TUART STUDY

Further Investigations at Mt Brown-Wattleup 1986

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INTRODUCTION

This report is the second part of a study initiated in 1984 to examine the rate of change and the possible causes of decline in Tuart (**Eucalyptus gomphocephala**) near Mt Brown, Wattleup. The main objective of the present study was to compare the present status of Tuart and associated vegetation with the 1984 status. It is anticipated that continuing assessments of the Wattleup sites and other, control, sites would assist in isolating the major factors causing changes in the health and structure of Tuart woodlands in the Kwinana industrial belt and in particular, the effects of pollutants from surrounding industries.

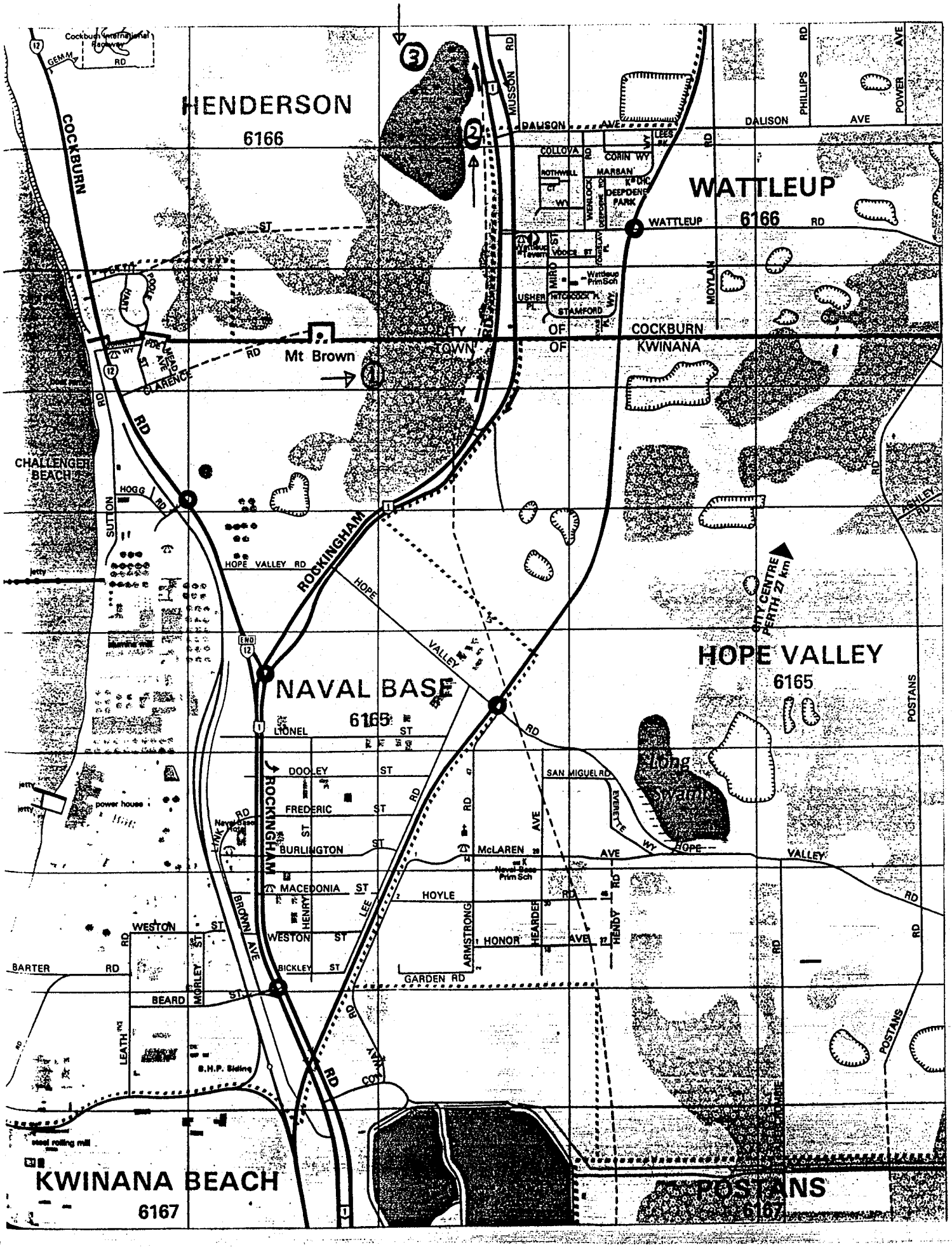
This report concentrates on two of the four criteria outlined in the first report (Fox & Dunlop 1985) for testing the effects of emissions from industrial facilities on the vegetation. These two criteria were:

1. Is there evidence of increased death over time?
2. Is there evidence of induced changes in the associated flora?

The 1986 investigation was restricted to the three sites in the Wattleup area, and comparative examinations of the other previously assessed areas (Bold Park and Neerabup) have not been made.

Figure 1 shows the location of the three sites at Wattleup. Site 1 is on a sloping hillside with an easterly aspect immediately east of the limestone ridge which forms the peak of Mt Brown. The Tuart here form an ill-defined belt of vegetation between the low limestone heath higher up the ridge to the west, and a mixed

FIGURE 1 Location of Sites Mt Brown-Wattleup Area



Eucalyptus marginata/Banksia woodland to the east towards Rockingham Road.

The Tuart at this site are the closest to the sea but receive some shelter from off-shore salt-laden winds by virtue of the limestone ridge. Site 1 lies north-east of the alumina refinery. Site 2 comprises trees to the south-east side of the low lying depression known as Brown Lake or Brownman Swamp, between Rockingham Road and the Lake edge. Site 3 is located to the north-west of Brownman Swamp on land sloping down to the **Melaleuca** fringe around the Lake. The Tuart here form a distinctive stand separated from a **Melaleuca rhaphiophylla** and sedge swamp (which surrounds the Lake) to the south-east and **Banksia** woodland to the north-east, with low heath further west.

METHODS

Sites were visited over the period April-May 1986. At each site measurements were made of representative Tuart trees measured in 1984, and a re-assessment made of the associated flora. Tuarts were assessed using:

1. Height (live and dead)
2. Stem diameter at breast height
3. Crown diameter (N-S, E-W) (live and dead)
4. Crown health (scoring system included in Appendix 1)
5. Number of stems.

The understorey vegetation was assessed using 10 x 1m plots running south of the tagged Tuarts. Trees measured in 1984 had not been permanently tagged. Most of the original trees at site 2

could not be found (tree 1-5 Tuart measurements were not available in 1984). However, trees 8, 9 and 10 were found and these are comparable with 1984 data. Trees 1-7 are 'new' and the 1986 data will be useful in any subsequent assessments.

Most of the discussion in this report is concerned with the 10 trees at site 1, and 8 of the 10 trees at site 3. Detailed vegetation assessments were neglected for trees 1 and 2 at site 3 which are both located in swampland and were considered impossible to assess accurately. Figures 2-4 show the location of individual Tuarts for each of the sites.

Field data were used to calculate the number of species per unit area, and the species richness and relative abundances of species. The contribution of each species to the community in terms of its frequency of occurrence, density of individuals, and percentage coverage was also determined. From these values the Importance Value Index (IVI) was determined for each species.

No account was taken of annuals and emphemerals in the 1984 study. At the time of the 1986 measurements many annuals and emphemerals were identifiable, or were separable as unknown seedlings. These have been included in importance value and species richness data to give an indication of the contribution of introduced annuals relative to perennial species. Importance values of perennials for the current survey (Table 1) are therefore scaled down relative to 1984 values, and the figures given are not strictly comparable. However some comparisons on changes in the relative importance of species from 1984 to 1986 can be made. For ease of comparison, annuals and unidentified

FIGURE 2 Site 1 Mt Brown-Wattleup

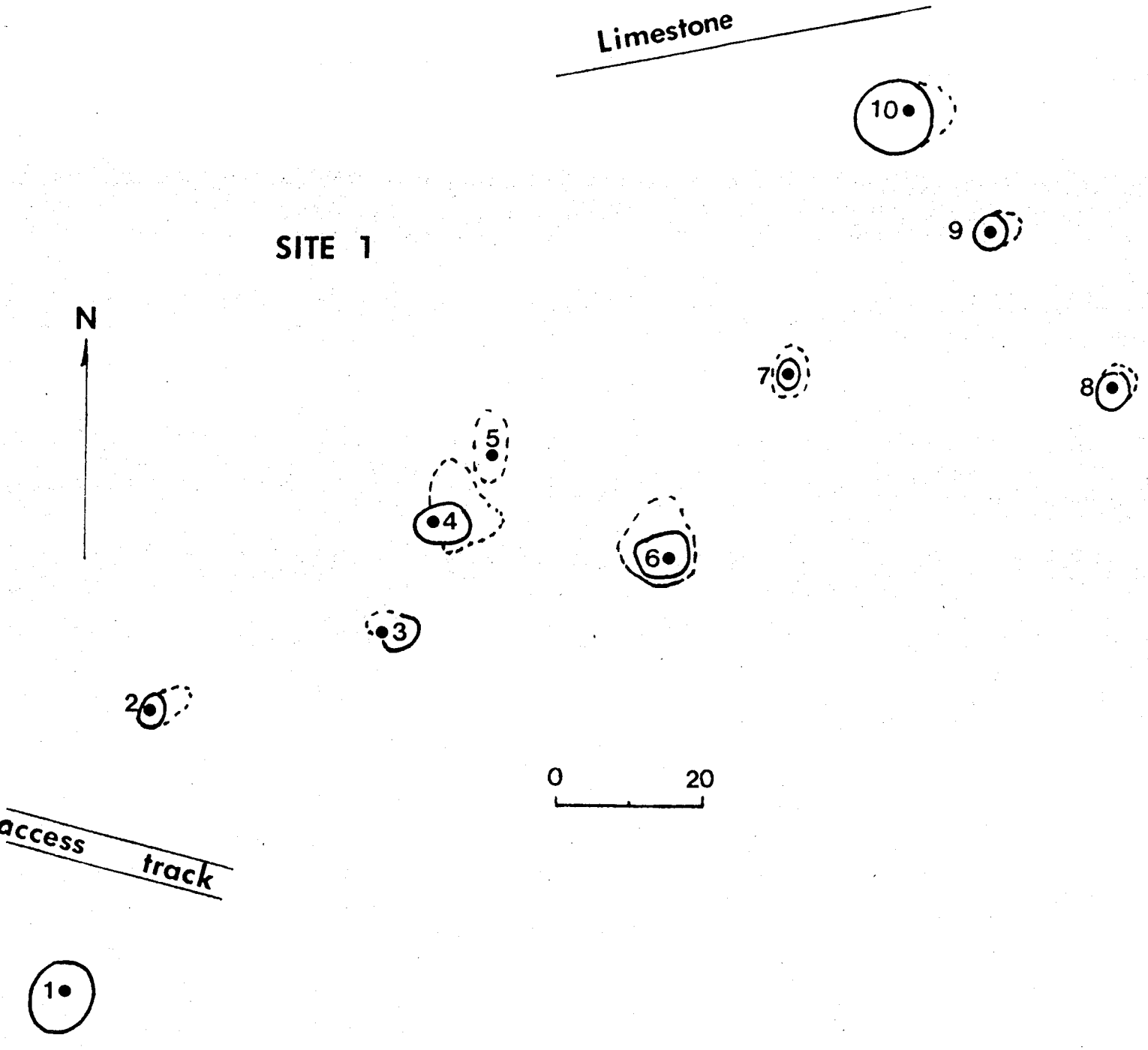


FIGURE 3 Site 2 Mt Brown Wattleup

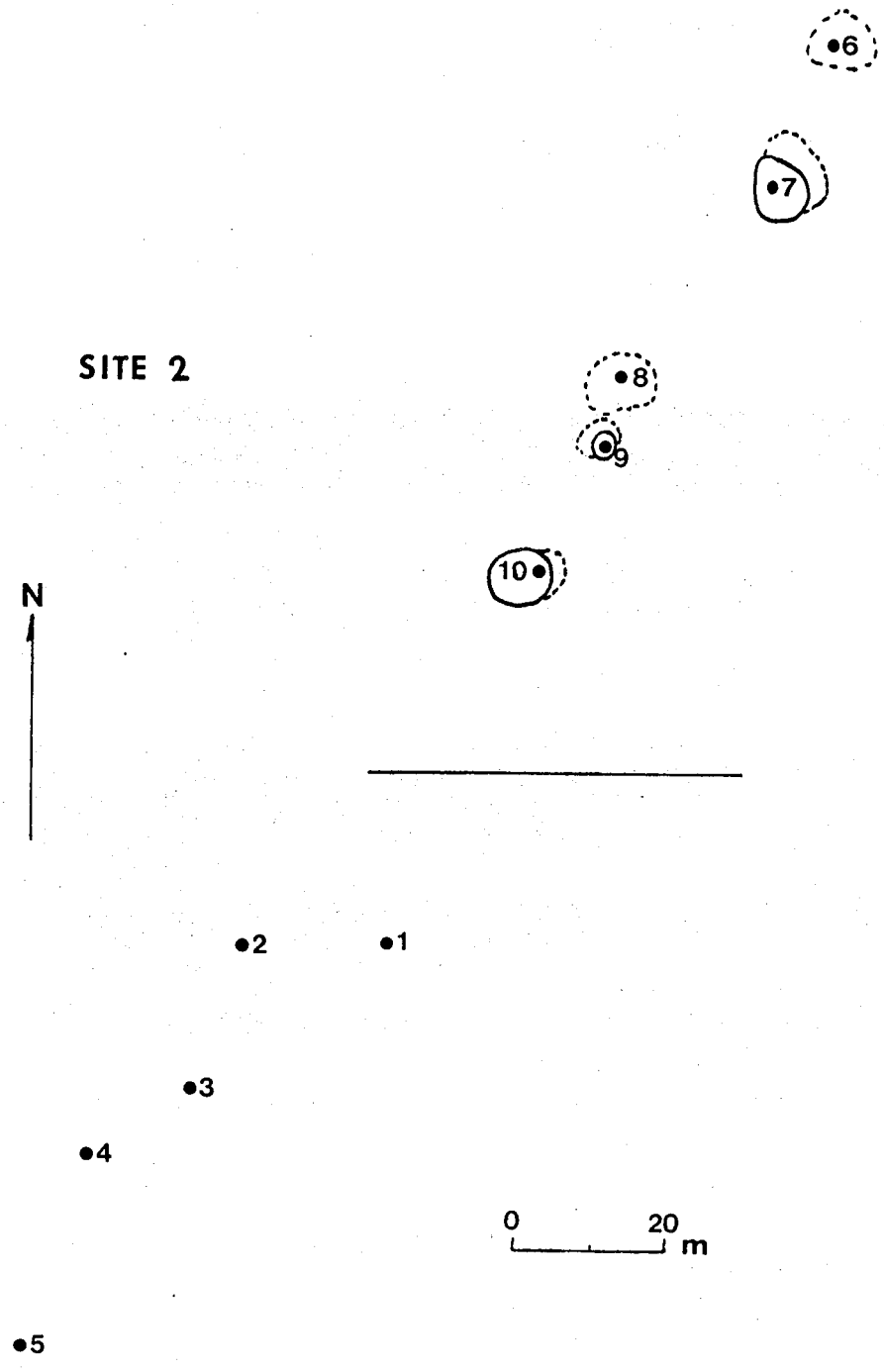
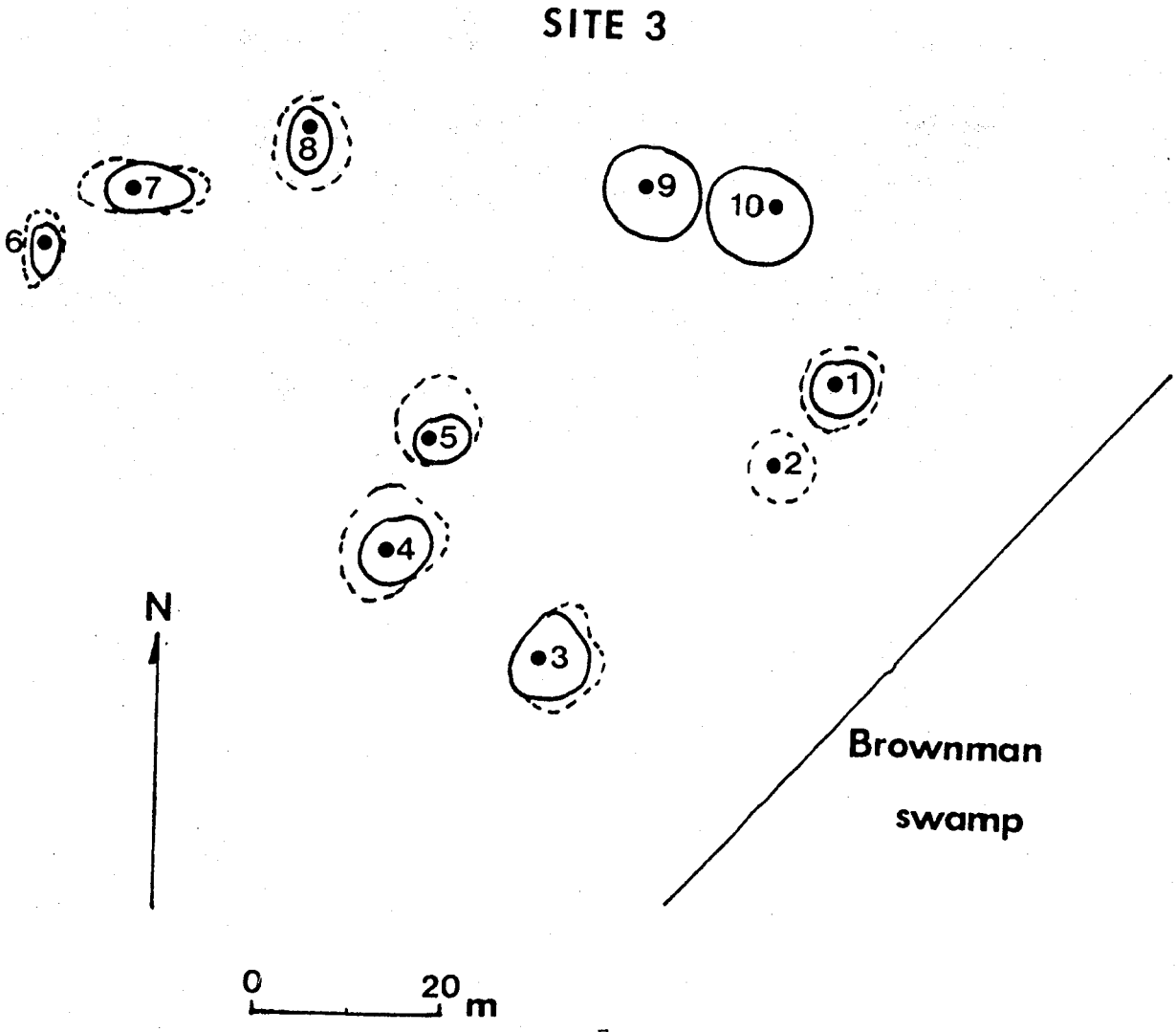


FIGURE 4 Site 3 Mt Brown Wattleup



seedlings have been grouped for the species area curves for the Mt Brown general locality (Figures 8 & 10).

Status of Tuart Trees

Measurements of Tuart trees for 1984 and 1986 are summarised in Appendix 1. It should be noted that all measurements involve some margin of error. Nevertheless, some interesting changes have occurred. These are discussed separately for each site.

Site 1

The most obvious change over the two year period was the death of tree 7 which had a crown health score of 2 in 1984. This tree had the lowest live height and crown diameter measurements in 1984. Trees 3 and 5 were already dead in 1984 and the mean crown health score for the remaining live trees was 2.1. This represents a fall of 0.28 from 1984.

Live crown diameter from N to S increased to some extent for all but two of the live trees. A reduction from 5.3 metres to 3m was recorded for tree 10; the decline of 0.1m for tree 9 may be attributed to error. Tree 10 also exhibited a decrease in crown diameter from E to W, a lower crown health score (from 2 to 1.5), and no apparent growth in terms of height.

A fall in the E-W crown diameters was recorded for trees 4, 6 and 8. This was accompanied by a decline in live heights for trees 4 and 6 and a lower crown health score for trees 4 and 8. Apart from dead height, mean values for all tree health measurements increased over the two year period at site 1 (t-tests conducted

on live tree measurements proved statistically significant).

Site 2

Only three of the ten trees measured at site 2 are comparable to 1984 data. One of these was dead in 1984 (tree 8). Trees 9 and 10 have both apparently 'improved' in health according to the recorded measurements. It should be noted that the 1984 set of measurements for understorey species for this site could not be correlated with the present distribution of Tuart trees. Data collected in 1986 should form the basis for comparison with further assessments.

Site 3

Overall mean values increased for most tree measurements between 1984-1986. Trees 1, 3, 6 and 9 had live height increases of 0.5m or more. Height changes were negligible for the remainder. As was the case at site 1, all trees had top death and the mean crown health score had fallen from 3.06 in 1984 to 2.94 in 1986 (for live trees). Live crown diameters of trees 5, 6 and 10 had slightly receded from N-S, and trees 1, 7, 9 and 10 from E-W.

Tuarts from all considered sites have not shown major changes over the two year period. Tuarts at site 1 were the most severely affected over the two years with one tree dying and several showing receding crowns in terms of height and crown diameter. Changes in dead height measurements are presumably a result of loss of dead branches. Stem diameter measurements showed mean increases of 0.24cm (site 3) and 1.69cm (site 1). These will be more useful in following Tuart health over a longer study period.

Associated Flora

Species Richness

The species richness of an area gives an indication of the degree of disturbance (or stability) of a vegetation area. Some species cannot persist if an area suffers detrimental environmental change whereas others, such as many of the introduced annuals, may flourish. Members of the Poaceae and Asteraceae tend to be over-represented in Tuart stands where environmental disturbance has been a major influence.

Introduced grasses and other annuals were not included in species richness analysis in 1984 because most had died off. As mentioned previously, many (though not all) annuals and emphemerals were identifiable in the 1986 study and have been included so that an assessment of their contribution to the vegetation can be made. A re-assessment of the species richness for each site is also necessary because previously sampled transects were not permanently marked. This years plots (now marked) may not be positioned in exactly the same spot although this is unlikely to have resulted in any major differences. Figures 5-10 are a series of species area curves which are indicators of the numbers of species likely to be encountered per unit area for each site and for the Mt Brown general locality. Figures 5-7 summarise the species area data for the 24 Mt Brown-Wattleup plots separately by sites. The total number of species per $10m^2$ varied from 6 to 22 (including annuals and emphemerals). Total species varied from 4 to 14 in 1984. As in 1984, site 1 (Figure 5) recorded the richest variety of species, and site 3

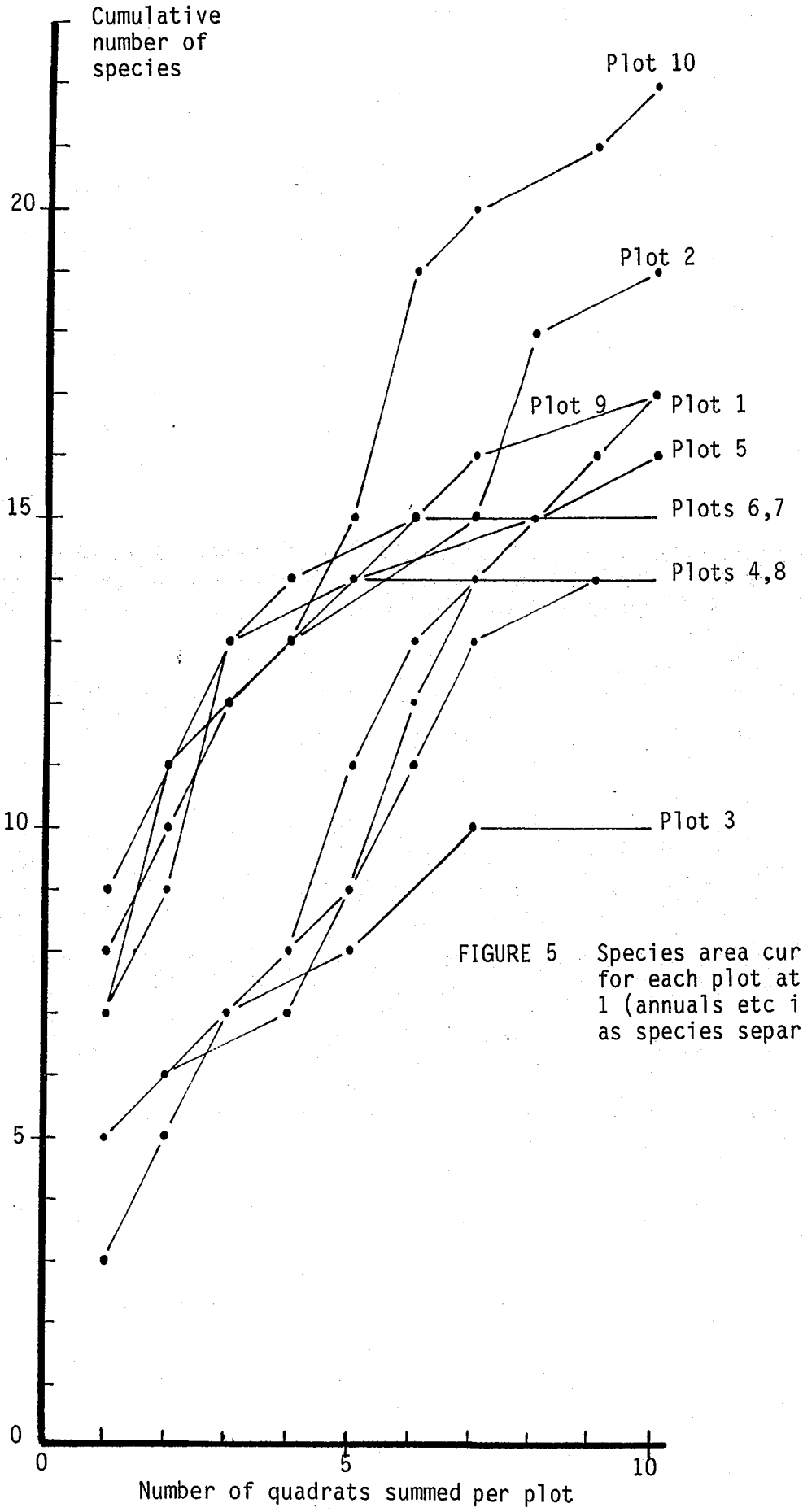
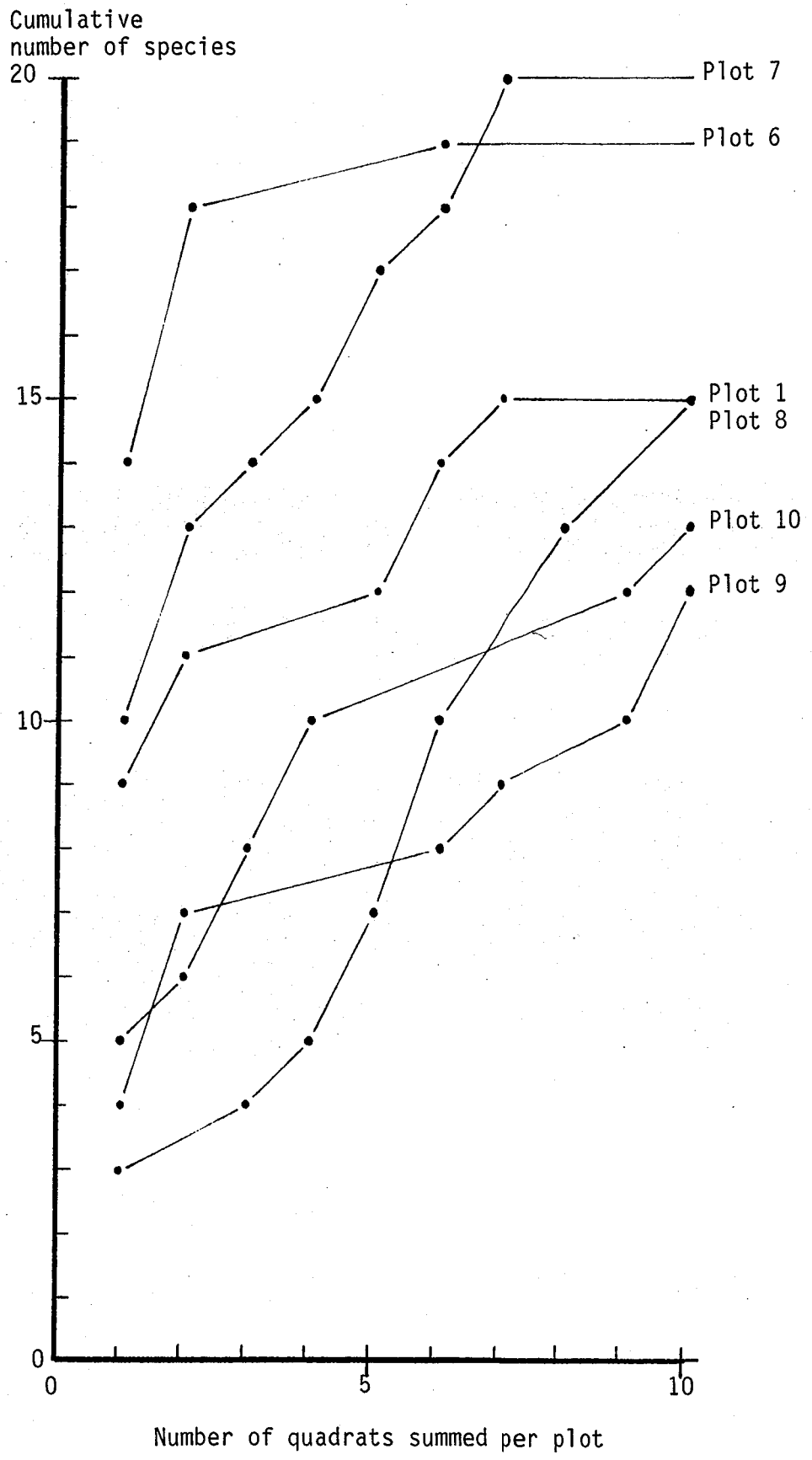


FIGURE 5 Species area curves for each plot at Site 1 (annuals etc included as species separately).

FIGURE 6 Species area curves for each plot at Site 2 (annuals etc included as species separately).



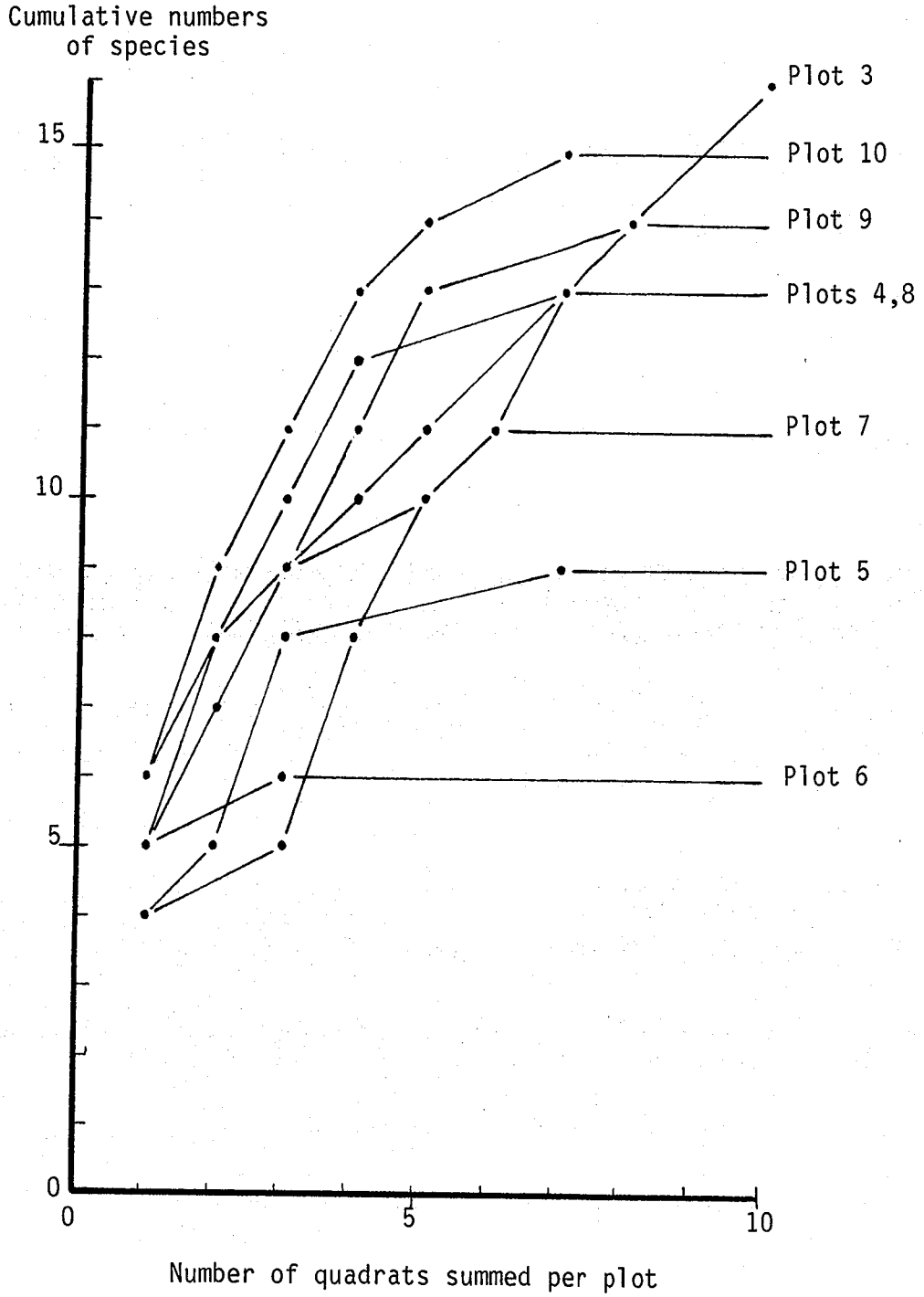


FIGURE 7 Species area curves for each plot at Site 3 (annuals etc included as species separately).

(Figure 7) the poorest (with plot totals ranging from 6 to 16). Site 2 gave the greatest increase with the highest total increasing from 10 species in 1984 to 20 species in 1986 (Figure 6).

The actual proportion of the increase in species richness which can be attributed to the inclusion of introduced annuals can be seen in Figure 8. This shows the mean cumulative number of species for all plots at each site, with and without annuals separated (where they are grouped, all annual species are considered as one). Mean totals including annuals separately show a similar trend for sites 1 and 2 with site 3 recording considerably less species. However, there is less disparity between sites 2 and 3 where annuals are grouped. The mean total is slightly higher for site 3 than site 2 (10.7 compared to 9.8). This indicates that site 3 is richer in native perennial species than site 2. This was not the case in 1984. It should also be noted that plots 1 and 2 were excluded from this years analysis. Species from these plots would have increased the mean and total numbers of species encountered for site 3 if included.

Site 1 remains the most species rich site using this method. This may be due to its proximity to the limestone ridge where a number of calcicole species were present.

Figure 9 shows the cumulative total of species encountered at each site. Each new species is added to the cumulative total at the area position in which it was recorded. Total figures are again higher than in 1984 because of the inclusion of annuals. Total species ranged from 21 at site 2, to 30 at site 3 and 32 at

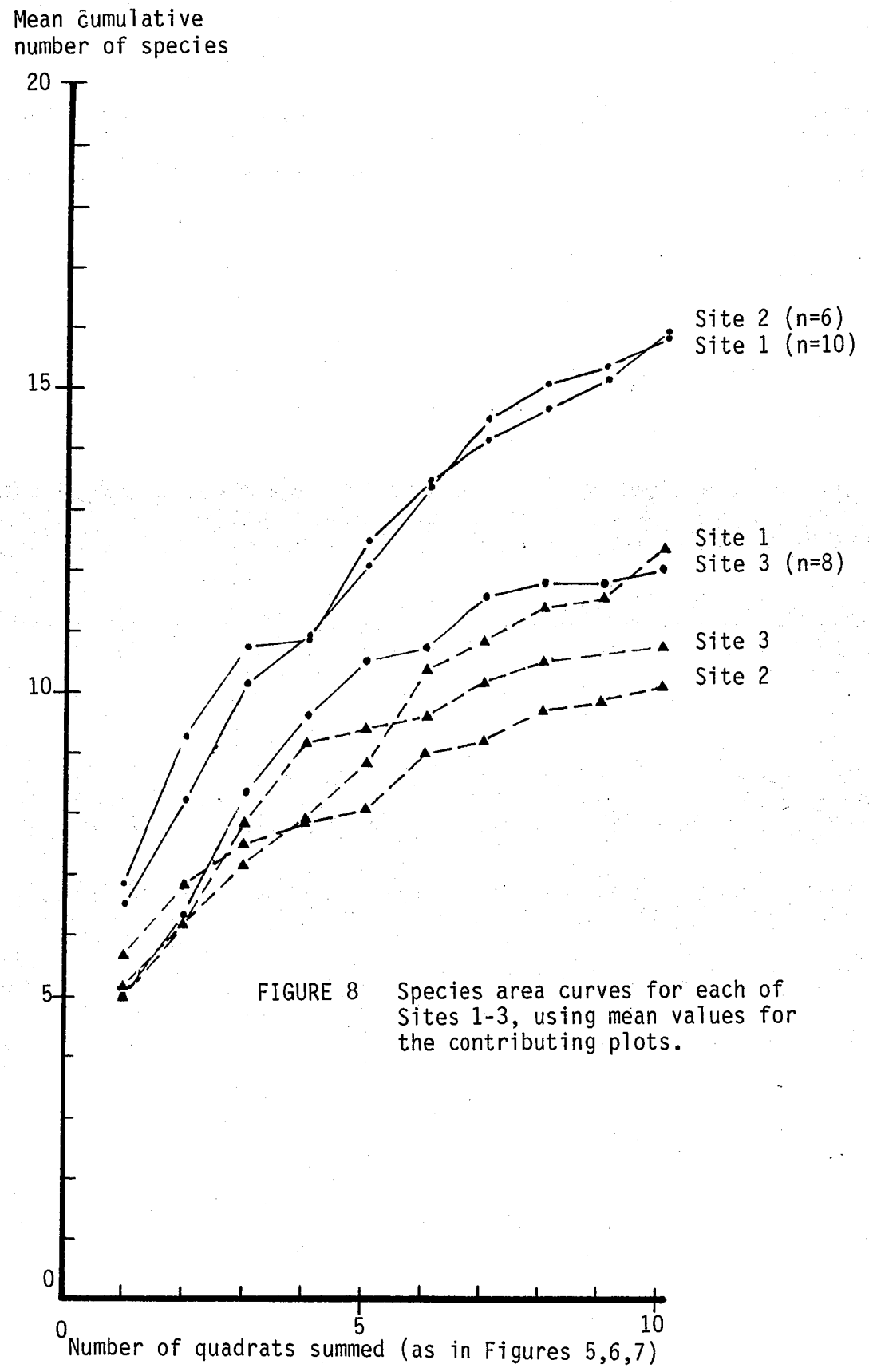


FIGURE 8 Species area curves for each of Sites 1-3, using mean values for the contributing plots.

• Annuals and unidentified seedlings counted separately

▲ Annuals and unidentified seedlings counted as a group

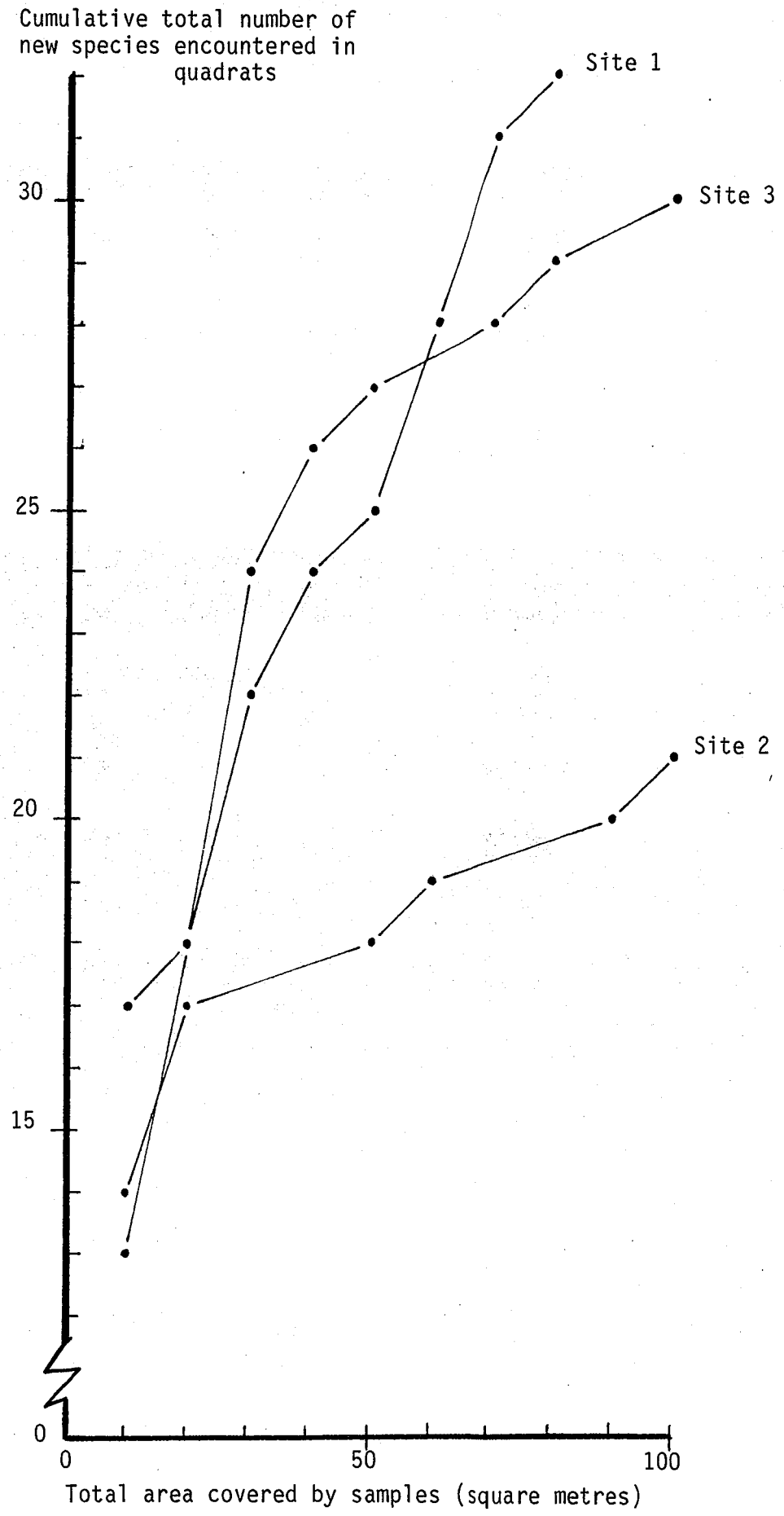
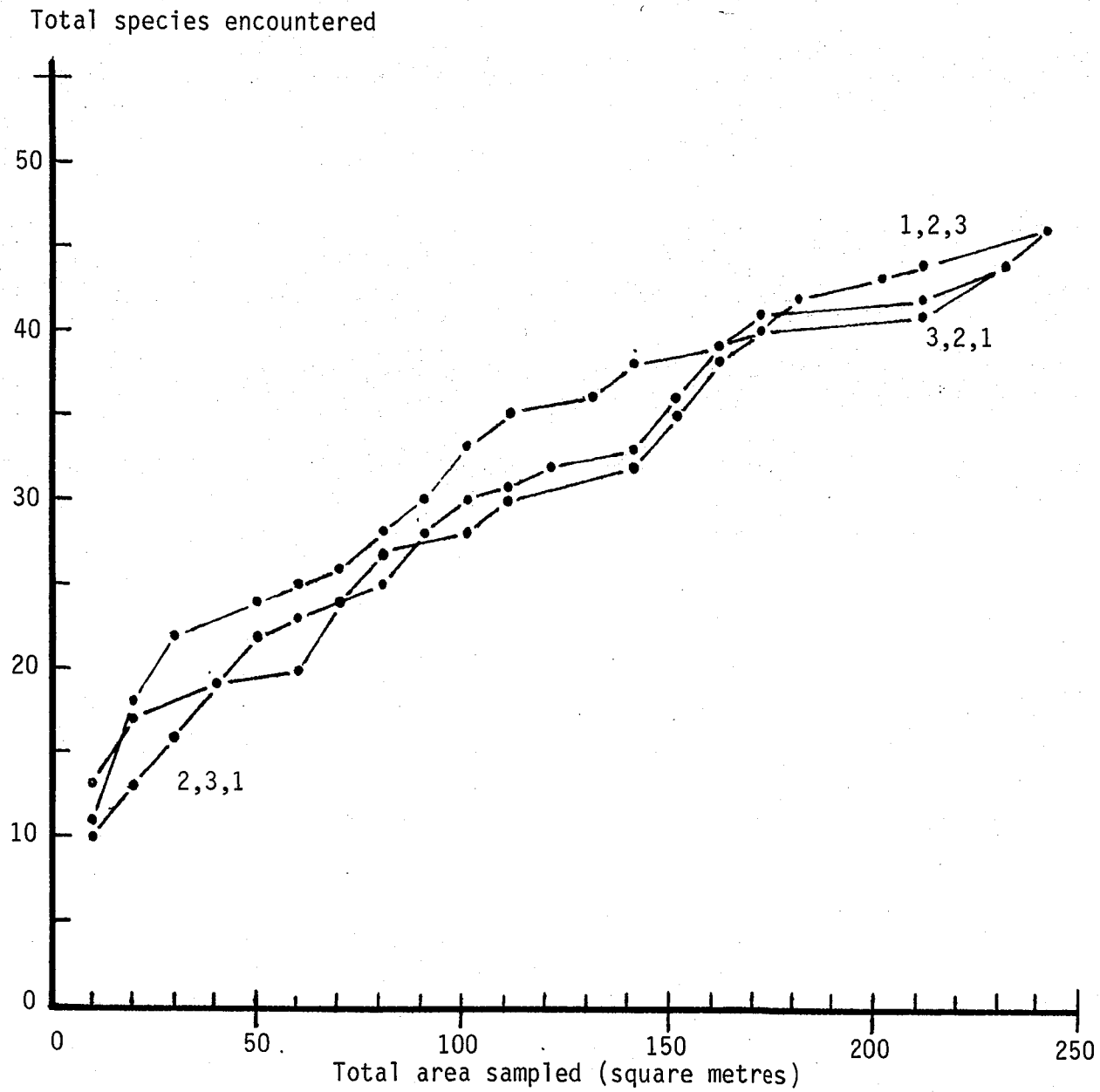


FIGURE 9 Total species area curves at each of the three sites (annuals etc. included as species separately).

FIGURE 10 Species area curve for the Mt Brown-Wattleup locality using all quadrats successively, and lumping data from 3 starts as shown (annuals etc. included as species separately).



site 1. This compares with 19, 19 and 26 species respectively in 1984. A revision of the species area curve for the Mt Brown locality is shown in Figure 10. 36(78 percent) of the 46 species recorded at Mt Brown would be encountered in a sample size of $140\text{-}160m^2$ (depending on which site is taken first). This compares with $160\text{-}210m^2$ in 1984. This curve is useful for comparison with other Tuart localities.

Importance Values

In the present report I have decided not to compare importance values of perennial species for 1984 and 1986, though this of course could be done by excluding annuals recorded in 1986 but not in 1984. Thus for the data presented it is not valid to compare absolute importance values for species between years because of the inclusion of introduced annuals and seedlings in the 1986 data set. However, it is useful to consider alterations in the relative importances of species at each site.

Table 1 lists the mean IVI's for species at each site for the two years (alphabetical order). There are no great differences in the order of importance of species at site 1. Total mean IVI for annuals and unidentified seedlings constitute by far the highest value (96) in 1986. This is more than double the most important perennial which was **Xanthorrhoea preissii** (40). In 1984, **Conostylis candicans** was recorded as the most important species (number 2 in 1986). **Hibbertia hypericoides, Dryandra nivea** and **Eucalyptus gomphocephala** maintained the same relative importances. As in 1984, the remainder of the ten most important perennial species included **Banksia menziesii, Melaleuca acerosa**

TABLE 1. Mean importance values of species recorded at Mt Brown for 1984 and 1986.

Species	Site 1		Site 2		Site 3	
	1986	1984	1986	1984	1986	1984
Acacia pulchella	3.95	-	-	-	-	-
A. rostellifera	-	-	-	(1.6)	4.25	3.3
A. saligna	-	-	4.19	(2.12)	2.02	5.38
A. truncata	-	0.29	-	-	-	-
Acanthocarpus preissii	-	-	31.23	(33.57)	-	-
*Anagallis arvensis	3.64	-	59.85	(2.12)	-	-
*Arctotheca calendula	0.43	-	-	-	-	-
Banksia attenuata	3.09	10.41	-	-	-	-
Banksia menziesii	13.35	19.22	-	-	-	-
*Briza maxima	-	-	1.35	-	-	-
Burchardia umbellata	0.16	-	-	-	-	-
*Cactus	-	-	-	-	0.27	-
Carpobrotus virescens	-	-	-	-	1.0	1.0
Clematis microphylla	-	1.26	2.16	(2.88)	-	-
C. pubescens	-	-	3.18	-	0.26	-
Conostylis candicans	34.14	59.2	0.3	-	-	-
Corynotheca micrantha	0.17	-	-	-	-	-
Dianella revoluta	0.39	1.0	-	(1.07)	-	-
Dryandra nivea	19.63	30.6	-	-	7.09	25
*Ehrharta calycina	25.96	-	-	-	-	-
Eremophila glabra	-	-	-	-	-	1.51
Eriostemon spicatus	-	2.1	-	-	-	-
*Erodium cicutarium	1.67	-	3.26	-	3.82	-
Eucalyptus gomphocephala	15.09	22.5	25.52	(30.45)	27.44	62.9
E. marginata	-	-	-	-	0.53	2.0
Euphorbia sp.	0.5	-	2.97	-	-	-
*Geranium molle	4.11	-	7.27	-	-	-
Grevillea thelemanniana	0.15	1.22	-	-	-	-
G. vestita	3.67	4.54	-	-	-	-
Hardenbergia comptoniana	2.01	2.4	1.1	(6.04)	3.72	6.0
Helichrysum cordatum	-	0.25	-	-	-	-
Hibbertia hypericoides	30.51	39.4	-	-	38.48	65.6
H. polystachya	1.77	3.9	-	-	0.76	2.3
Hovea stricta	-	-	-	-	-	0.66
Hypocalymma angustifolium	-	0.55	-	-	-	-
*Hypochaeris glabra	26.51	-	2.52	-	-	-
Kennedia prostrata	0.16	-	-	-	2.31	-
*Lactuca sativa	3.51	0.47	2.5	-	-	-
Laganifera huegellii	0.16	-	0.58	-	-	-
*Lagurus ovatus	28.7	-	10.36	-	-	-
Lepidosperma angustatum	-	2.6	2.33	(23.59)	-	-
L. gracile	1.2	11.7	0.32	(0.91)	-	-
Leucopogon parviflorus	-	-	0.85	(10.5)	0.72	2.1
*Lily weed	0.53	-	0.27	(11.28)	0.77	-
Lomandra endlicheri	1.59	-	-	(1.1)	-	-
Loxocarya flexuosa	4.76	4.2	-	-	6.94	-
Macrozamia reidlei	4.0	6.3	0.85	(2.9)	11.09	18
Melaleuca acerosa	13.11	19.99	-	-	-	-
Mesomelaena stygia	0.16	-	-	-	-	-
Oxalis corniculata	0.86	-	10.91	-	3.22	-

Phyllanthus calycinus	-	0.77	17.06	-	10.24	3.58
Rhagodia baccata	-	0.3	-	-	0.59	-
Schoenus grandiflorus	1.5	2.4	11.42	(0.7)	0.88	-
Scirpus antarcticus	-	4.37	0.38	-	-	-
***Solanum nigrum**	1.24	-	-	-	-	-
***Sonchus sp.**	-	-	0.48	-	-	-
Stipa sp.	-	-	-	-	6.85	-
Thysantous patersonii	0.48	-	-	-	0.2	-
***'Trikkala'**	-	-	0.71	-	-	-
Unidentified Poaceae (3 species)	0.6	-	-	-	2.99	-
Unidentified seedlings (9 species)	4.44	-	15.64	-	117.75	-
Total annuals & unidentified seedlings	96.07	-	94.38	-	120.74	-
Xanthorrhoea preissii	40.24	48.3	82.66	(145)	43.75	52.7

* introduced

and Macrozamia reidlei. However, Lepidosperma gracile and Banksia attenuata declined in importance and Loxocarya flexuosa and Acacia pulchella (not recorded in 1984) had higher values.

Annuals and unidentified seedlings were considerably over-represented at site 3 which contained the greatest proportion of annuals of all the sites (IVI 118). No major restructuring in importance of the major species occurred although, as in site 1, Xanthorrhoea preissii was the top species in 1986 instead of Hibbertia hypericoides. The ten most important perennial species in 1986 were as follows:- Xanthorrhoea preissii, Hibbertia hypericoides, Eucalyptus gomphocephala, Macrozamia reidlei, Phyllanthus calycinus, Dryandra nivea, Loxocarya flexuosa, Acacia rostellifera, Hardenbergia comptoniana and Kennedia prostrata.

Two of these species were not in the top ten in 1984 and were not recorded as being present at site 3. These were Loxocarya flexuosa and Kennedia prostrata. These replaced Acacia saligna and Hibbertia polystachya which both fell in relative importance.

Site 2, data as mentioned above, are not comparable because sampled plots were in different areas than in 1984. However these plots still sampled essentially the same community and certain trends are apparent. The order of the three main species is the same for both years. Xanthorrhoea preissii is well over-represented and far more important than at sites 1 and 3. Acanthocarpus preissii, absent from sites 1 and 3, is also well represented. This was also the case in 1984. The ten main species recorded in 1986 are as follows:- Xanthorrhoea preissii, Acanthocarpus preissii, Eucalyptus gomphocephala, Phyllanthus calycinus,

Schoenus grandiflorus, Acacia saligna, Clematis pubescens, Euphorbia sp., Lepidosperma angustatum and Clematis microphylla. Annuals and unidentified seedlings again have the highest IVI (94).

It is difficult to draw any conclusions from these importance value data in terms of floristic change over the two year period. Exclusion of annuals in the 1984 data sets complicate the patterns but it would appear that rearrangements in the relative importances of most species are subtle. Xanthorrhoea preissii recorded the highest importance value of perennials at all sites, no doubt a reflection of the high incidence of fires in the Mt Brown area. Site 1 had a more even distribution of importance values than sites 2 and 3 which tended to be dominated by fewer species. There appears to be no simple or direct relationship between Tuart health and floristic diversity between the three sites. This may merely indicate that there is insufficient difference between the three sites in terms of environmental disturbance, and does not negate the possibility of such a relationship existing for Tuart areas in general. It may be of more benefit to consider changes in the Mt Brown area as a whole in relation to other less disturbed Tuart woodlands (such as at Ludlow and Neerabup).

The inclusion of introduced annuals and emphemerals in importance value data clearly quantifies the degree of environmental disturbance in all three of the Mt Brown sites. However, it is suggested that these species could be ignored in future assessments (particularly if made during summer/autumn) because

of the difficulty in identifying and counting them, and due to the seasonal dependence of such species. Careful assessments of the perennial species should provide an adequate gauge of floristic change.

CONCLUSIONS

The present study has shown that little change has occurred in the Mt Brown locality since 1984. In general, Tuart health does not appear to have shown a decline over the period although one Tuart died at site 1. Several other trees exhibited receding crowns at sites 1 and 2.

Analysis of associated flora showed that site 1 was the most species rich. This was also the case in 1984; site 3 was the least rich in 1984 whereas site 2 showed the most environmental disturbance in 1986.

Future assessments of the Mt Brown locality require to be conducted over a longer period (e.g. 5 years). For vegetation surveys perennials should be concentrated on. It would also be more useful to continue comparisons of the Wattleup sites with observations in more stable Tuart stands (such as at Ludlow and Neerabup) in a similar fashion to the work carried out in 1984. This would enable wiser and more scientifically based judgements to be made concerning indicator species and the effects of industrial pollution on the Tuart environment. As it stands, no quantification can be made of the effects of industrial effluents in the Wattleup area.

REFERENCE

Fox, J.E.D., and J.N. Dunlop. 1985. Tuart Study: Preliminary Investigations. Mulga Research Centre, School of Biology, WAIT, Bentley.

ACKNOWLEDGEMENTS

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APPENDIX 1

Tree measurement data for tuarts at sites 1, 2 and 3, Mt Brown-Wattleup.

Tuart measurements at site 1, Mt Brown, 1984 and 1986 data.

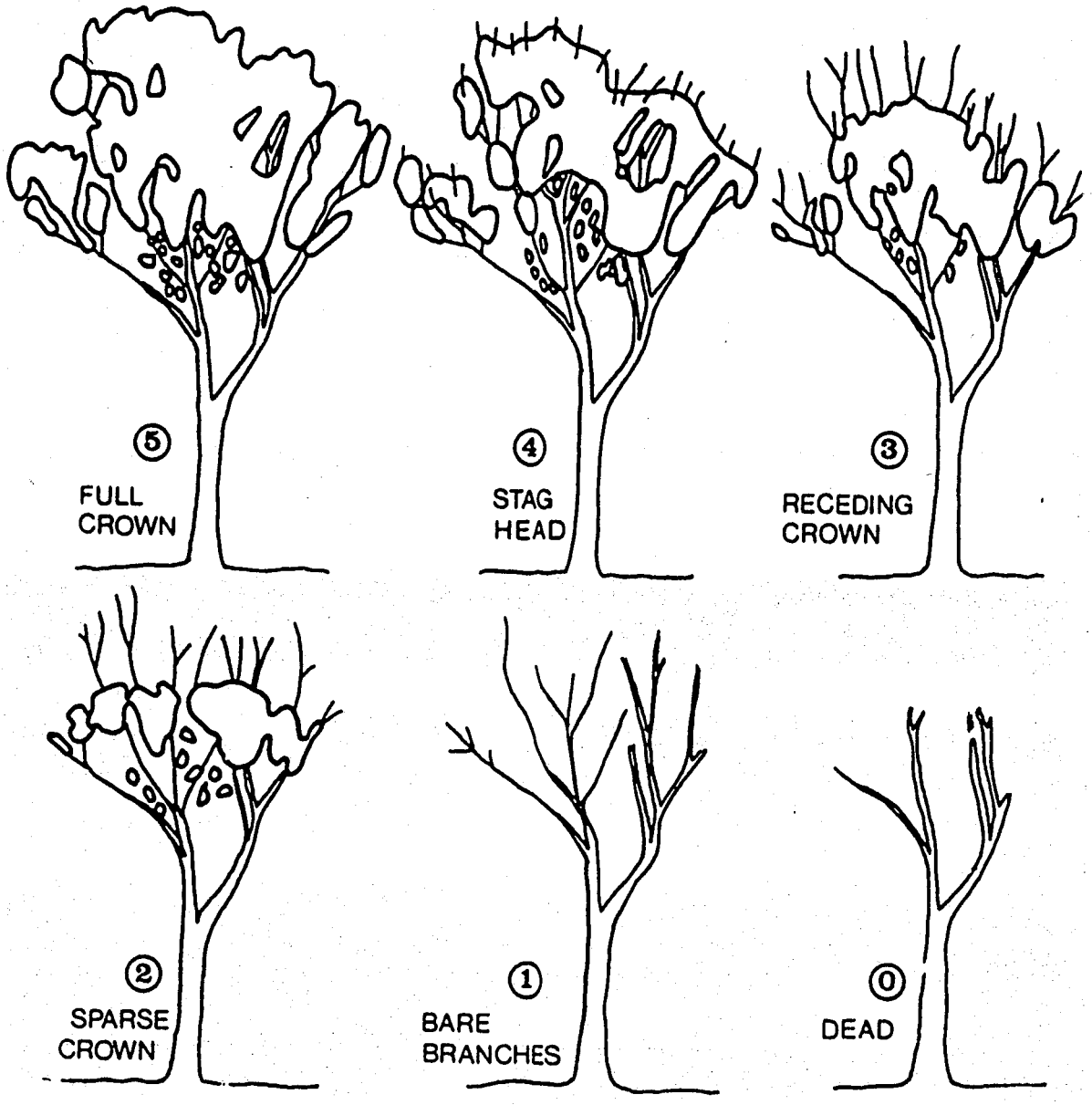
TREE	CROWN HEALTH (0-5)		HEIGHT (M) Alive		HEIGHT (M) Dead		STEM DIAMETER (cm) at 1.5m		CROWN DIAMETER Alive N-S		CROWN DIAMETER Alive E-W		CROWN DIAMETER Dead N-S		CROWN DIAMETER Dead E-W	
	1984	1986	1984	1986	1984	1986	1984	1986	1984	1986	1984	1986	1984	1986	1984	1986
1	4	4	13.6	17.1	14.1	20	64.4	65	10.9	11.5	9.1	11.3	-	12.1	-	11.3
2	1.5	1.5	5.8	5.7	10.5	12.6	41.5	43	3.6	5.2	4.2	12.6	-	-	5.1	3.8
3	DEAD		-	-	19.2	-	61.5	-	-	-	-	-	5.6	-	6.3	-
4	2	1.5	9.9	5.8	15.8	16.5	107.7	108	5.9	6.6	8.8	5.6	13.9	15	12.2	11.8
5	DEAD		-	-	12.6	-	85.7	-	-	-	-	-	10.1	-	3.1	-
6	2	2	13.4	13.1	14.9	16	54.0	55	5.9	6.3	9.1	7	14.4	12.3	11.2	11.9
7	2	DEAD	4.0	-	8.8	-	36.5	-	3.6	-	2.5	-	4.9	-	5.3	-
8	3	2	11.5	12.7	16.3	-	38.5	40	7.6	9.2	9.5	7.9	3.1	14.6	4.0	8.6
9	2	2	8.7	8.9	13.7	12.1	72.4	69	4.6	4.5	5.1	5.5	6.0	4.5	8.6	9.4
10	2	1.5	4.2	4.1	7.5	11	24.0	42	5.3	3	5.5	4	6.3	4.6	5.5	5.3
MEAN (live trees)	2.38	2.1	8.89	9.6	13.36	12.6	58.61	60.3	5.92	6.6	6.72	7.7	8.04	9.0	6.81	8.9

Tuart measurements at site 2, Mt Brown, 1984 and 1986.

TREE	CROWN HEALTH (0-5)		HEIGHT (M) Alive		HEIGHT (M) Dead		STEM DIAMETER (cm) at 1.5m		CROWN DIAMETER Alive N-S		CROWN DIAMETER Alive E-W		CROWN DIAMETER Dead N-S		CROWN DIAMETER Dead E-W		NO. OF STEMS
	1984	1986	1984	1986	1984	1986	1984	1986	1984	1986	1984	1986	1984	1986	1984	1986	
1	-	4	-	21.7	-	-	-	59	-	10.2	-	12.6	-	-	-	-	1
2	-	4.5	-	21.1	-	-	-	70	-	13.5	-	13.3	-	-	-	-	2
3	-	4.5	-	28.5	-	-	-	59.5	-	16.6	-	15.3	-	-	-	-	2
4	-	3.5	-	13.05	-	15.6	-	28.6	-	6.9	-	6.3	-	-	-	-	1
5	-	4	-	22.4	-	23.8	-	68.6	-	13.5	-	12.4	-	-	-	-	1
6	-	3	-	16.9	-	19.9	-	89.5	-	5.9	-	8.0	-	18.1	-	21.3	1
7	-	4	-	25.6	20.2	26.3	-	123.5	-	22.3	-	18.1	-	23.65	-	-	1
8	0	0	-	-	20.5	-	72.0	-	-	-	-	-	12.8	-	13.0	-	-
9	2	2	8.1	8.15	15.5	11.35	65.6	66.0	2.9	5.2	2.7	3.95	5.6	8.05	4.0	6.55	1
10	2	4.5	22.1	25.8	22.2	20.5	121.0	123.5	16.6	20.8	17.1	23.95	-	-	11.3	-	1
MEAN (live trees)	-	3.4	-	20.36	-	13.05	-	76.47	-	12.77	-	12.66	-	5.53	-	3.09	1.2

Tuart measurements at site 3, Mt Brown, 1984 and 1986.

TREE	CROWN HEALTH (0-5)		HEIGHT (M)				STEM DIAMETER (cm) at 1.5m		CROWN DIAMETER								NO. OF STEMS
			Alive		Dead				Alive				Dead				
									N-S		E-W		N-S		E-W		
	1984	1986	1984	1986	1984	1986	1984	1986	1984	1986	1984	1986	1984	1986	1984	1986	
1	2.5	2.5	9.9	12.0	19.2	19.4	66	67.5	6.7	8.1	8.1	5.7	11.4	12.0	13.0	10.0	1
2	0	0	DEAD		20.9	-	123.7	109	-	-	-	-	12.9	-	9.4	-	1
3	3.5	4.5	23.7	26.9	-	29.7	107	111	18.5	26.9	14.3	16.3	20.2	29.7	8.9	11.0	1
4	3	3.5	21.5	23.5	23.4	24.2	138	137	12.2	14.0	10.8	13.0	20.3	20.4	16.5	18.7	1
5	2	2	11.8	11.2	14.0	18.6	68.2	68.5	4.0	3.4	3.7	3.8	13.7	13.8	9.5	8.0	1
6	3	2	8.0	12.3	11.5	15.8	34.2	35	7.2	5.9	2	3.0	9.9	9.5	4.9	4.0	3
7	3	2	9.5	11.5	12.5	16.1	68.3	69	2.6	4.0	10.7	9.9	3.5	6.2	14.9	13.5	1
8	2.5	2	10.7	15.0	15.9	17.9	98.7	100	4.4	5.1	4.4	6.8	10.2	9.5	11.1	14.7	1
9	4	4.5	20.6	21.0	-	22.5	91	92	13.8	17.9	18.3	14.0	-	17	-	15.3	1
10	4	3.5	22.2	22.3	-	-	70.3	74	15.2	12.8	16.2	16.8	-	12.7	-	17.5	2
MEAN (live trees)	3.06	2.94	15.32	17.3	16.77	20.52	86.54	86.3	9.4	10.89	9.83	9.92	12.76	14.53	11.02	12.52	1.3



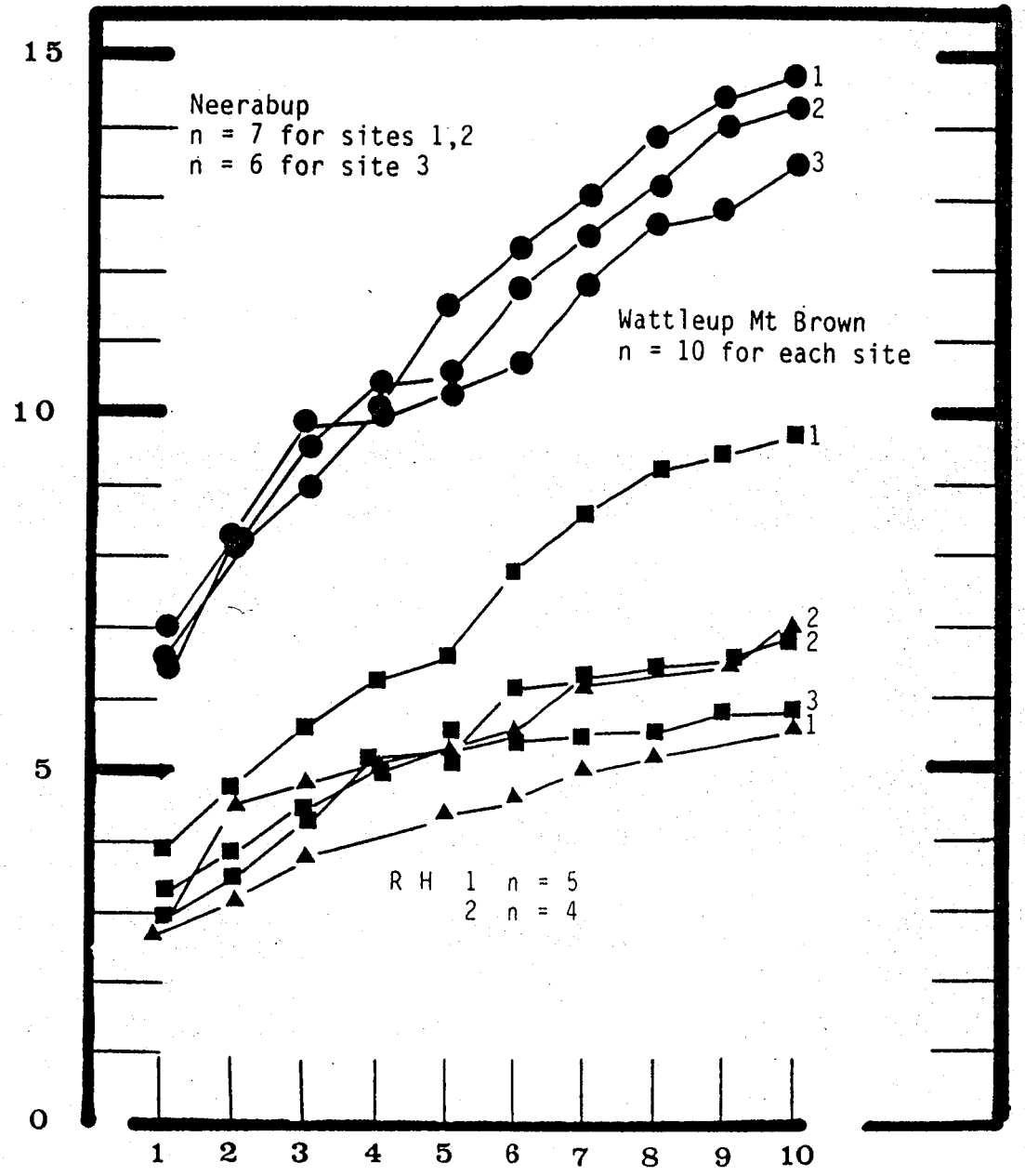
Scoring system for crown health status.

Appendix 2

Appendix 3

Species Area Curves 1984 Data Sets

FIGURE 1 3 Localities (8 sites)



Mean cumulative totals of all species encountered for sets of 10 1 x 1m quadrats located from near the base of Tuart trees (20 at Neerabup, 30 at Mt Brown, 9 at Reabold Hill)

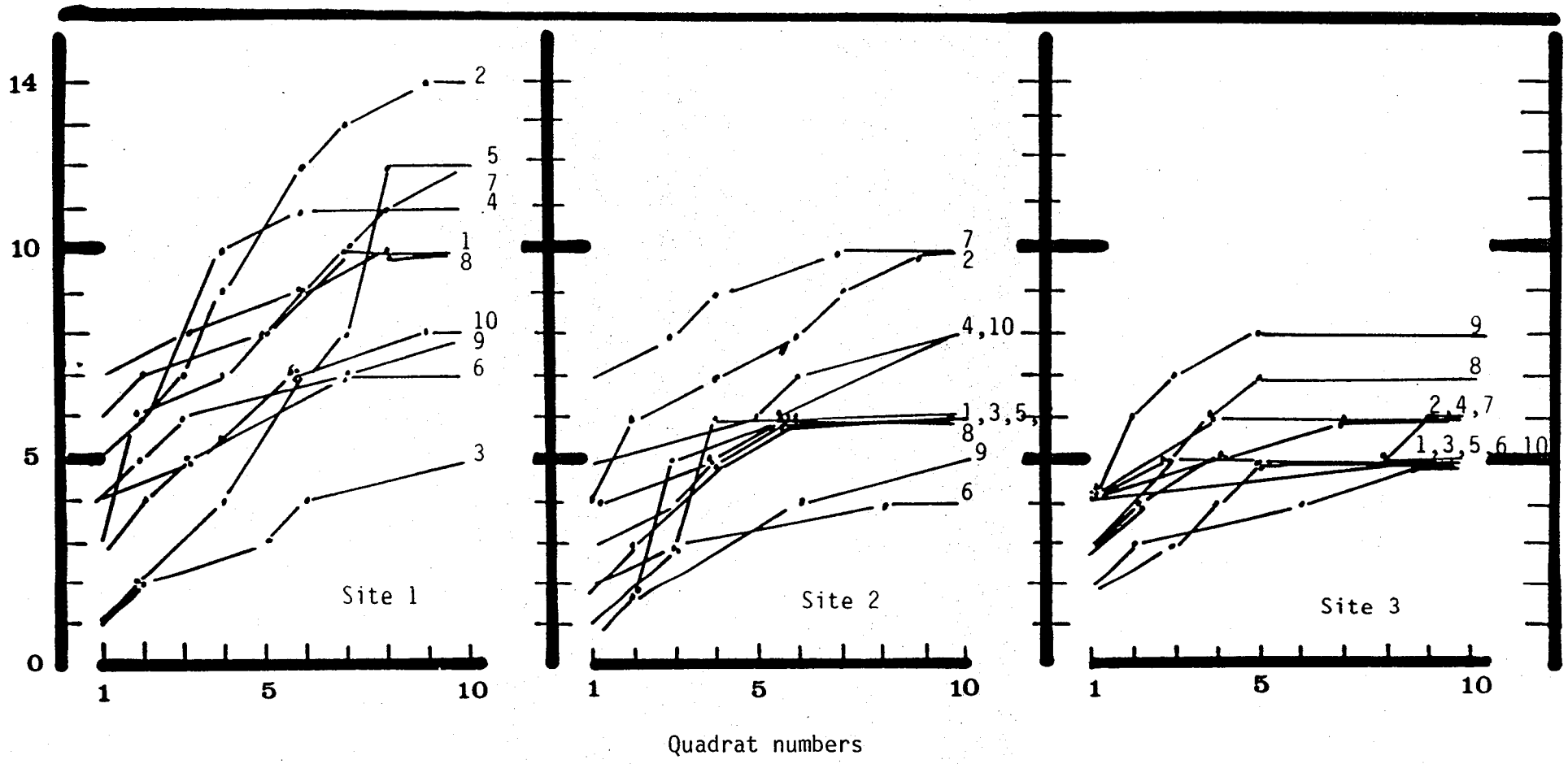


FIGURE 2 Species area curves for all 1 x 10 m plots at the three Wattleup-Mt Brown sites.

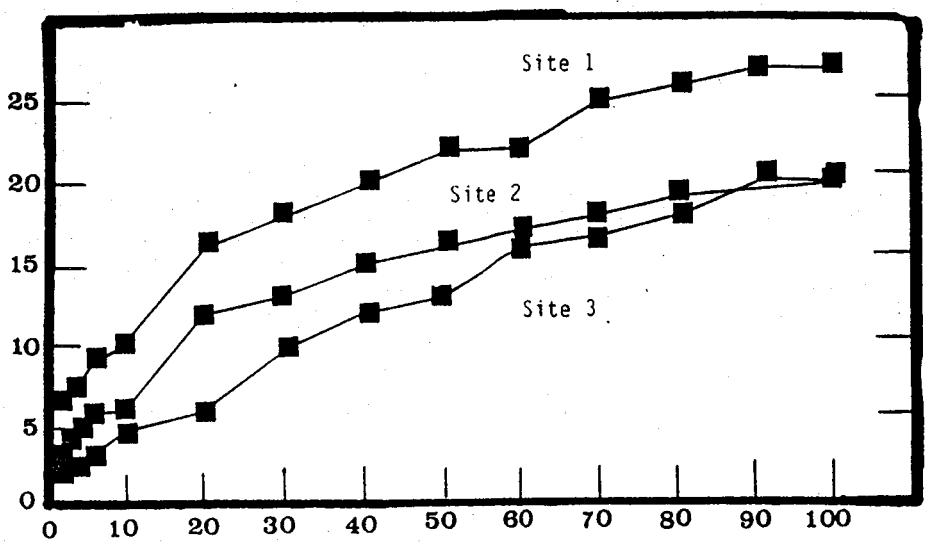


FIGURE 4 Species area curves for each of the 3 Mt Brown-Wattleup sites.

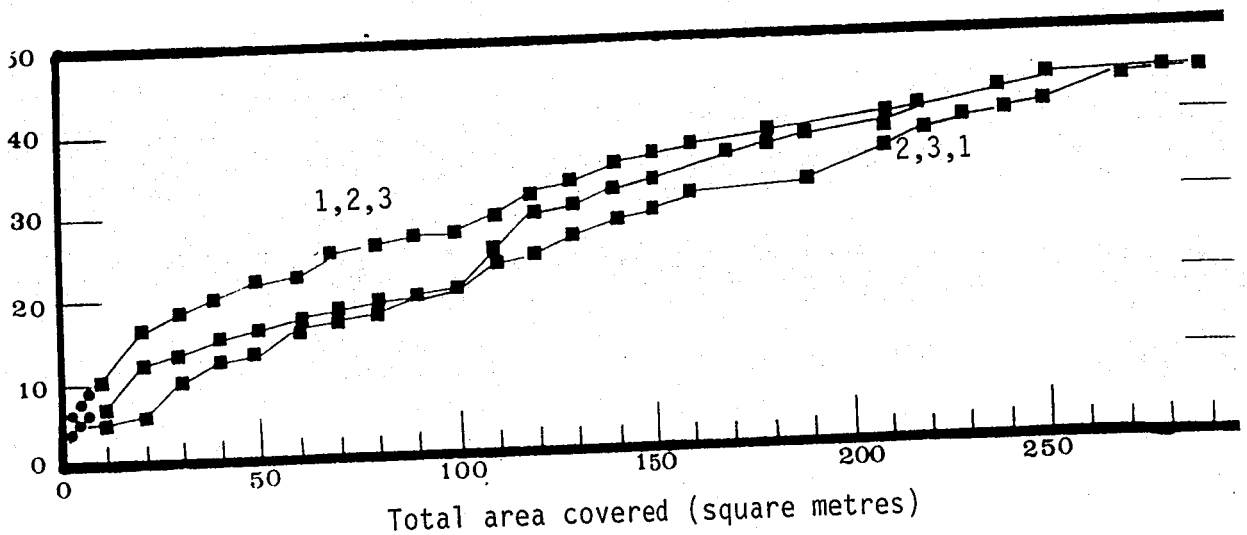


FIGURE 5 Species area curve for the Mt Brown-Wattleup locality. Each curve using all quadrats successively, lumping data from 3 starts as shown.