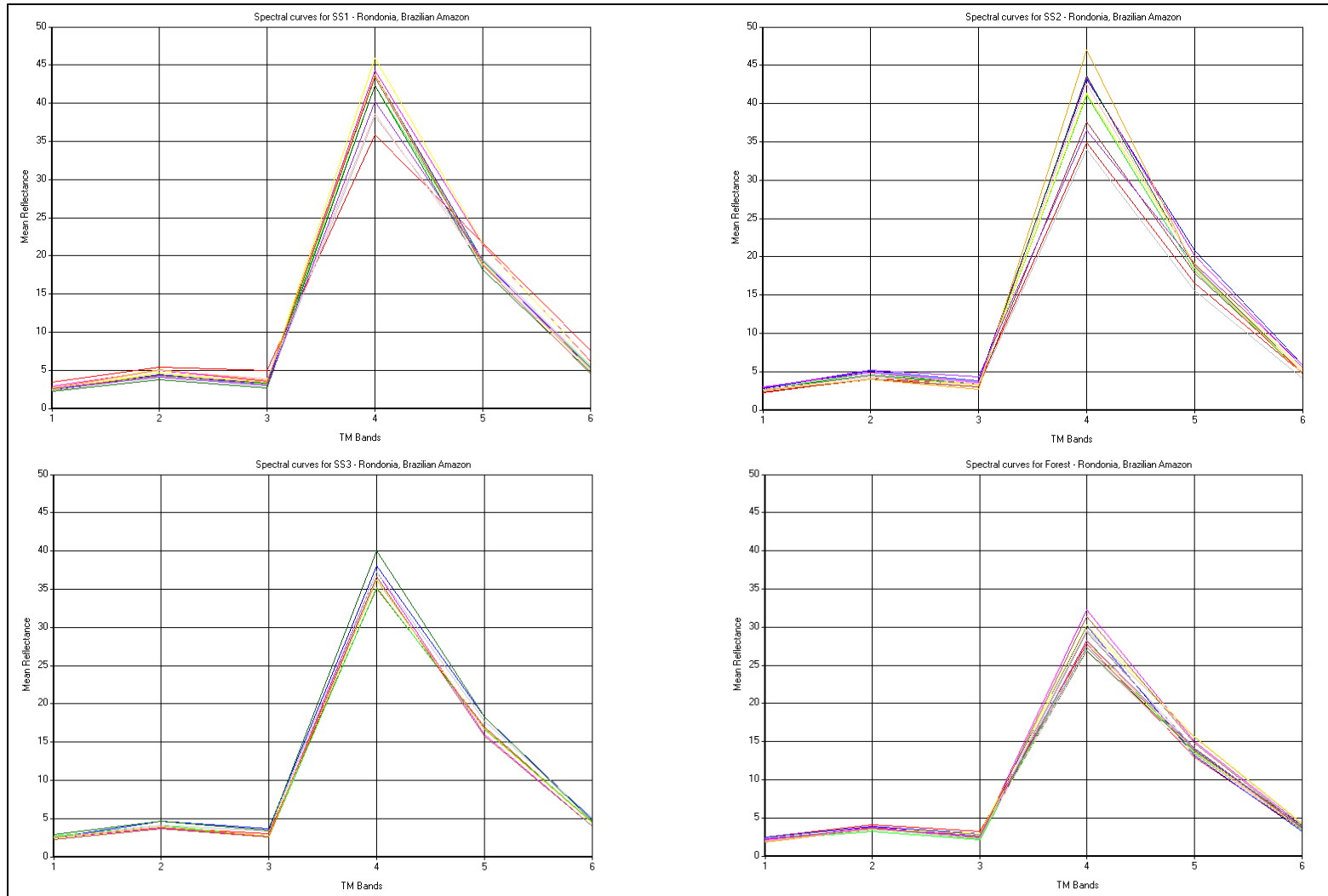
Machadinho d'Oeste and Vale do Anari.

Figure 33 - Spectral curves for each group of plot samples in Machadinho d'Oeste and Vale do Anari (SS1, SS2, SS3, and forest).
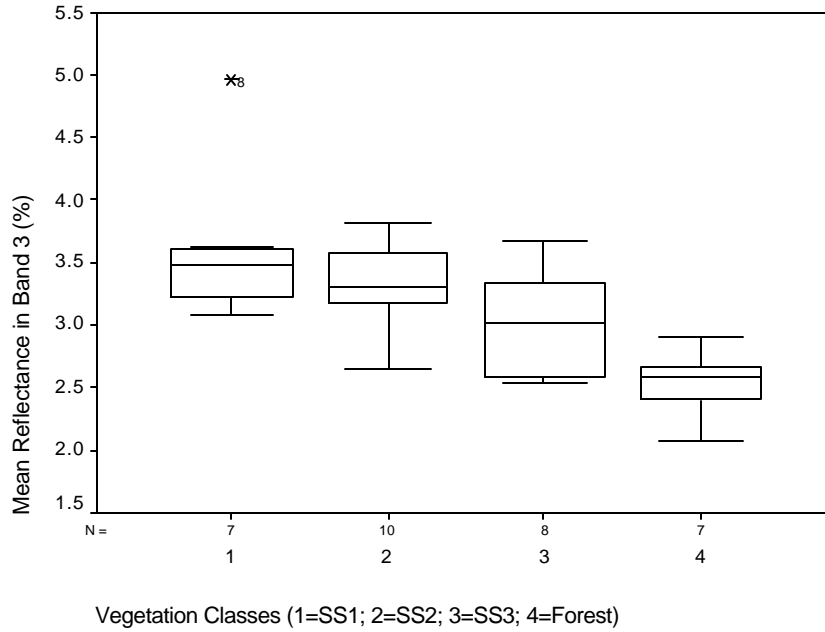
Figure 34 - Distribution of mean reflectance in Landsat TM band 3 within vegetation

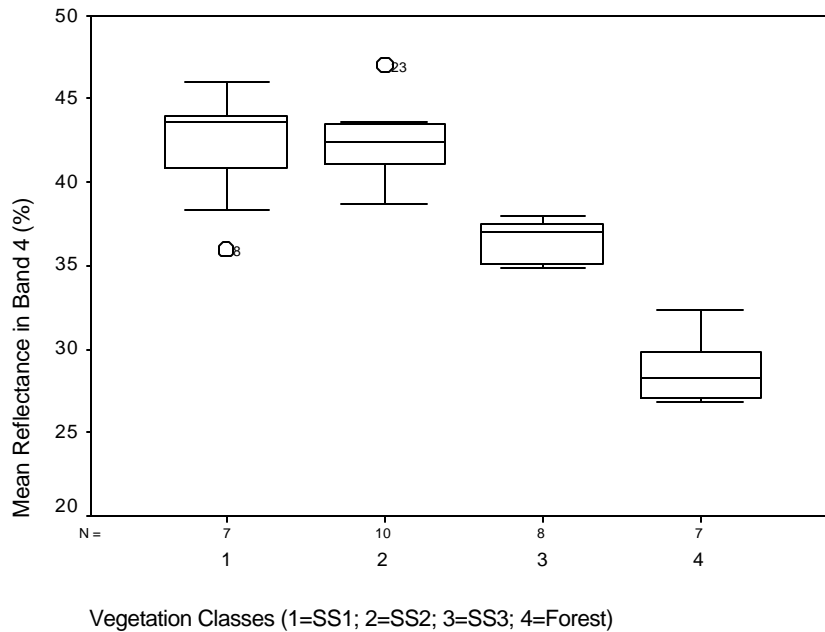classes sampled in Machadinho d'Oeste and Vale do Anari.

Figure 35 - Distribution of mean reflectance in Landsat TM band 4 within vegetation

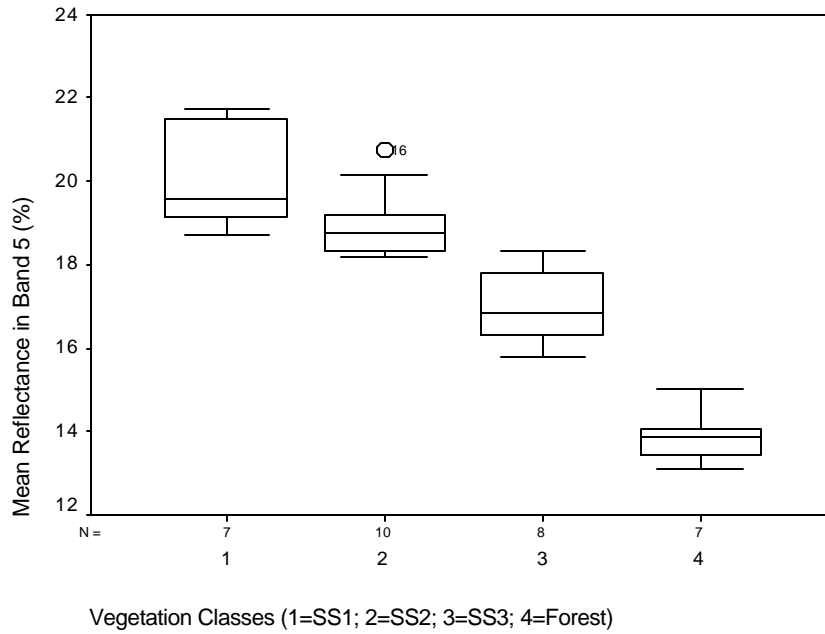classes sampled in Machadinho d'Oeste and Vale do Anari.

Figure 36 - Distribution of mean reflectance in Landsat TM band 5 within vegetation

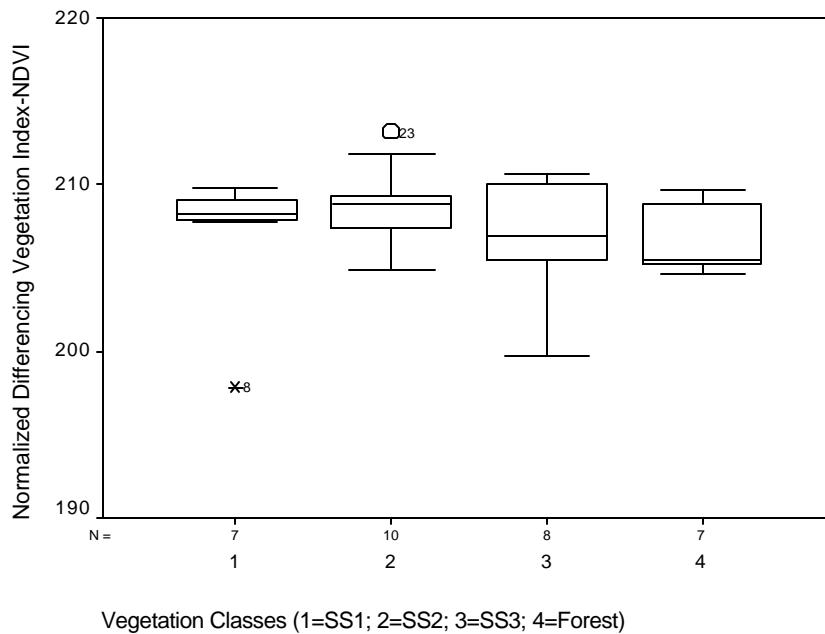classes sampled in Machadinho d'Oeste and Vale do Anari.

Figure 37 - Distribution of mean reflectance in Landsat TM NDVI within vegetation

classes sampled in Machadinho d'Oeste and Vale do Anari.

Table 10 - Analysis of variance (ANOVA) for mean reflectance in Landsat TM bands and NDVI of sites sampled in Machadinho d'Oeste and Vale do Anari.

		Sum of squares	df	Mean square	F	Sig.
Band 1	Between Groups	1.408	3	.469	7.935	.001
	Within Groups	1.656	28	5.914E-02		
Band 2	Between Groups	5.889	3	1.963	14.456	.000
	Within Groups	3.802	28	.136		
Band 3	Between Groups	4.436	3	1.479	7.383	.001
	Within Groups	5.607	28	.200		
Band 4	Between Groups	925.239	3	308.413	53.620	.000
	Within Groups	161.050	28	5.752		
Band 5	Between Groups	167.230	3	55.743	61.877	.000
	Within Groups	25.225	28	.901		
Band 7	Between Groups	17.214	3	5.738	16.530	.000
	Within Groups	9.719	28	.347		
NDVI	Between Groups	23.357	3	7.786	.804	.502
	Within Groups	271.255	28	9.688		

Note: df = degrees of freedom; F = F test of significance; Sig. = Significance
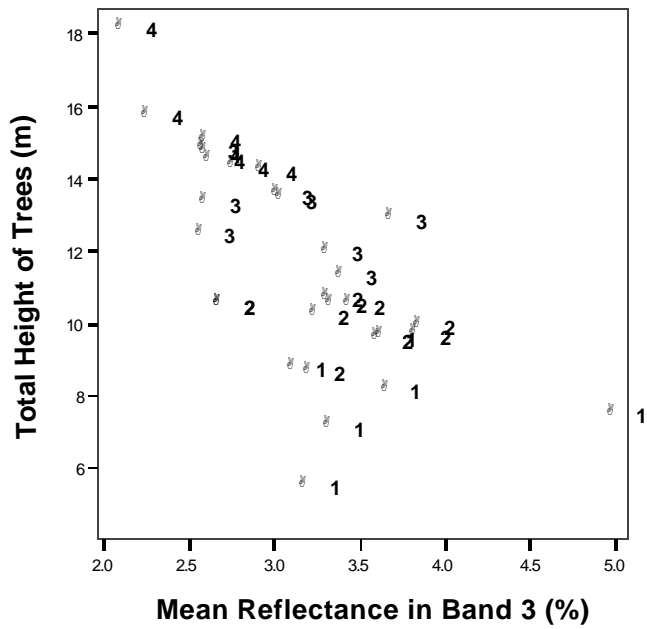
Figure 38 - Total height of trees and mean reflectance in Landsat TM band 3 within

vegetation classes sampled in Machadinho d'Oeste and Vale do Anari.
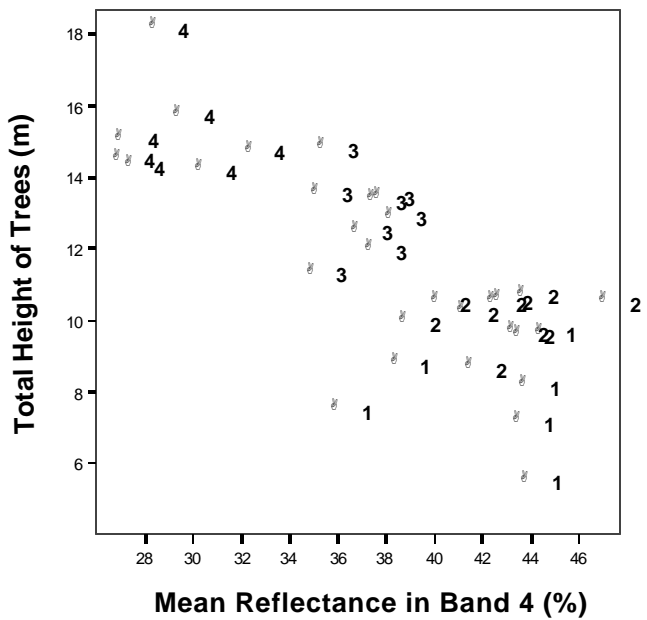

Figure 39 - Total height of trees and mean reflectance in Landsat TM band 4 within

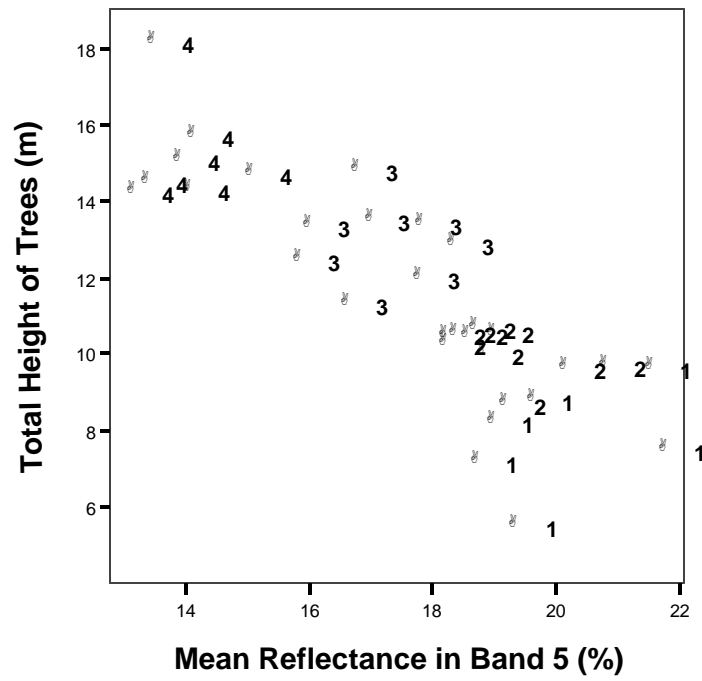vegetation classes sampled in Machadinho d'Oeste and Vale do Anari.

Figure 40 - Total height of trees and mean reflectance in Landsat TM band 5 within vegetation classes sampled in Machadinho d'Oeste and Vale do Anari.
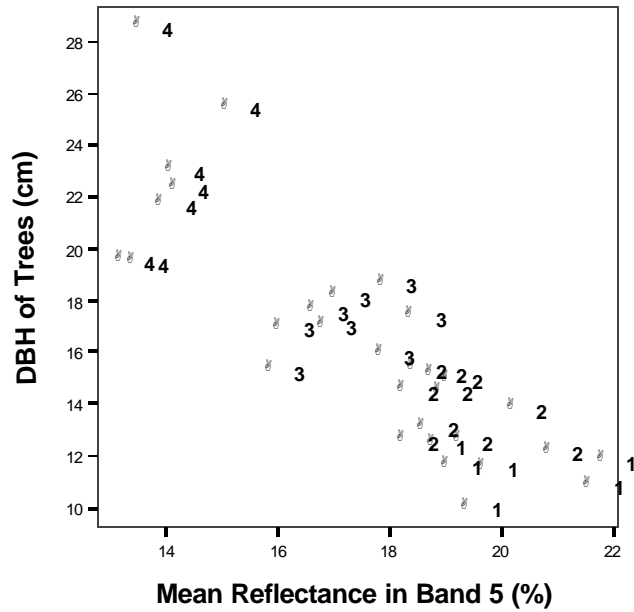
Figure 41 - DBH of trees and mean reflectance in Landsat TM band 5 within vegetation

classes sampled in Machadinho d'Oeste and Vale do Anari.

Figure 42 - Total basal area and mean reflectance in Landsat TM band 5 within

vegetation classes sampled in Machadinho d'Oeste and Vale do Anari.

Figure 43 - Density of trees and mean reflectance in Landsat TM band 5 within

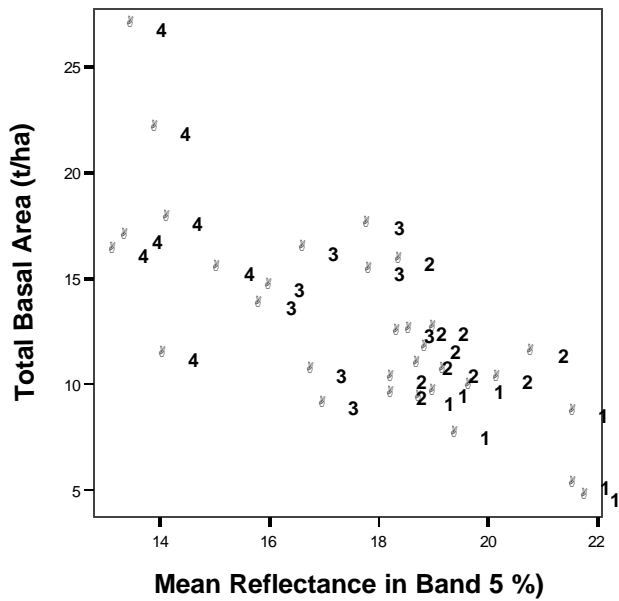vegetation classes sampled in Machadinho d'Oeste and Vale do Anari.

Figure 44 - Total biomass and mean reflectance in Landsat TM band 5 within vegetation

classes sampled in Machadinho d'Oeste and Vale do Anari.

Figure 45 - Total height, DBH, and mean reflectance in Landsat TM band 4 within

vegetation classes sampled in Machadinho d'Oeste and Vale do Anari.

Figure 46 - Total height, DBH, and mean reflectance in Landsat TM band 5 within

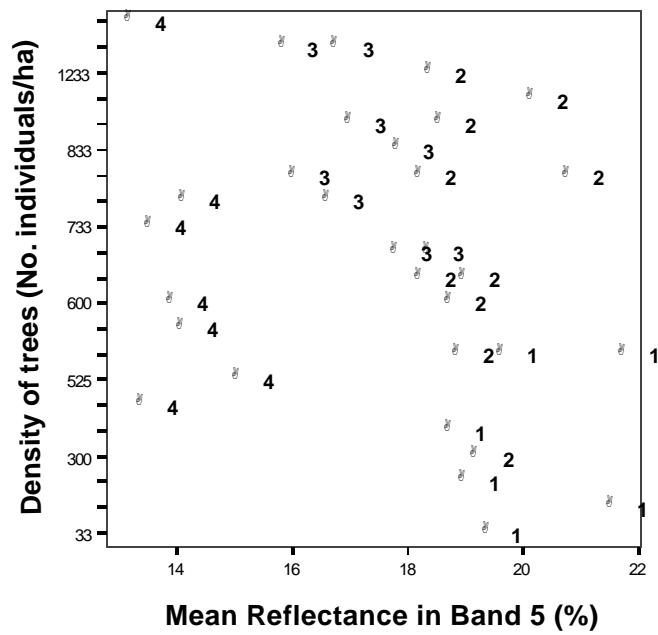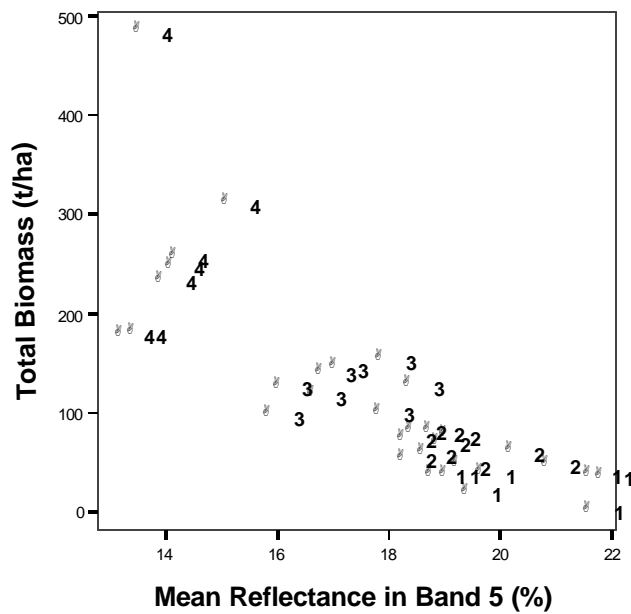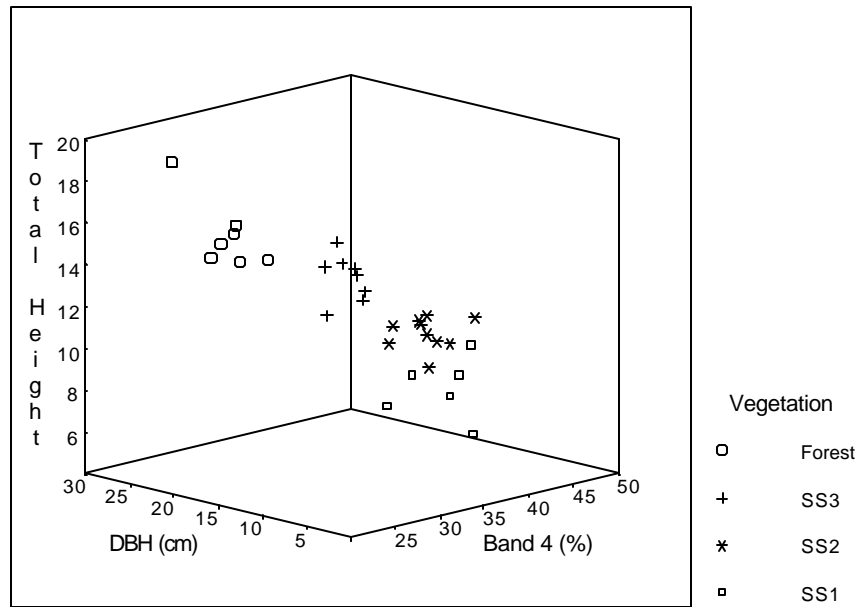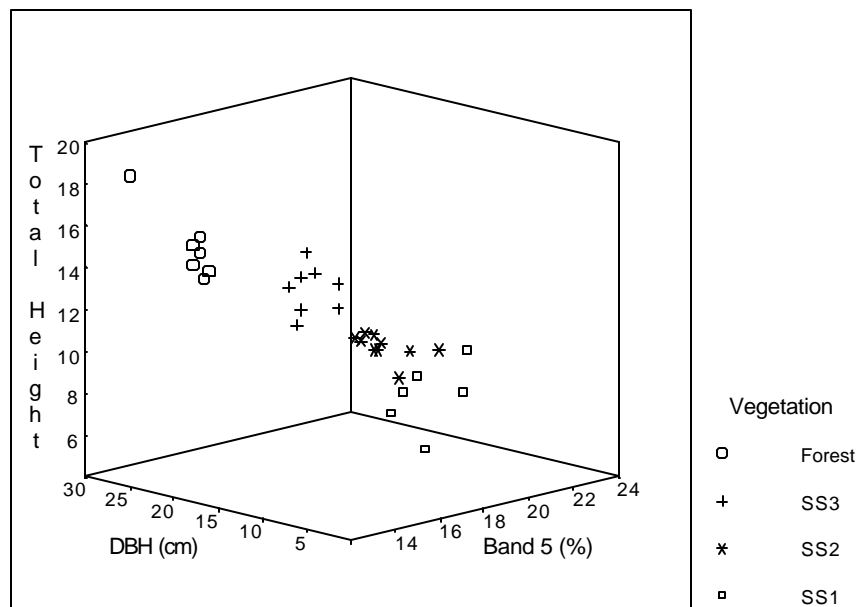vegetation classes sampled in Machadinho d'Oeste and Vale do Anari.

Table 11 - Pearson correlation coefficients for selected vegetation structure variables, mean reflectance in TM bands, and NDVI for sites sampled in Machadinho d'Oeste and Vale do Anari.

		Class	Age	Density of trees	Density of Saplings	Density Ratio	DBH of Trees	Basal Area of Trees	% Tree Basal Area	Total Basal Area	Height of Trees	Biomass of Trees	Total Biomass	Band 3	Band 4	Band 5	NDVI
Class	Correlation	1.000	.906	.432	-.732	-.445	.904	.818	.760	.764	.931	.835	.835	-.660	-.854	-.912	-.119
	Sig. (2-tailed)	.	.000	.015	.000	.012	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.516
Age	Correlation	.906	1.000	.351	-.688	-.335	.868	.801	.701	.730	.847	.833	.834	-.615	-.905	-.900	-.150
	Sig. (2-tailed)	.000	.	.053	.000	.066	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.413
Density of trees	Correlation	.432	.351	1.000	-.431	-.521	.270	.187	.153	.265	.444	.190	.191	-.269	-.226	-.350	.051
	Sig. (2-tailed)	.015	.053	.	.015	.003	.142	.313	.410	.150	.012	.307	.304	.143	.221	.054	.785
Density of Saplings	Correlation	-.732	-.688	-.431	1.000	.589	-.673	-.574	-.573	-.525	-.731	-.616	-.616	.419	.614	.618	.108
	Sig. (2-tailed)	.000	.000	.015	.	.000	.000	.001	.001	.002	.000	.000	.000	.017	.000	.000	.557
Density Ratio	Correlation	-.445	-.335	-.521	.589	1.000	-.401	-.312	-.347	-.331	-.505	-.301	-.301	.133	.331	.296	.150
	Sig. (2-tailed)	.012	.066	.003	.000	.	.025	.088	.056	.069	.004	.100	.099	.476	.069	.106	.421
DBH of Trees	Correlation	.904	.868	.270	-.673	-.401	1.000	.930	.902	.777	.914	.971	.971	-.631	-.830	-.851	-.101
	Sig. (2-tailed)	.000	.000	.142	.000	.025	.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.589
Basal Area of Trees	Correlation	.818	.801	.187	-.574	-.312	.930	1.000	.809	.907	.839	.952	.952	-.628	-.754	-.810	-.051
	Sig. (2-tailed)	.000	.000	.313	.001	.088	.000	.	.000	.000	.000	.000	.000	.000	.000	.000	.780
% Tree Basal Area	Correlation	.760	.701	.153	-.573	-.347	.902	.809	1.000	.575	.763	.816	.815	-.453	-.720	-.726	-.196
	Sig. (2-tailed)	.000	.000	.410	.001	.056	.000	.000	.	.001	.000	.000	.000	.009	.000	.000	.281
Total Basal Area	Correlation	.764	.730	.265	-.525	-.331	.777	.907	.575	1.000	.763	.795	.796	-.614	-.654	-.759	.011
	Sig. (2-tailed)	.000	.000	.150	.002	.069	.000	.000	.001	.	.000	.000	.000	.000	.000	.000	.954
Height of Trees	Correlation	.931	.847	.444	-.731	-.505	.914	.839	.763	.763	1.000	.879	.880	-.692	-.792	-.841	-.026
	Sig. (2-tailed)	.000	.000	.012	.000	.004	.000	.000	.000	.000	.	.000	.000	.000	.000	.000	.888
Biomass of Trees	Correlation	.835	.833	.190	-.616	-.301	.971	.952	.816	.795	.879	1.000	1.000	-.647	-.801	-.811	-.054
	Sig. (2-tailed)	.000	.000	.307	.000	.100	.000	.000	.000	.000	.000	.	.000	.000	.000	.000	.771
Total Biomass	Correlation	.835	.834	.191	-.616	-.301	.971	.952	.815	.796	.880	1.000	1.000	-.648	-.801	-.812	-.053
	Sig. (2-tailed)	.000	.000	.304	.000	.099	.000	.000	.000	.000	.000	.000	.	.000	.000	.000	.772
Band 3	Correlation	-.660	-.615	-.269	.419	.133	-.631	-.628	-.453	-.614	-.692	-.647	-.648	1.000	.476	.772	-.519
	Sig. (2-tailed)	.000	.000	.143	.017	.476	.000	.000	.009	.000	.000	.000	.000	.	.006	.000	.002
Band 4	Correlation	-.854	-.905	-.226	.614	.331	-.830	-.754	-.720	-.654	-.792	-.801	-.801	.476	1.000	.856	.364
	Sig. (2-tailed)	.000	.000	.221	.000	.069	.000	.000	.000	.000	.000	.000	.000	.006	.	.000	.041
Band 5	Correlation	-.912	-.900	-.350	.618	.296	-.851	-.810	-.726	-.759	-.841	-.811	-.812	.772	.856	1.000	-.026
	Sig. (2-tailed)	.000	.000	.054	.000	.106	.000	.000	.000	.000	.000	.000	.000	.000	.000	.	.887
NDVI	Correlation	-.119	-.150	.051	.108	.150	-.101	-.051	-.196	.011	-.026	-.054	-.053	-.519	.364	-.026	1.000
	Sig. (2-tailed)	.516	.413	.785	.557	.421	.589	.780	.281	.954	.888	.771	.772	.002	.041	.887	.