REGIONAL TRAPPING OF AUSTRALIAN RINGNECK PARROTS (*BARNARDIUS ZONARIUS*) TO REDUCE VEGETATION DAMAGE : RESULTS OF THE KOJONUP TRIAL

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FINAL REPORT

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A KOJONUP LCDC PROJECT

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EXECUTIVE SUMMARY

Damage to vegetation caused by Twenty-eight Parrots (the name commonly used in Western Australia for the various forms of the Australian Ringneck parrot *Barnardius zonarius*) has become a problem in south-west Western Australia in recent years. Extensive parrot damage occurs in commercial Bluegum plantations and other farm tree and landcare plantings, orchards, vineyards, crops and farm gardens. Damage and deaths of Grasstrees have been observed in remnant native vegetation from Moora to Frankland.

Open season shooting of Twenty-eight Parrots is currently permitted, but shooting is costly and time consuming and has not provided effective management of the problem at a regional level. More effective control methods have been sought by farmers. This project aimed to establish whether a regional community trapping program could achieve a significant reduction in Twenty-eight Parrot numbers and the damage they cause to planted trees and Grasstrees.

Trapping was conducted in a 160,000 hectare area immediately south-west from Kojonup, over a 23 month period from May 1997 to March 1999. Many farmers also continued to shoot parrots in the trial area during the trial. Parrot counts (estimates of abundance) and River Red Gum and Grasstree damage were monitored in both the trapping area and in adjacent 'control' (no trapping) areas to determine if trapping/shooting had an effect on parrot abundance and damage activities. Monitoring started several months prior to commencement of trapping.

It is estimated that about 63,400 parrots were removed during the 23 month trial, an estimated 2.6 to 3.3 fold increase on pre-trial levels. Of the total number of parrots culled during the trial, 69 % were trapped. Participation of land owners in the trapping trial was good, reaching 67 % in the second year. However, the number of parrots removed was limited by the relative sparsity of traps (due to the large size of farms in the area) and the fact that more than 60 % of landholders interviewed in the area trapped less than 500 parrots per year. During the trial the design for a large, walk-in trap that proved easy to use and effective, was adopted and developed.

Results show that at a regional level, culling an estimated 63,400 parrots over 23 months did not greatly reduce parrot counts, River Red Gum damage or Grasstree damage. While there were significant reductions from pre-trapping levels in parrot counts and Grasstree damage in the Trapping area, the reductions were not large enough relative to trends in the Control areas to conclude that they were due to trapping. Other factors (not fully understood) had a bigger effect on parrot browsing than did trapping. Most landholders in the trapping area interviewed on completion of the trial thought that numbers of parrots were similar to or greater than pre-trapping, after trapping commenced.

There is not a definitive explanation of why trapping did not have a great effect on parrot abundance and damage activity. The most likely explanation is that insufficient numbers of parrots were culled given the base parrot population size, breeding rates and /or mobility. Again, there is insufficient understanding of parrot mobility to know whether the size of the trapping area was sufficient for a large parrot cull to effect a 'durable' large decline in parrot abundance in the area.

There was some evidence that ongoing intensive trapping/shooting (at least 1000 parrots per year) provided a degree of local control of parrot damage. However, even intensive ongoing culling cannot guarantee successful management of parrot damage in high damage areas or during 'high damage years'.

Recommendations are made for improving the effectiveness of any future Twenty-eight Parrot trapping program, some alternative approaches to the application of trapping in problem areas are outlined, other mechanisms for managing parrot damage are raised and questions for further research are listed.

CONTENTS

1.0 INTRODUCTION

Twenty-eight Parrot is the name commonly used in Western Australia for the various forms of the parrot *Barnardius zonarius* (Australian Ringneck). Two subspecies of the Australian Ringneck are recognised in Western Australia. These are *Barnardius zonarius semitorquatus* and *Barnardius zonarius zonarius* (Johnstone and Storr, 1998).
Barnardius zonarius semitorquatus occurs in the very south-west corner of Western Australia including the forest areas on the Darling Range (Johnstone and Storr, 1998). It is a slightly larger parrot than *B. z. zonarius* which occurs on the edge of the wheatbelt and further to the north and east in the more arid and semiarid areas of Western Australia.
Barnardius z. zonarius has a yellow belly (rather than green as in *B. z. semitorquatus*) and little or no red frontal band above the bill. In more recent years a hybrid of these two subspecies has been identified which coincides with the wheatbelt and agricultural areas east of the Darling scarp and north of Perth (Figure 1). The study area (including the Boyup Book, Kojonup and Cranbrook Shires) is situated within this hybrid zone. In recognition of the local name given to these parrots, the Australian Ringneck will be referred to as the Twenty-eight Parrot in this report.

Damage to vegetation by the Twenty-eight Parrots has become a problem in south-west Western Australia in recent years. Damage has been reported to commercial Bluegum (*Eucalyptus globulus*) and other farm tree and landcare plantings, Balga Grasstree (*Xanthorrhoea preissii*) stands in native bush, orchards and vineyards, crops and farm gardens. Ritson (1995) reported that damage to Bluegum tree crops caused by Twenty-eight Parrots is an emerging problem which could threaten the viability of the Bluegum industry in south-west Western Australia. He found that between 4% and 98% of trees at twelve Bluegum sites were damaged by Twenty-eight Parrots. Damage and deaths of Balga Grasstrees (hereafter referred to as simply Grasstrees) have been observed in remnant native vegetation from Moora to Frankland (McNee 1997; Porter 1998). Porter reported that over a 12 month period between 1997 and 1998, the number of Grasstrees grazed increased by 16.9 % at 28 sites. By 1998, 12 of 28 sites had 50 % or more of their Grasstree populations grazed by Twenty-eight Parrots.

Twenty-eight Parrots strip bark from branches and lead shoots of bluegums and other trees. Bark removal that exposes wood tissue can result in breakage or death of the stem and stem structural deformity and development of lateral shoots. Development of lateral shoots below the area of stem damage results in multi-stemmed trees with reduced or no commercial value depending on the length of the undamaged section of trunk.

Twenty-eight Parrots also browse the fronds of Grasstrees cutting them off at the base. The parrots appear to chew small chaff size lengths of frond for the juice content. Bite sized pieces of the tender young fronds at the centre of the crown are chewed to a pulp before the parrot drops the remains. Pieces of older tougher fronds are also chewed leaving cut marks from their bill. Grasstree crowns grow new fronds from the centre of the crown. As these fronds grow they are moved outwards, in a spiral pattern, towards the edge of the crown. Once fronds have reached the outer edge of the skirt they have reached their full length and are unable to grow back if chewed back by parrots.

Fronds cut back by parrots at the centre of the crown will continue to grow and increase in length if no further browsing occurs. The frond growth rate is greatest during the winter to spring months (Lamont and Downs 1979). The Grasstree crowns grow back during the winter and spring months when little or no parrot browsing occurs. Grasstree crowns that have been observed to be heavily grazed over a number of years, have eventually died (McNee 1997).

Figure 1. Twenty-eight Parrot (*Barnardius zonarius*) in the Kojonup area

Twenty-eight Parrot damage to trees and Grasstrees occurs seasonally (McNee 1997; Ritson 1995). Attack rates in Bluegums were greatest over the summer months and lowest during the period from April to October (Ritson 1995). High rates of Twenty-eight damage to Grasstrees occur in the summer months, beginning in the November-December period. Rates of damage have greatly decreased by June and continue to decline until late spring (McNee 1997). Attacks on trees and Grasstrees are influenced by alternative food availability, such as nectar flows in eucalypt flowering (McNee 1997, Shedley, *pers. comm.*).

This project was initiated by the Kojonup LCDC. Results of a survey in the south-west quadrant of the Kojonup Shire supported complaints of increases in Twenty-eight Parrot damage to Grasstrees, farm tree plantings and farm gardens (P. Coffey, *pers. comm.*). It was claimed that extensive areas in the region existed where 90 to 100 % of Grasstrees had been destroyed by Twenty-eight Parrot damage. The survey of landholders also indicated a broad willingness to participate in a regional scale parrot control program.

Twenty-eight Parrots are considered by many in the farming communities of south-west Western Australia to be a pest species and open season shooting is currently permitted. However, shooting is costly and time consuming and other control methods have been keenly sought by farmers.

Trials with localised control (one landowner shooting and/or trapping) indicated little, if any, effect in alleviating damage in Bluegums (Ritson 1998, *pers. comm.*). This project was designed to establish whether a regional community trapping program could achieve a significant reduction in Twenty-eight Parrot numbers and the damage they cause to planted trees and Grasstrees.

2.0 METHODS

The project was conducted near Kojonup, about 264 km south-east of Perth, Western Australia. The trapping program was undertaken on a regional scale, with licences issued to landholders in the south-west quadrant of the Shire of Kojonup for a twenty three month period, finishing March 1999. Twenty-eight Parrot numbers and the rate of damage incurred on farm tree plantings and Grasstrees, were monitored in both the trapping area and adjacent untreated 'control' areas. Monitoring commenced pre-trapping in February/March 1997 with trapping commencing in May 1997.

2.1 STUDY AREA

Mean annual rainfall in the project area ranges from about 500 mm to 700 mm, with the isohyets orientated in an approximately north-west:south-east direction (Figure 2). The area lies immediately to the south-west of Kojonup and forms a rough square about 40 km across encompassing an area of about 160,000 ha (Figure 3). The trapping area was bounded by Albany Highway-Shamrock Rd to the east, Boyup Brook-Cranbrook Rd to the south, Boyup Brook-Kojonup Rd to the north and Foley Rd (Tone River Rd) to the west. Boundaries were chosen for convenience of communication (within the same shire and mail run).

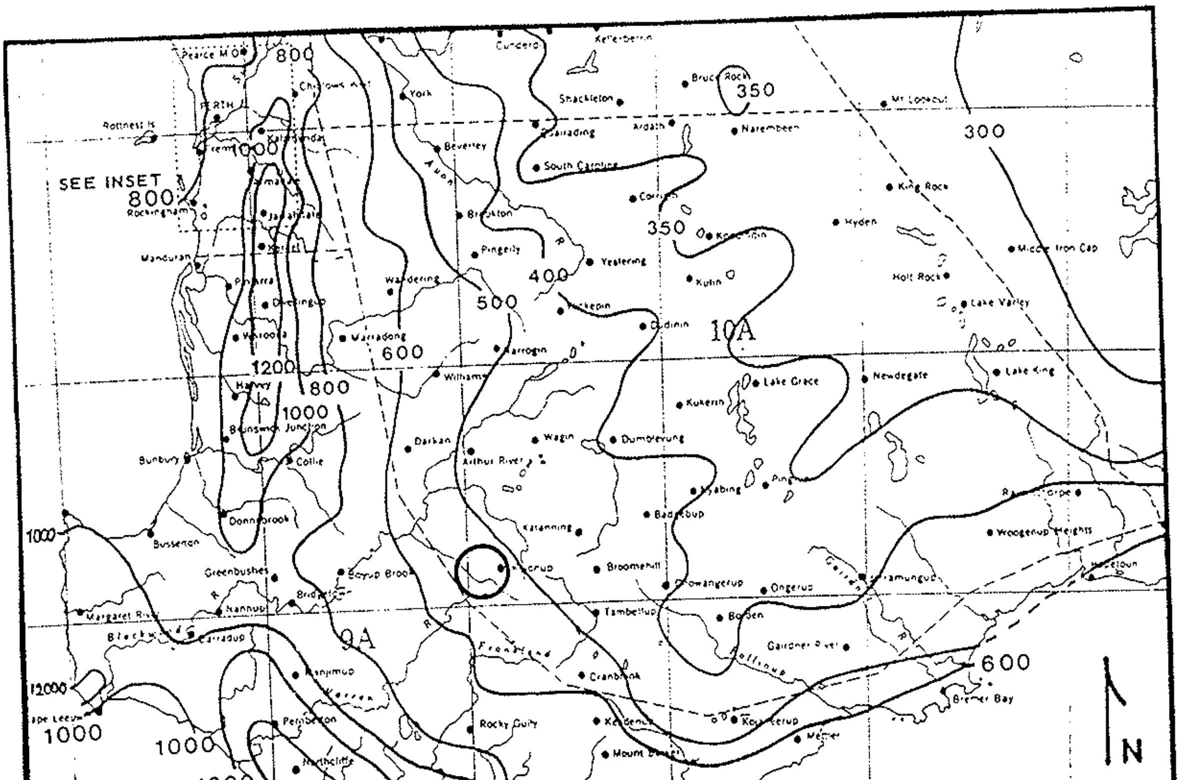

Figure 2. Average annual rainfall map of south-western Australia, based on records to 1979 (Bureau of Meteorology. Circle gives location of Trapping area.

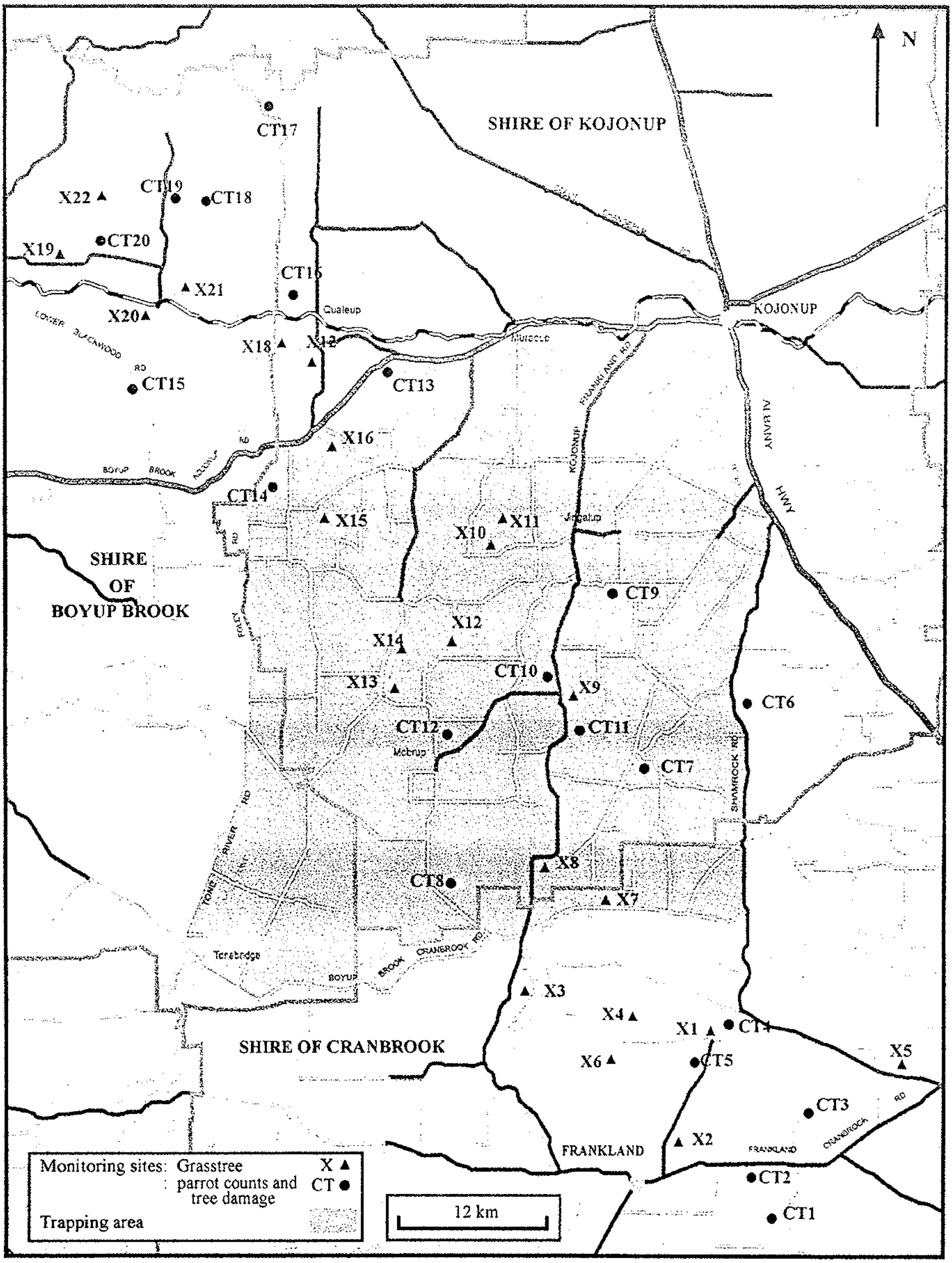

Figure 3. Twenty-eight Parrot Trapping area and monitoring sites.

The project area lies at the head of three river catchments – those of the Blackwood (Balgarup), Frankland and Warren (Tone) Rivers (Figure 3). Vegetation and soil systems of the area have been summarised by Grein (1994). Natural vegetation communities in the trial area are predominantly Jarrah-Wandoo woodland and Jarrah-Marri woodland (Grein 1994).

The major land use in the project area and immediate surrounds is sheep grazing (wool), with some (increasing) cropping (mainly oats, with some wheat and canola). Farm tree plantings include Bluegum (low rainfall margin of area considered suitable for Bluegum crops), River Red Gum (*E. camaldulensis*), Wandoo (*E. wandoo*) and other *Eucalyptus* species. The area includes numerous small farm Bluegum plantings as well as some large plantations (particularly in the Frankland area).

2.2 TREATMENT - REGIONAL TRAPPING

Following project approval, conditional temporary Twenty-eight Parrot trapping licences were issued to landowners in the Trapping area by Wildlife Branch, Dept CALM. Licence conditions included inspection of 'traps at least once per day and release unharmed any non-target bird species'. Twenty-eight Parrots in traps were to be 'killed humanely by shooting, neck extension or a severe blow to the head'.

Initial distribution of bird traps to farmers took place at a field day early in May 1997 and trapping commenced from that time. These first traps were small, with a height of about 60 cm and diameter of 1.2 m. Peter Coffey subsequently adopted and refined the design of a large walk-in trap (about 1.8 m high), which became available from the end of Spring, 1997 (Figure 4).

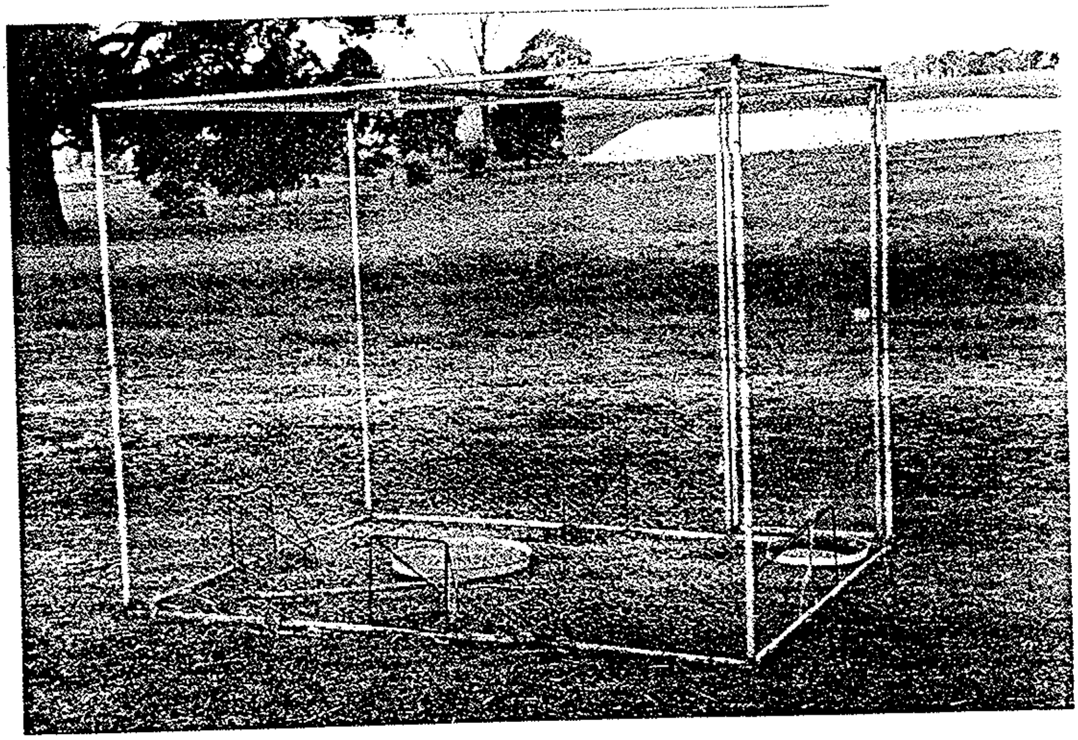

Figure 4. Large walk-in trap used to catch Twenty-eight Parrots.

An important element for the success of the project was the need for farmers in the adjacent control areas to 'carry on as usual' as regards existing Twenty-eight Parrot control measures (shooting) and not be motivated to increase bird control, given this project's publicity.

Access to stored grain may be a factor in sustaining Twenty-eight Parrot populations. Grain handling practices continued as normal during the project. Information on grain handling practices was gathered as part of a phone survey of trial participants at the end of the project.

2.3 MONITORING

Sites were selected to monitor Twenty-eight Parrot numbers and parrot browsing (damage) on farm trees and Grasstrees. Using three measures of abundance/activity increased the chance of detecting any significant effects of trapping.

2.3.1 Sites

Monitoring sites were sought to fit within a linear belt orientated approximately north-west:south-east, a similar orientation to the rainfall isohyets in that area, so minimising rainfall variability between sites (Figure 2). The monitoring belt extended over about 100 km, and included the control areas which lie up to 20 km to the north-west (**NW Control**) and south-east (**SE Control**) of the **Trapping** area boundary (Figure 3). It was decided to monitor twenty sites (20 farm tree sites and 22 Grasstree sites). Eight farm tree sites and ten Grasstree sites were in the Trapping area and 12 of each in the Control areas (Table 1). Grasstree sites were not at the same location as farm tree and parrot count sites simply because they have different distributions. Some Control and Trapping area sites were located near the border of the Trapping area so as to detect any boundary effects.

Table 1 Site locations between treatment areas

Treatment Area	Grasstree sites	Total	Parrot counts/ tree sites	Total
SE Control	X 1, 2, 3, 4, 5, 6	6	CT 1, 2, 3, 4, 5, 6	6
Trapping	X 7, 8, 9, 10, 11, 12, 13, 14, 15, 16	10	CT 7, 8, 9, 10, 11, 12, 13, 14	8
NW Control	X 17, 18, 19, 20, 21, 22	6	CT 15, 16, 17, 18, 19, 20	6

2.3.1.1 Parrot counts

Parrot count transects, comprising segments totalling 1 km in length, were marked at each site. The transects contained similar lengths of similar environment types, including 400 m adjacent to farm tree plantings, 300 m along paddock fence lines bordering treed road verges and 300 m bordering remnant vegetation and paddock (Figure 5). An effort was made to include stubble paddocks adjacent to part of the count transect line. Transects were positioned such that there was clear vision for 100 m on either side of the walk. Transect layouts were initially designed around tree damage assessment plots, but some were re-routed for farm hygiene (minimise movement of soil).

2.3.1.2 Grasstree sites

The criteria for selecting sites were that at least some crowns were being actively browsed on by parrots, that the damage levels were moderate to high, that we had the support and permission of landowners, and that the sites were reasonably accessible. The criterion that sites needed moderate to high damage was difficult to assess or predict.

2.3.1.3 Tree damage sites

River Red Gum was chosen to assess tree damage. River Red Gum is one of the most commonly planted tree species in the region and numerous potential monitoring sites were available for selection. Single species stands of trees were preferred (to avoid Twenty-eight parrot-tree species preferences). Furthermore, River Red Gum growth is slower than the other commonly planted species, Tasmanian Bluegum (*Eucalyptus globulus*), making assessment of tree damage over a two year period easier.

Figure 5. A typical remnant vegetation-pasture section of a parrot count transect located along the fence line.

Most importantly, River Red Gums appeared to be prone to Twenty-eight Parrot attack, making it the ideal species for quantification of any change in damage rate. Plantings from 1995 (eighteen months old) were selected for assessment. Younger plantings were not suitable (trees at that age not prone to consistent damage (Ritson, 1995)). Older plantings were already quite tall making future monitoring impractical.

Finding twenty suitable 1995 River Red Gum sites within the NW-SE transect belt was a fairly difficult task and some sites were not ideal. Some sites lay further from the site transect belt than preferred. Once the twenty sites were finalised, two plots of twenty five trees were pegged, mapped and numbered at each site. Non-River Red Gum trees occurring within the plots were not included.

2.3.2 Monitoring times

Table 2 below shows the monitoring schedule for the project. The first round of monitoring was pre-trapping and took place in February/March 1997. A second round of pre-trapping monitoring took place in April 1997, reflecting a preference for a second pre-treatment sample and the pressure to commence trapping in May prior to crop seeding and the commencement of the main trapping season (winter). Damage assessments were also made in December at the beginning of the high activity summer period and after the low activity period of winter and spring. Surveys were repeated at the same times each year. Financial constraints did not allow a December parrot count.

Table 2 Monitoring schedule

Number	Year	Month	Pre-Trapping	Grasstree Assessment	Tree Damage Assessment	Parrot Counts
1	1997	Feb/Mar	Y	Y	Y	Y
2		April	Y	Y	Y	Y
3		Dec		Y	Y	
4	1998	Feb/Mar		Y	Y	Y
5		April		Y	Y	Y
6		Dec		Y	Y	
7	1999	Feb/Mar		Y	Y	Y

2.3.3 Monitoring techniques

2.3.3.1 Parrot counts

Parrots were counted from 1 km standard transect walks at each site. Birds were counted if they were seen within 100 m either side of the transect line, while the observer walked at a 'normal' walking pace. Thus the count area of each transect was 20 ha. The birds distance from the transect line (four categories), species and in the case of Twenty-eight Parrot's, their activity at time of observation were noted. Counts began at about sunrise and were conducted at four sites each day within four hours. Four bird counts per site were conducted for each monitoring event, taking twelve days for two observers to complete. Groupings of sites counted on the same day were as follows: CT sites 1,2,3,4; 5,6,7,8; 9,10,11,12; 13,14,15,16; 17,18,19,20. The order in which four sites were visited on any one day was rotated (Table 3). Because of distances involved and the desire to complete the counts in a minimum number of days to minimise climatic variation during each survey, two people were involved in site counts, one counting at sites 1 to 12 and another counting at sites 13 to 20 (sites 1 to 8 and 9 to 20 in March 1999 survey).

Table 3 Rotation of site bird counts

Count	Order of Sites			
1	a	b	c	d
2	b	c	d	a
3	c	d	a	b
4	d	a	b	c

2.3.3.2 Measuring Grasstree damage

At each site, 25 Grasstrees were identified with a numbered metal tag nailed in to the base of the caudex (trunk). Damage levels were recorded for each crown. Where Grasstrees had more than one crown, each crown was identified by a letter which was marked with paint on the skirt or caudex. The number of crowns per Grasstree varied from one to 12. The minimum number of crowns at any site was 27 and the maximum was 108.

During a survey, the preceding months' damage of Grasstree crowns were recorded by estimating the percentage of each crown chewed back by parrots. This was referred to as '*current season damage*'. The *current season damage* refers to the summer-autumn damage of a particular 'year' (~December to May) and therefore does not include damage that occurred in previous years. Although damage from previous years was often present at damaged crowns, it could be distinguished from *current season damage* by the colour of the cut frond tips. *Current season damage* had white, yellow or pale grey tips compared to dark grey tips of previous year's damage. *Current damage* was distinguishable for approximately four to six months.

Intensive browsing activity at Grasstree crowns continued through the summer and early autumn months until the first wet-season rains (usually in May or June), when browsing activity was greatly reduced and eventually ceased altogether during the early spring months.

The percentage of each crown damaged by parrots was represented by an index of crown damage (from 1 to 7) where 1 = zero damage, 2 = 1-10%, 3 = 11-33%, 4 = 34-66%, 5 = 67-90%, 6 = 91-100% and 7 = 100% of a crown damaged (Figure 6). The percentage (or index number) of a crown which is damaged represents the balance between the number of new fronds produced by the crown and number of fronds chewed back by parrots. During the summer months the number of fronds chewed back by parrots greatly exceeds the number of new fronds produced. Thus, the index number for each crown increases with time (sometimes from a 3 (11-33%) in December to a 6 (91-99%) in February or April). During the winter and spring months the crowns can recover (when parrot browsing is very low or zero and frond growth is high) and produce a large crown of full length fronds. The index of crown damage herefore becomes greatly reduced at a site (sometimes from a 6 (91-99%) in April to a 1 (0%) by December). The December survey was used to record the extent crowns had recovered and the degree that intensive Twenty-eight Parrot browsing activity of Grasstrees had begun.

A second measure, referred to as '*recent damage*', recorded the number of fronds damaged within the previous one to 14 days of the survey. The colour changes that occurred at damaged frond tips made it possible to determine whether a frond was *recent damage* or not. When a frond is first broken the tip is transparent and green. Within a few days the tip becomes opaque and white. The colour of the tip continues to change and becomes a pale yellow after approximately seven days, creating an area of 'dieback'. When the damaged frond is approximately 14 days old an orange line forms at a distance of one to three millimetres from the tip, within the dieback zone. Thus, only damaged fronds without an orange line were included as *recent damage*.

Recent Damage gives a measure of the intensity of parrot activity for the two week period prior to the time of the survey. It will be sensitive to short term seasonal and unseasonal events such as the flowering of Marri (*Corymbia calophylla*) and unseasonal rains.

(a)

(b)

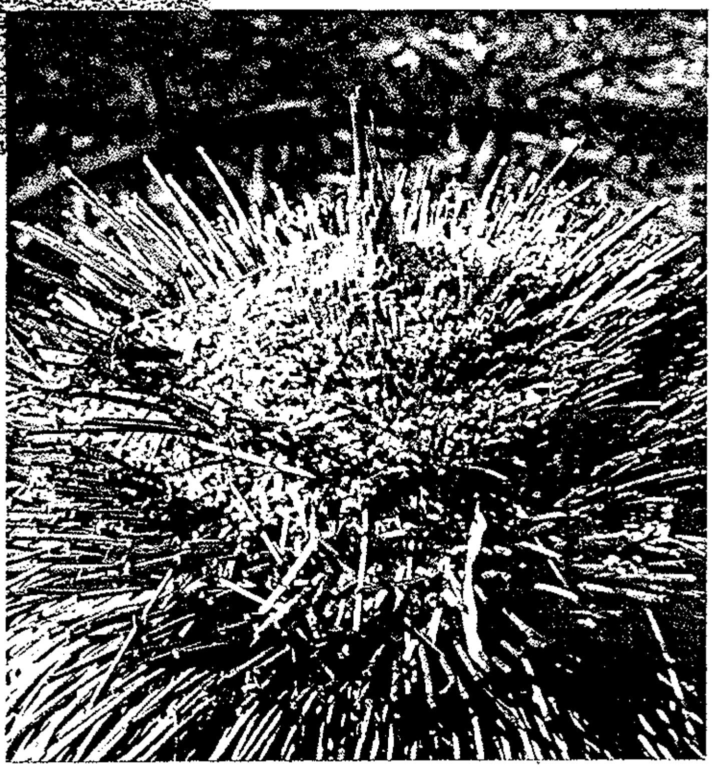

Figure 6. Grasstree crown with 91-99% (index 6) of crown damaged by parrots. (a) Grasstree from site X19. (b) Close up of damaged crown.

Grasstrees that had died during the year were replaced by tagging additional trees during the December survey. Deaths occurred at 18 of the 22 sites.

2.3.3.3 Measuring Damage to River Red Gums

River Red Gum parrot damage is referred to as either stem or branch damage in this report (Figure 7(a)). Damage assessment of each tree in the monitoring plots began by recording the presence/absence of new stem and branch parrot damage (since last monitoring event). Categories of damage severity were used based on the observation that lateral branching is likely to occur where some bark is removed to the wood and that stem breakage almost always occurs where >80% of stem circumference bark is removed to the wood at some point of the damage (Figure 7(a); also observed for Tasmanian blue gum stem breakage, P. Ritson *pers. comm.*). Therefore, details of stem damage were collected if bark was removed to the wood at some point of the damage

AND

(i) if length of damage was >5 cm if stem circumference of bark removed to wood was <80% (**'moderate damage'**)

OR

(ii) any length of damage where stem circumference of bark removed to wood was >80% (**'severe damage'**) (Figure 7(b)).

A single length of stem damage was defined as including continuous damage or segments of damage that were less than 5 cm apart. Length (cm) of moderate and severe stem damage was recorded and the number of discrete damage lengths recorded. Initial observations indicated that Twenty-eight Parrot stem bark stripping damage was done as discrete lengths, with new damage starting from an undamaged section of stem and not continuing from the finish point of old damage. New stem breakage associated with parrot damage was recorded as either breakage of newly damaged stems (damaged since last monitoring event) or breakage associated with old damage. No distinction was made as to the hierarchy of damaged stems (whether main or primary stems, secondary stems etc).

Branch damage, once assessed, was discretely marked to distinguish it as old damage for future monitoring. Marking was done with yellow tree marking crayon or red Sakura Solid Marker solidified paint stick. The latter was found to be more effective and longer-lasting than the yellow crayon.

2.3.4 Participant surveys

2.3.4.1 Trapping data - Farm records

All those participating in the trapping program were asked to keep daily records of the numbers of Twenty-eight Parrots shot and trapped (Appendix 1). Participants were also asked to record numbers of non-target species trapped and any non-target species deaths that might occur. Data from farm records was entered into a database.

Final estimates of numbers of Twenty-eight Parrots shot and trapped during the project and not recorded on Farm Record sheets were collected as part of a participant survey (see below).

2.3.4.2 Participant interviews

During April 1999, following completion of the last field survey, a phone interview of project participants was conducted.

Figure 7. River Red Gum (*E. camaldulensis*) stem and branch parrot damage.
(a) Extensive damage in a River Red Gum crown, including branch breakage.
(b) 'Severe' stem damage in River Red Gum.

An effort was made to contact all those living in the Trapping area. Interviews were conducted in a set format, following the questions and sequence shown in the survey form included in Appendix 2(a). Questions aimed to gather participant observations on parrot numbers and parrot damage, whether they undertook trapping and/or shooting during the trial, opinions regarding trapping efficacy and trapping techniques and finally information on availability of grain on farms. Approximate location of the main trapping/shooting activities of each participant was mapped.

Landholders in Control areas whose properties contained survey sites and/or who were the contacts for those sites, were also interviewed with similar questions (Appendix 2(b)).

Answers of interview questions were compiled and percentages of response categories calculated.

2.3.5 Analysis

Survey design and data analysis was based on BACI (before and after monitoring at control and impact sites), e.g. see Stewart-Owen and Murdoch (1986).

2.3.5.1 Parrot count and River Red Gum damage analysis

Regional analysis

Total transect parrot counts for each site and survey time were aggregated to mean counts per treatment area per sample time and analysed. Studentised residuals of the mean counts were found to be heteroscadastic and were log transformed ($\log_{10}[x+0.1]$; Zar, 1984). An outlier that was considered to be a suspect data point was dropped for the analysis (see section 3.2.2 and 3.3.1.1 below).

Tree stem/branch damage lengths and number of occurrences were converted to a rate per 30 days by dividing each survey period's data by the number of days since the last survey and multiplying that outcome by 30. Mean damage rates per tree per 30 days were determined for each site (per 50 trees for the 'number of damage occurrences'). Damage rates were aggregated to mean damage rate per treatment area per survey time for analysis. The data did not need transforming.

In an effort to optimise detection of any regional effect of trapping, damage rates were derived for 'core' sites in the Trapping area (four central sites, CT9-12) and NW Control and SE Control areas (four sites farthest from the Trapping area boundary in both Control areas: sites CT17 - 20 in NW Control; sites CT 1-3,5 in SE Control). Analysis of core sites effectively excluded sites that may reflect boundary effects and therefore conceptually would not reflect the strongest treatment effect. Mean damage rates for the core sites were derived for each of the three treatment areas and analysed. Similarly, mean damage rates for high and moderate damage sites were determined for each of the treatment areas and analysed (see more detail in section 3.2.2.3 below).

The seasonal nature of parrot damage activity in the trial area made it convenient to analyse March and April survey data separately from the December data (section 3.2.3.1 below).

For the December survey analysis, the data needed to be analysed at 'site' level so as to have sufficient data points. However, ANOVA (Analysis of Variance) of 'site' mean damage rates was not appropriate because treatments were not assigned randomly to sites. To apply an ANOVA to the December site data it was therefore necessary to calculate for analysis the difference between mean December survey damage rates for each site (December 1998 less December 1997).

ANOVA was used to test for significant differences between before and after trapping parrot counts and tree damage and to test between Trapping and Control area trends from pre- to post-trapping in counts and damage rates. Where significant effects of factors were determined by the ANOVA, a Tukey comparison of means test was used to determine which factor levels were significant.

Other analysis
Parrot counts per transect , an indicator of parrot abundance over time, provided a simple estimate of parrot abundance per hectare once divided by the number of hectares that a transect count represents (20 ha).

Correlation analyses was applied to mean April survey parrot counts and tree damage rates to determine if there was any association between them. A Pearson correlation coefficient was determined. Only April survey data was analysed for correlation because that data offered the best correspondence in timing between parrot transect counts (which are a measure of parrot abundance at the time of the survey) and damage rates (which represent accumulated damage since the preceding survey (in the case of the April survey, damage accumulated over the month preceding the April survey and converted to a rate per 30 days).

Cumulative damage levels were derived and graphed as a record of total damage levels at River Red Gum sites. River Red Gum survey damage data was added sequentially to the total damage recorded in the first survey (March 1997).

Systat 8.0 for Windows (1998) computer package was used to generate the statistics.

2.3.5.2 Grasstree damage analysis
Data for Grasstree sites were presented as per crown rather than as per Grasstree (with the exception of percentage of deaths which were given as both per crown and per Grasstree). Means and percentages were calculated per live crown (rather than per damaged crown) as most sites had one or more crown deaths during the trial and most sites had one or more crowns with no parrot damage.

Data from sites for each of the respective areas (Trapping, SE Control and NW Control) were pooled together for analysis providing estimates of mean index of crown damage, mean recent damage and percentage of crowns damaged, percentage of crowns severely damaged and percentage of crown or Grasstree deaths. These estimates were firstly used to compare sites within the three areas (high to low damage sites) and trends within each area from year to year (either increasing, decreasing, or no change in damage levels). Secondly, the estimates were used to determine whether the three areas were similar (represented same levels of damage or similar trends). Thirdly, it was determined whether parrot damage levels in the Trapping area differed from the Control areas and whether any differences that might be observed could be attributed to trapping efforts. For this last analysis, the mean ratio between two surveys (prior to trapping and after trapping had begun) for each site was calculated and then the Trapping and Control areas were compared.

Comparisons were made using non-parametric tests. Kruskal-Wallis test was used when comparing more than two means and Mann-Whitney U test when comparing two means. Where the data was transformed prior to the analysis, such as with the log ratios of mean index crown damage (when comparing Trapping area with Control areas), a One Way Analysis of Variance (ANOVA) was used to compare more than two means. Fisher's PLSD test was used to determine which means were significantly different. When comparing two means with transformed data a t-test was used. Percentages were transformed using the arcsine transformation (Zar 1984).

Comparisons were made between the Trapping area and the SE and NW Controls, between the high damage sites in the Trapping area verses the high damage sites in the SE and NW Controls (pooled together), and between the Trapping area and NW Control.

2.3.5.3 Additional Notes

Statistical tests were determined to be significant (ie. the means compared to be significantly different) when P (probability) ≤ 0.05. Bars in figures represent standard errors of the sample mean.

3.0 RESULTS

3.1 PARTICIPATION IN THE TRAPPING TRIAL AND NUMBER OF TWENTY-EIGHT PARROTS CULLED

3.1.2 Participation rate - Trapping

Ninety three landowners/associates living in the treatment area were interviewed regarding the Twenty-eight Parrot trapping program (representing a large proportion of landowners in the area, though the total number is not known). Nine other landowners/associates could not be contacted because they had sold or left the farm or were away on holiday.

Of 93 people interviewed, 76 % (71) trapped at some time during the project (Table 4). About 50% (46) trapped during the first year (1 May1997 to 30 April 1998). Six people discontinued trapping after the first year, siting such reasons as disliking killing the birds, too busy, away on holidays and difficulty using the small trap that was distributed at the start of the trial. A further push to increase participation at the start of the second winter (1998) and availability of the improved tall traps resulted in a substantial increase in participation to 72 % (67 interviewees) in the second year (1 May 1998 to 31 March 1999). Of the 22 participants in the Trapping area that did not trap during the trial (Table 4), 12 shot Twenty-eight Parrots.

Table 4 Participation in the Twenty-eight Parrot trapping program - Trapping area

	Number of Interviewees Trapping*a*			
	Year 1 *b*	Year 2 *b*	Both Years	Overall Participation
Yes	46	67	42	71
No	47	26	22	22
Total Interviewed	93	93	93	93

a Numbers shooting not shown as this was not accurately determined in the interview.
b Year 1: 1 May 1997 to 30 April 1998; Year 2: 1 May 1998 to 31 March 1999

3.1.3 Numbers and distribution of Twenty-eight Parrots removed from the Trapping area

3.1.3.1 Numbers culled

Over the 23 months of trapping, it was estimated that Twenty-eight Parrot numbers were reduced by more than 60,000 (Table 5). More were taken during the second year of the trial (about 56 % of the total). Of the total cull, a little less than 45,000 (69 %) were trapped (Table 5). The number trapped increased by 45 % in the second year. A significant level of shooting also took place, contributing a little under one-third of the total cull. Numbers shot were similar in the first and second years. Many people both trapped and shot parrots.

The vast majority (84 %) of people who trapped and were interviewed (64), thought they had culled (shot and/or trapped) more Twenty-eight Parrots than in previous years. Fifty seven percent said they culled 'much more'. Twelve and a half percent said they culled about the 'same' number as pre-trial years.

However, numbers of Twenty-eight Parrots culled per participant per year were relatively low. Of the 93 people in the Trapping area who were interviewed, 72 % in the first year and 66 % in the second year trapped and/or shot less than 500 parrots/year (Table 6).

Table 5 Estimated numbers of Twenty-eight Parrots culled in the Trapping and Control areas during the trapping trial

Area	Year[a]	Data Source	Shot	Trapped	Total Killed
Trapping Area	1st Year	Recorded data	1271	9697	10968
		Estimates	8320	8562	16882
	Sub-Total		*9591*	*18259*	*27850*
	2nd Year	Recorded data	530	8374	8904
		Estimates	9565	17077	26642
	Sub-Total		*10095*	*25451*	*35546*
	Total		19686	43710	63396
Control Area					
- **SE Control** (data for 11 of 12 sites)	1st Year	Estimated			1854
	2nd Year	Estimated			1230
	Total				**3084**
- **NW Control** (data for 10 of 12 sites)	1st Year	Estimated			1850
	2nd Year	Estimated			1450
	Total				**3300**

a Year 1: 1 May 1997 to 30 April 1998; Year 2: 1 May 1998 to 31 March 1999
b 2000 Twenty-eight Parrots shot by professional shooters in 1998.

Table 5 shows that about 10,000 parrots were shot each year during the trial. To the extent that some participants reduced their shoot when they undertook trapping, we might estimate that the 'normal' or pre-trial shoot for the 93 interviewees in the Trapping area is 10,000 to 13,000 parrots per year. Therefore the number of parrots removed during the trial (23 months) represents an estimated increase of between 2.5 and 3.3 times pre-trial levels.

Table 6 Numbers of Twenty-eight Parrots culled per participant in the Trapping area (shot and/or trapped)

Estimated number of parrots trapped or shot	Number of interviewees in trapping area	
	Year 1[b]	**Year 2[b]**
0 to 499	67[a]	62[a]
500 to 999	23	22
≥1000	3	9
Total	**93**	**93**

a Includes 22 interviewees who did not trap, of whom 10 neither shot nor trapped.
b Year 1: 1 May 1997 to 30 April 1998; Year 2: 1 May 1998 to 31 March 1999

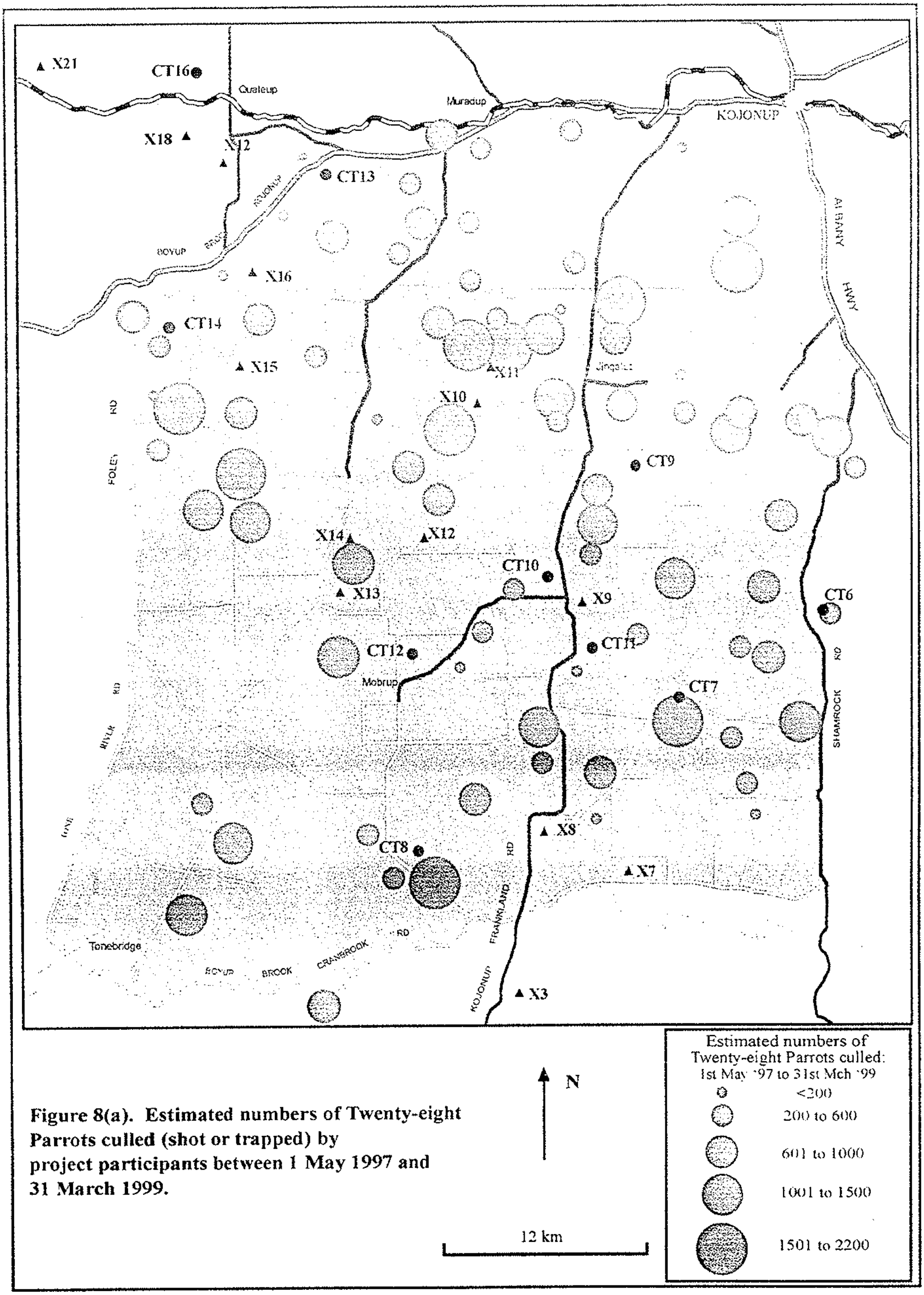

Figure 8(a). Estimated numbers of Twenty-eight Parrots culled (shot or trapped) by project participants between 1 May 1997 and 31 March 1999.

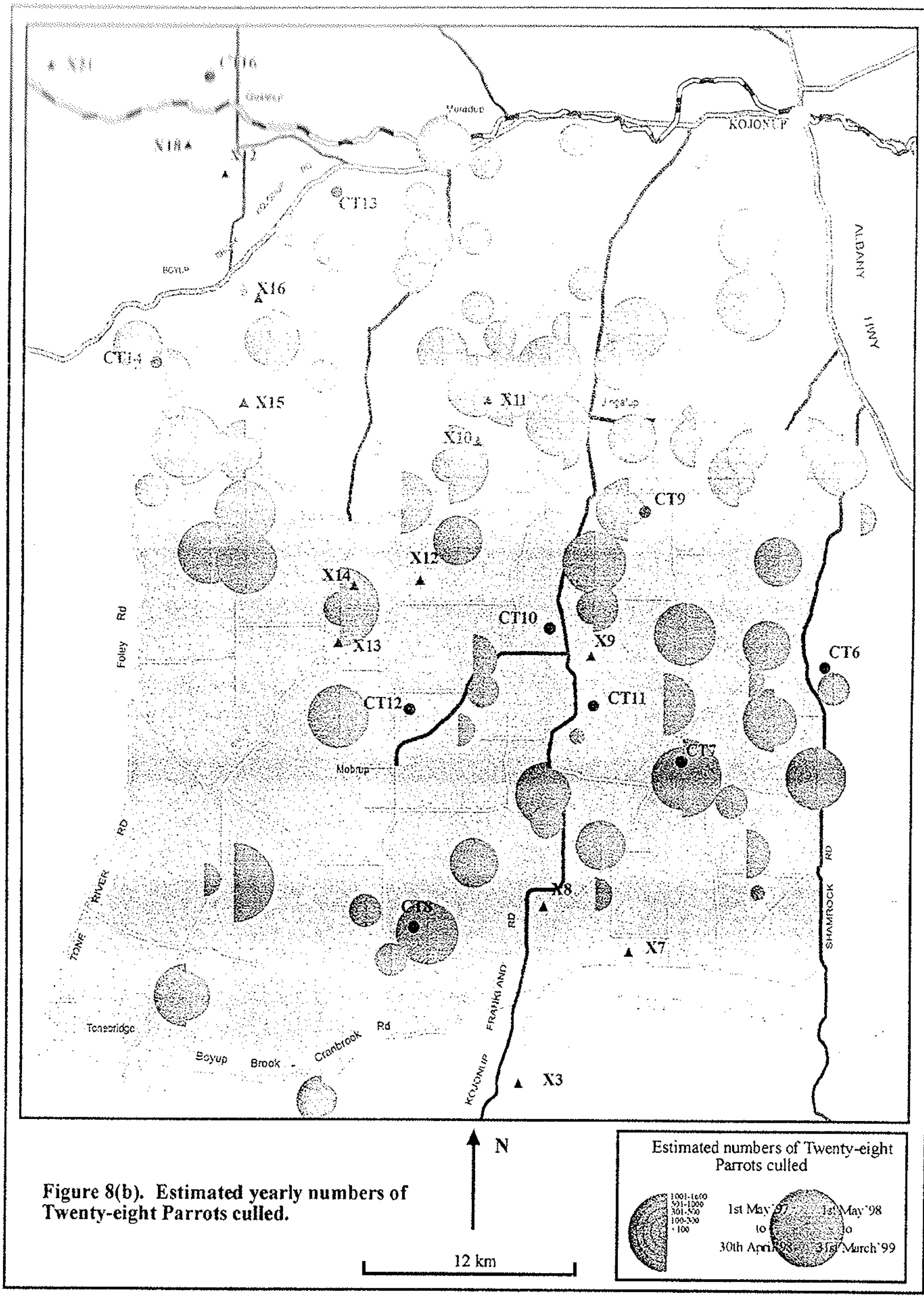

Figure 8(b). Estimated yearly numbers of Twenty-eight Parrots culled.

3.1.3.2 Distribution and intensity of trapping/shooting
The distribution of Twenty-eight Parrots trapped is shown in Figures 8(a) and (b). While some concentrations of trapping are evident (around the monitoring sites X10 and X11), the overall impression is of a fairly even scattering of trapping based around the NW-SE orientated belt of monitoring sites.

A simple estimate of the density of shooting/trapping sites in the Trapping area is derived by dividing the total trapping area (160,000 ha) by the estimated 83 trapping/shooting locations. Thus, on average, there was one trapping/shooting location per 1,930 ha. The area per trapping/shooting location is overestimated to the extent that not all residents/landholders were included in the survey and, on a local scale, to the extent that some areas had a greater concentration of traps. Nevertheless, it serves to illustrate that trapping and shooting locations in the Trapping area were widely spaced.

3.1.4 Twenty-eight Parrot culling adjacent to Control Area monitoring sites
Twenty of the 24 of landholders in the Control area who had monitoring sites located on or adjacent to their properties, were interviewed. Three of the interviews could not be completed (one, for example, because the interviewee had only recently moved on to the farm). Of the 17 landholders interviewed, eight (about 50 %) reported they shot Twenty-eight Parrots (about 6,384 parrots during the trapping trial, Table 5).

Of the estimated 6,384 birds shot in the Control area, 2,284 were shot by professional shooters at one Bluegum plantation site in the SE Control area, adjacent to monitoring site X4. The shooters made visits, sometimes weekly, mainly during summer months, with a maximum shoot of about 300 parrots in one week (R. Quaiffe, *pers. comm.*).

On a per farm (17) basis, this equates to a cull rate of 375 per farm over 23 months in the Control area. If the professional shoot is excluded on the basis that professional shoots were relatively uncommon in the area, then the Control' areas cull was on average 241 parrots per farm (4,300 birds culled by 17 farmers interviewed). This compares with Trapping area estimate of 681 parrots per farm over the 23 months of the trial and estimates of pre-trial removal of between 205 and 270 parrots per farm over an equivalent 23 month period. It should be noted that the Trapping area shooting/trapping data included one report of 1000 Twenty-eight Parrots shot by professional shooters at a Bluegum site during the second year of the project.

Of the six shooters from monitoring sites who commented on the number of birds shot, four reported shooting about the same number as pre-trial years.

3.2 PRELIMINARY CONSIDERATIONS PRIOR TO ANALYSIS OF THE REGIONAL EFFECTS OF TRAPPING

3.2.1 Trends in severity of tree stem damage
Cumulative length and number of occurrences of moderate (bark removed to wood to a maximum of <80 % of stem circumference in a section of damage) and severe (bark removed to wood to a maximum of ≥80 % of stem circumference in a section of damage) tree stem damage are shown for Trapping and Control areas in Appendix 3. Mean moderate and severe lengths of damage remained similar throughout the trial. The number of moderate damage occurrences were higher than the number of severe damage occurrences, especially during

the high damage periods (December to April). This is reflected in the growing gap between cumulative moderate and severe damage lines over time (Appendix 3(a)). Nevertheless, the trends in the number of moderate and severe damage occurrences over time are similar within and between the Trapping and Control areas and hence it was decided to analyse only total damage lengths and occurrences.

3.2.2 Variation in parrot counts and parrot damage between sites (high to low intensity damage sites) and between Trapping and Control Areas

Although high activity sites were preferred in the site selection process, there was in fact great variation in damage levels between sites (partially due to limited site availability). There was also considerable variation in parrot counts between sites. This variation in parrot counts and damage between sites made it more difficult to identify the effects of trapping on parrot numbers and parrot damage.

Sites were classified into different 'damage intensity' groups in order to improve the comparison of damage intensity between trial areas. High damage sites would be expected to be more sensitive to any trapping effects than low damage sites and were therefore separated out for further analysis of trends.

3.2.2.1 Parrot counts

There was considerable variation in Twenty-eight Parrot counts per transect between sites (Figure 9, Appendix 4). The highest mean sample count of 64 was recorded at site CT14 in the NW Control area in April 1997 (Figure 9, Appendix 4). On the other hand, Site CT4 in the SE Control area had consistently low mean counts, with the highest being 6 and 11 Twenty-eight Parrots per count.

Mean parrot counts per transect were similar in the Trapping and NW Control areas. Mean counts in the SE Control area were considerably lower, with the exception of the March 1999 counts (Figure 10).

Analysis Consideration - March 1999 Parrot Counts: SE Control

The large March 1999 SE Control count is most likely an anomaly resulting from a change in field staff for the last count in that area. The high March 1999 parrot count was counter to earlier declining trends in the SE Control area and counter to declining trends observed in the Trapping and NW Control areas through to the March 1999 survey (Figure 10). The sharp increase in March 1999 SE Control counts was <u>not</u> reflected in greatly increased parrot tree damage for that period (see section 3.2.2.3). Length of damage per 30 days in River Red Gums in SE Control, between December 1998 and March 1999, were only a little greater than the same period the year before, and there was even a small decline in average damage occurrence per tree per 30 days. Furthermore, the SE Control damage rates were considerably less than that for the NW Control and Trapping areas for the same period, and yet the SE Control March 1999 parrot counts per transect were much higher than the other areas. However, Grasstree damage in the SE Control area did show an increase in damage for February 1999. This increase was not as dramatic as in the parrot counts as it only reached pre-trapping levels after a decrease in summer 1998 (see section 3.2.2.2).

On balance, the SE Control March 1999 mean parrot count appears to be an anomalous data point and was excluded from statistical analysis (see section 3.3.1.1).

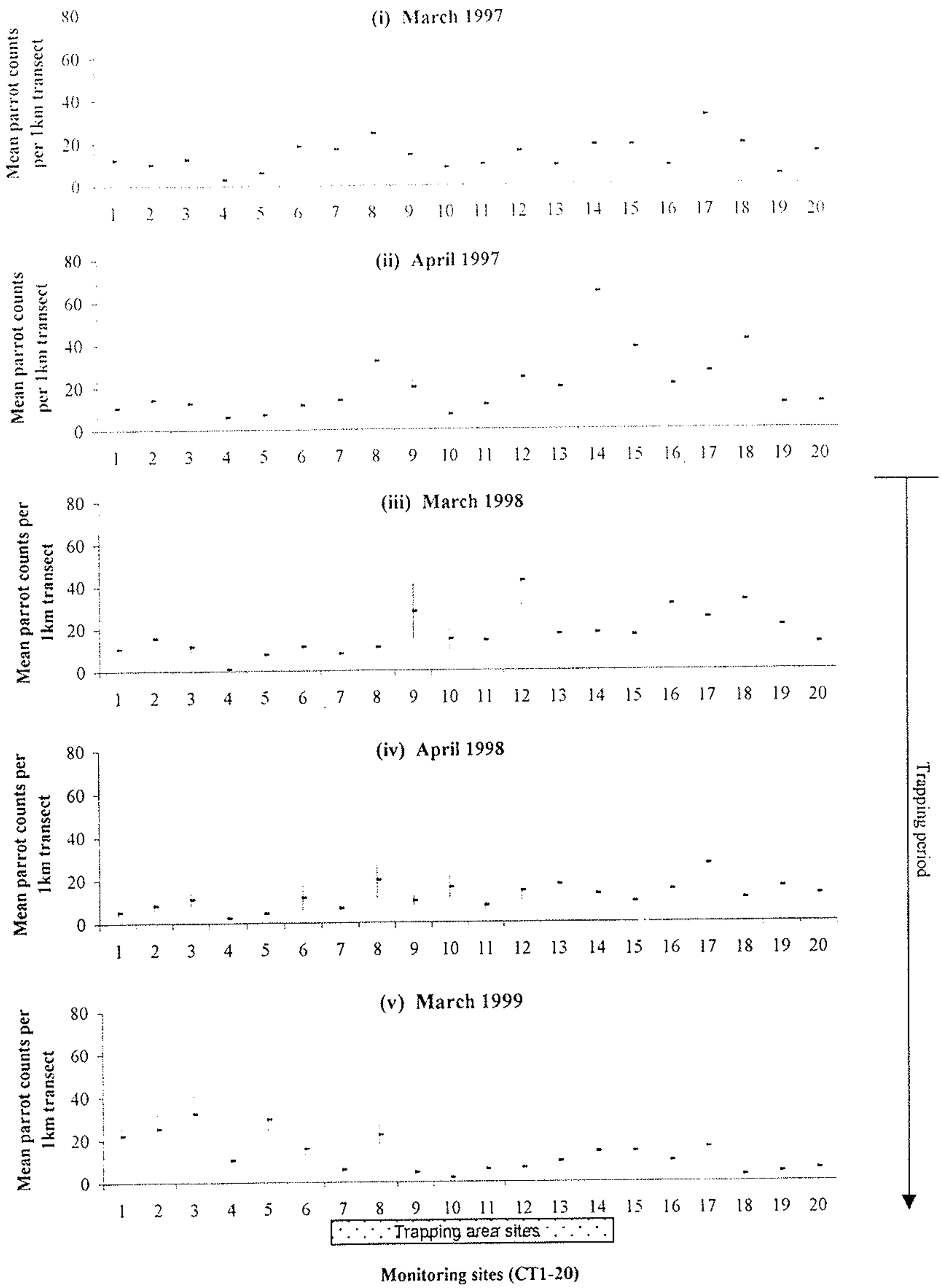

Figure 9 Mean parrot counts per transect for each site and each survey

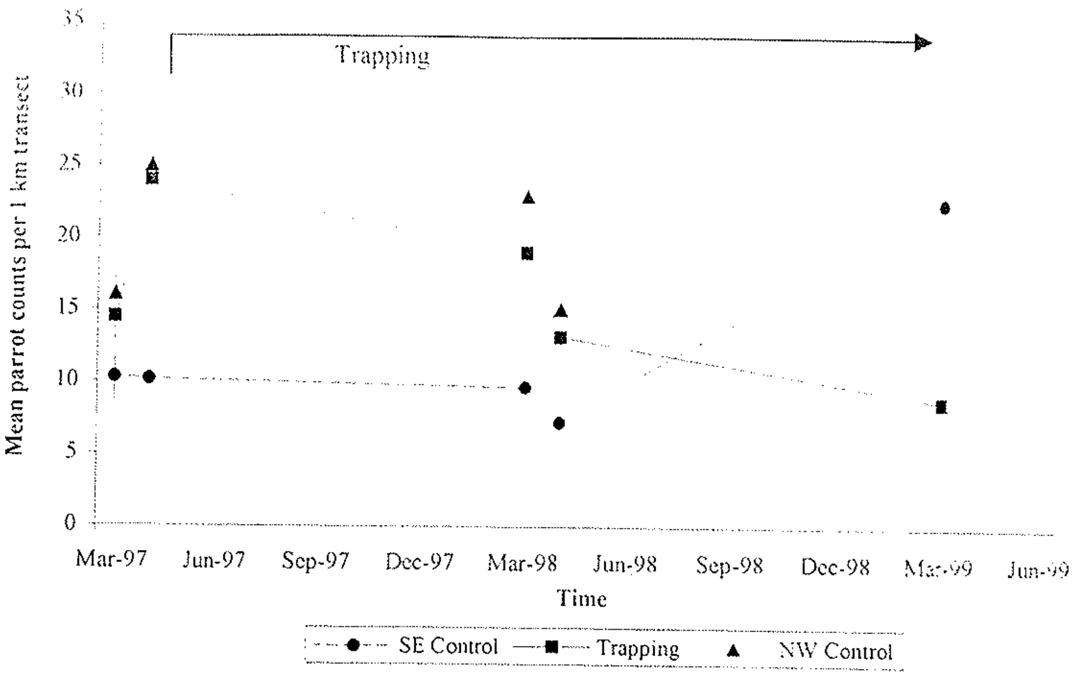

Figure 10 Mean parrot counts per transect for Trapping and Control areas.

3.2.2.2 Grasstree damage

Damage levels at Grasstree sites

The severity of parrot damage at Grasstree crowns varied among the 22 sites. Parrot damage at each site was classified as either High, Moderately-high, Moderate, Moderately-low or Low using the guidelines given in Table 7 (also see Figure 11).

Table 7 Guidelines used to group Grasstree sites in to six damage level categories

Damage level categories at Grasstree sites	% of crowns with damage	Mean index of crown damage (1 - 7)
High	95 - 100%	5.0 - 7.0
Moderately-high	85 - 94.9%	3.5 - 4.9
Moderate	70 - 84.9%	3.0 - 3.4
Moderately-low	50 - 69.9%	2.5 - 2.9
Low	30 - 49.9%	2.0 - 2.4
very Low	1 - 29.9%	1.0 - 1.9

Prior to trapping, half of the sites in the SE Control (three of six sites) and Trapping areas (five of 10 sites) had High to Moderately-high parrot damage (Table 8, Appendix 5). The NW Control had just over half of its sites (four of six sites) with High to Moderately-high damage. The SE Control and Trapping areas included two and three sites, respectively, which had Moderately-low or Low damage. By contrast, no Moderately-low or Low damage sites were surveyed in the NW Control area.

Grasstree sites can reach peak levels of damage where most crowns have 91-100% of their fronds browsed on by parrots. A ceiling of high damage is reached at these sites (eg. crowns cannot have more than 100% damage) which is usually sustained between surveys. This was the case for the three High damage sites in the Trapping area (Appendix 6).

Table 8 indicates that by the end of the trapping trial (in February 1999) a number of sites had decreased in damage (moved down one or more levels) and some had increased in damage (moved up one or more levels). In the Trapping area four sites (40%) had decreased in damage and one site (10%) had increased. At both the SE and NW Control areas. one site (16%) had decreased and two sites (33%) had increased in damage.

In conclusion, the Grasstree sites monitored in the Trapping area included the widest range of damage levels followed by the SE Control area. The NW Control area had the highest proportion of high damage sites.

Table 8 Damage levels at Grasstree sites in the Trapping, NW Control and SE Control areas.

	NUMBER OF GRASSTREE SITES and individual sites with:				
beginning & end of survey$_a$	**High damage**	**Moderately -high damage**	**Moderate damage**	**Moderately-low damage**	**Low damage**
SE Control area (n = 6)					
Feb/Apr 1997 sites	1 (X4)	2 (X1. X6)	1 (X2)	2 (X3. X5)	0
2 years later Sites	1 (X4)	2 (X2. X6)	0	1 (X5)	2 (X3. X5)
Trapping area (n = 10)					
pre trapping Sites	3 (X8.X10. X11)	2 (X9. X16)	2 (X7, X15)	2 (X12. X14)	1 (X13)
post trapping Sites	3 (X8. X10. X11)	1 (X15)	1 (X16)	3 (X7. X9. X12)	2 (X13. X14)
NW Control area (n = 6)					
Feb/Apr 1997 Sites	1 (X21)	3 (X18. X19. X22)	2 (X17. X20)	0	0
2 years later Sites	2 (X19. X21)	1 (X22)	2 (X17. X18)	0	1 (X20)

a Beginning of trial or 'pre trapping' = February & April 1997, and end of trial was '2 years later' or 'post trapping' = February 1999.

Comparison of damage levels between the Trapping, SE Control and NW Control areas
The percentage of crowns with parrot damage were similar between the Trapping, NW Control and SE Control areas with the exception of the December 1997 survey (Comparison of Trapping and Control areas for December 1997 survey, Kruskal-Wallis Test; $H = 9.523$, $P = 0.0086$) where the Trapping area had a significantly higher percentage of crowns with parrot damage than the SE Control sites and to a lesser extent higher than the NW Control sites (Figure 12).

(a)

(b)

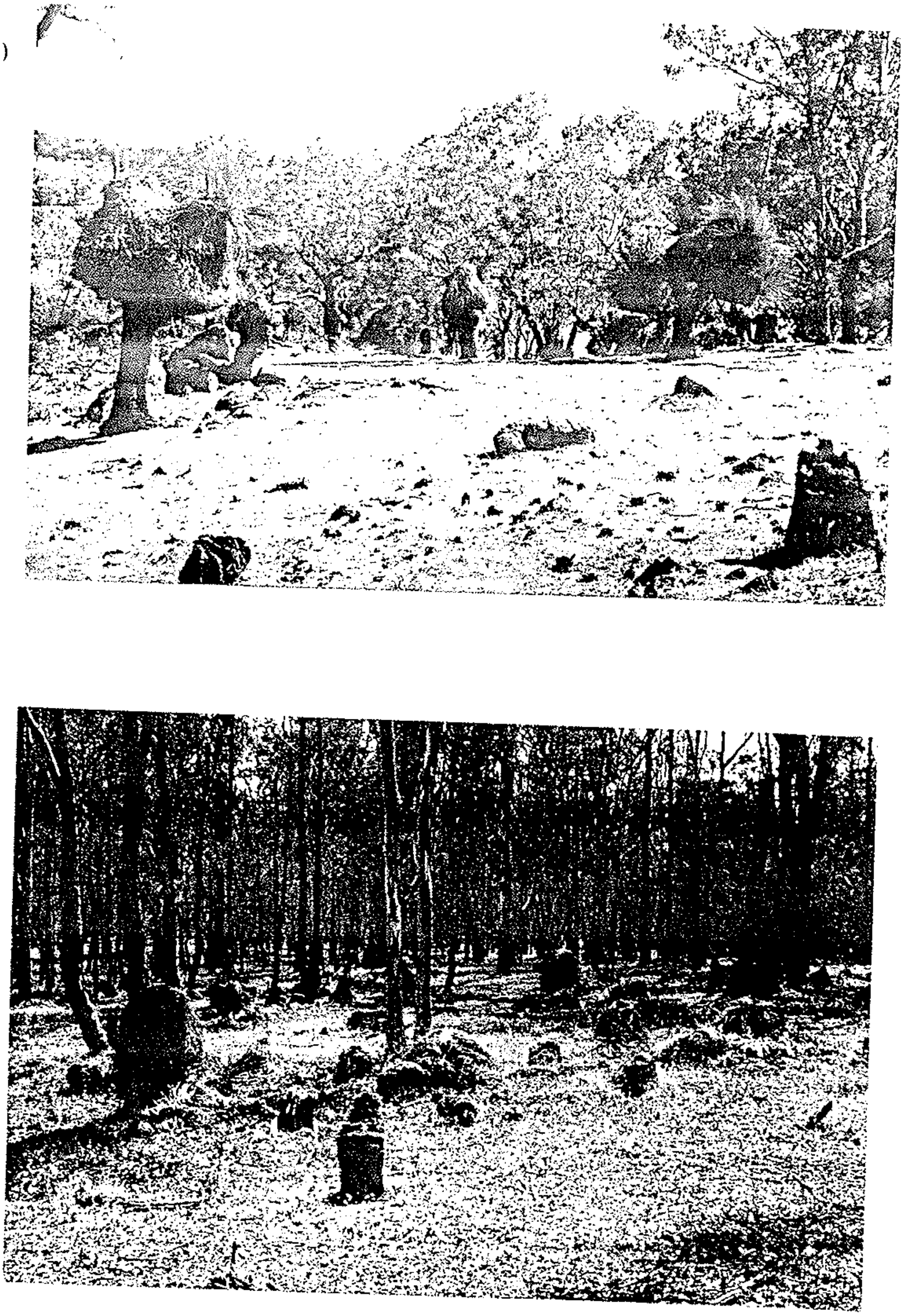

Figure 11 Two Grasstree sites in the Trapping area. (a) Moderately-low damage Grasstree site X12, and (b) High damage Grasstree site X11.

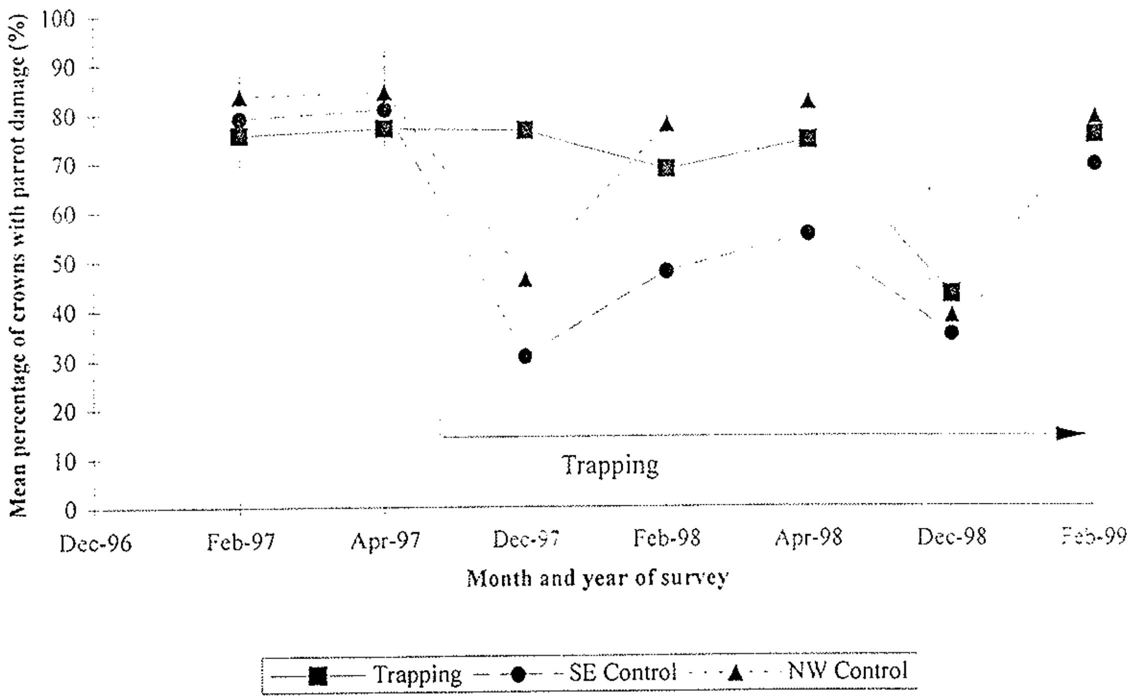

Figure 12 Comparison of the mean percentage of crowns with '*current*' parrot damage between the Trapping, SE Control and NW Control sites, for each survey.

It would appear that during the winter and/or spring months of 1997, parrot browsing activity was significantly greater in the Trapping area than the Control areas. Although regrowth occurred at the crowns in the Trapping area during the spring months (as indicated by a lower percentage of crowns with 91-100% of fronds damaged and lower index of crown damage (Figure 13)), the percentage of crowns with damage (*current damage*) remained high (Figure 12, Appendix 6 (vii) - (xvi)).

The intensity of parrot damage at crowns, given as the mean index of crown damage, in the Trapping, SE Control and NW Control areas were similar at the beginning of the survey (February and April 1997 surveys). However, the SE Control area had different trends in damage over the two year trial period (Figure 14). The overall trend in the SE Control was a decrease in damage during 1998 followed by an increase in damage in February 1999. By contrast, the Trapping and NW Control areas reached similar levels of high damage each year.

The trends observed at the SE Control area were significantly different from the Trapping and NW Control areas. The SE Control had significantly lower mean indexes of damage for December 1997, February 1998, April 1998 and February 1999 (Kruskal-Wallis Test: December 1997, $H = 182.402$, $P < 0.0001$; February 1998, $H = 92.003$, $P < 0.0001$; April 1998, $H = 77.475$, $P < 0.0001$; February 1999, $H = 20.254$, $P = < 0.0001$) and a significantly lower percentage of crowns with 91-100% damage in February and April 1998 (Kruskal-Wallis Test: February 1998, H = 8.854, P = 0.0120; April 1998, H = 6.769, P = 0.0339).

The trend of low damage in 1998 in the SE Control area could not be easily explained, particularly as it was not observed in the NW Control or Trapping areas for Grasstrees. However, among the River Red Gum sites in both the Trapping and SE Control areas there was a small decline in damage during 1998 (compared to pre-trapping levels), which contrasted with a large increase in the NW Control area.

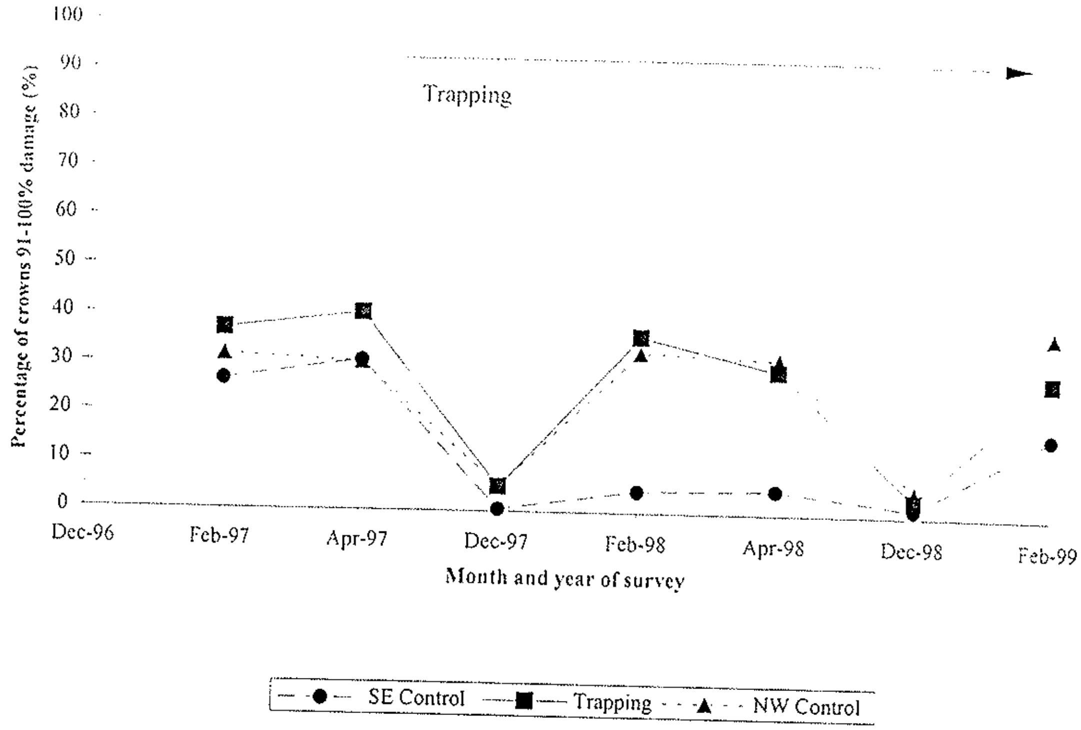

Figure 13 Comparison of the percentage of crowns with severe damage, where 91-100% of fronds have been damaged, between the Trapping, SE Control and NW Control areas, for each survey.

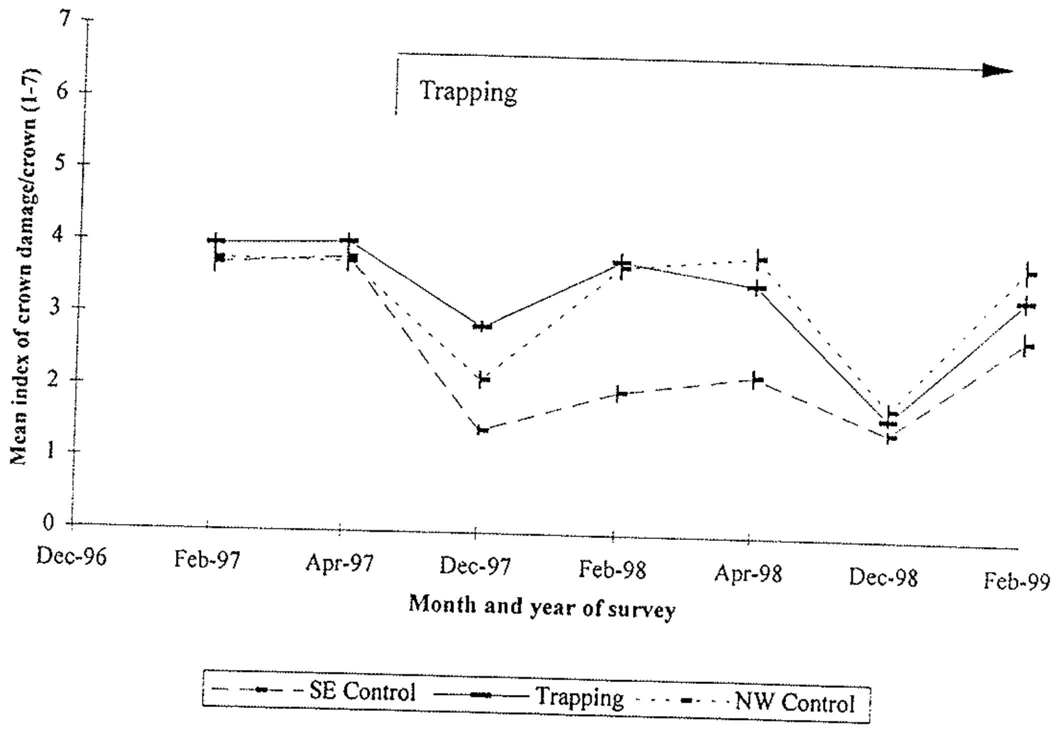

Figure 14 Comparison of the mean index of crown damage for the Trapping, SE Control and NW Control sites, for each survey.

An alternative method used to compare the Trapping and Control areas was to divide the Grasstree sites in to high damage (High to Moderately-high) and low damage (Moderate to Low) sites (Figure 15 and 16). The trends in damage between consecutive surveys was very similar between the Trapping and Control areas, whether for high or low damage sites. However, the high damage sites had larger fluctuations in damage between surveys than the low damage sites (Figures 15 and 16). The trend of low damage in 1998 in the SE Control area is now less obvious being balanced out by the NW Control sites.

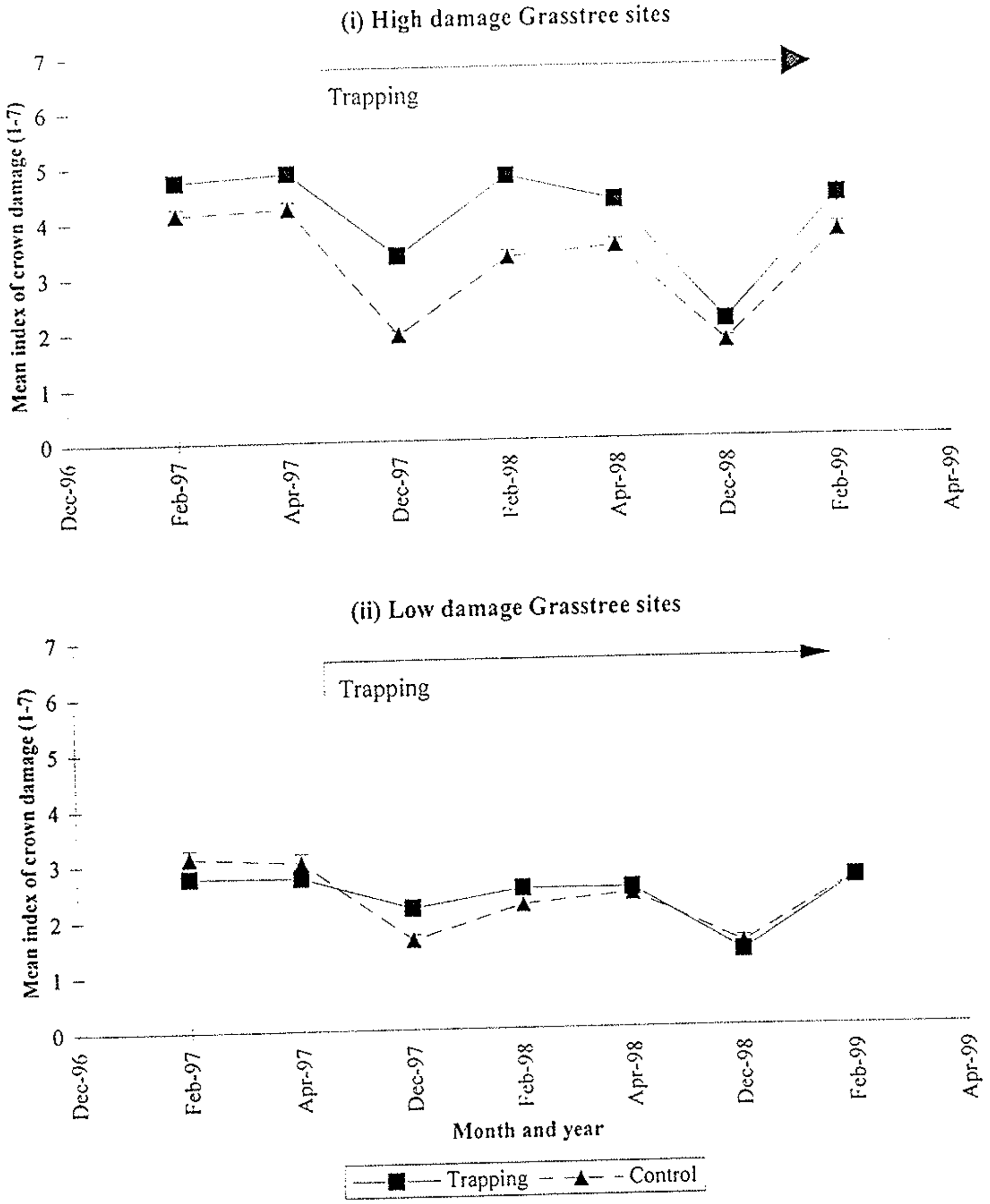

Figure 15 Comparing the mean index of crown damage for high (High and Moderately-high) and low (Moderate to Low) damage sites in the Trapping and Control areas, for each survey.

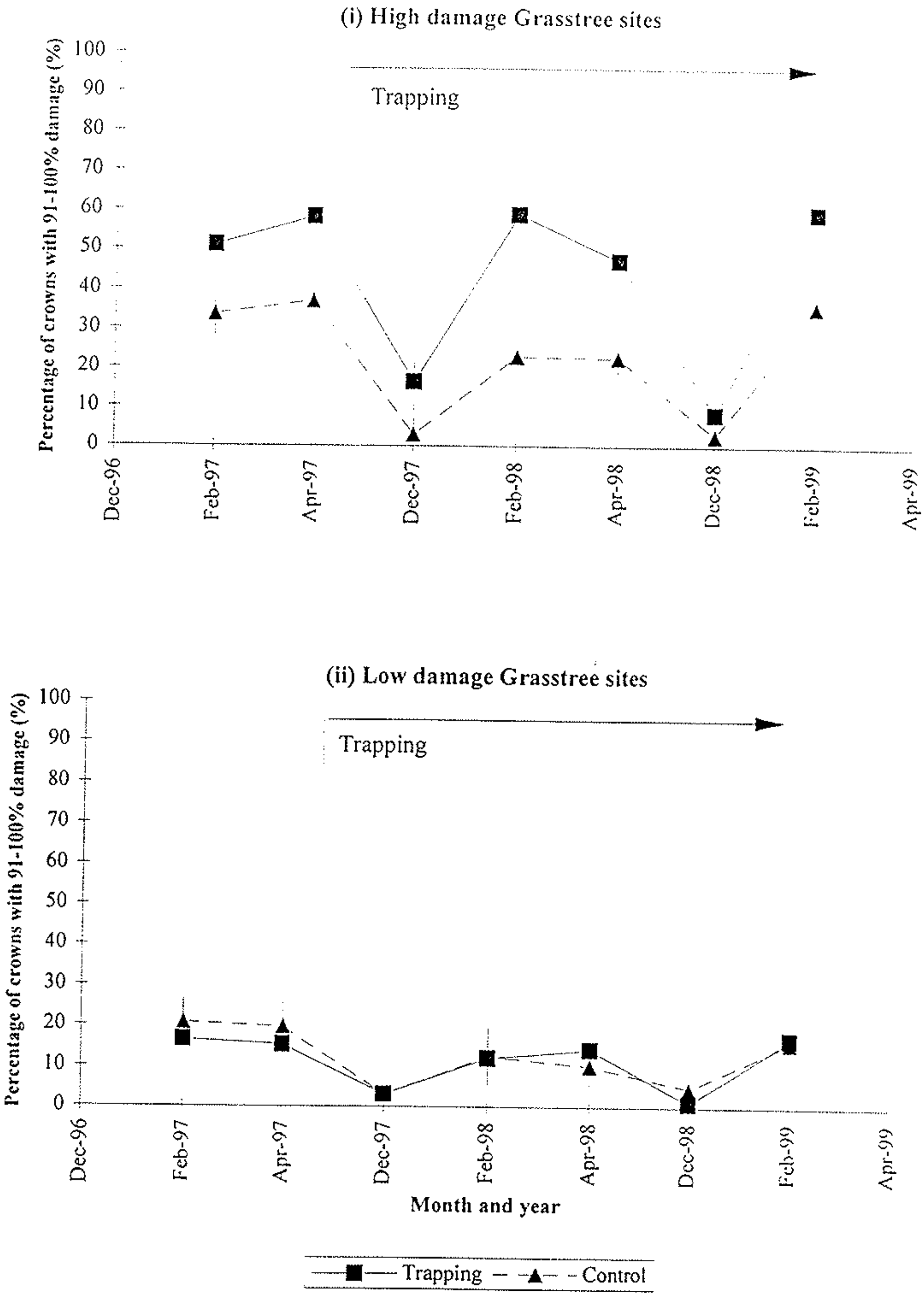

Figure 16 Comparing the mean percentage of crowns with 91-100% damage for high (High and Moderately-high) and low (Moderate to Low) damage sites in the Trapping and Control areas, for each survey.

The high damage sites in the Trapping area had considerably higher mean indexes than the Control (includes four NW Control sites and three SE Control sites) (Figure 15) (Mann-Whitney U test: Trapping verses Control, Feb '97, $Z = -4.16$, $P < 0.0001$; Feb '98, $Z = -7.37$, $P < 0.0001$; Feb '99. $Z = -3.56$, $P < 0.0004$; Apr '97, $Z = -4.69$, $P < 0.0001$; Apr '98, $Z = -4.71$, $P < 0.0001$; Dec '97. $Z = -12.56$, $P < 0.0001$; Dec '98. $Z = -2.36$, $P < 0.0185$).. The three High damage sites (X8, X10 and X11) in the Trapping area were the main contributors to the higher mean index (Appendix 6 (viii), (x) and (xi)).

The low damage Trapping and Control sites were not significantly different, with the exception of December 1997 where the Trapping sites had a significantly higher mean index than the Control sites (Mann-Whitney U test: Trapping verses Control, Dec '97, $Z = -4.57$, $P < 0.0001$) (Figure 15).

Deaths of Grasstrees in the Trapping, SE Control and NW Control areas
The percentage of crowns or Grasstrees that died in the Trapping, SE Control and NW Control areas are presented in Figure 17. The Trapping area had a higher percentage of crown deaths (mean of 29.63% $\pm$ 27.92 crown deaths by February 1999) than the two control areas (SE Control mean = 10.14% $\pm$ 7.00, NW Control mean = 14.99% $\pm$ 5.5 crown deaths by February 1999) although this was not statistically significant (arcsin√ ANOVA; $F_{2,19} = 1.581$, $P = 0.2317$), probably due to large variances. The three High damage sites were the main contributors to the higher percentage of deaths among the Trapping sites (46% of crowns died at site X11, 70% at site X8 and 79% at site X10 by February 1999).

It was concluded that the percentage of deaths was similar between the Trapping and Control areas. However, it was also noted that severely damaged sites can have a very high percentage of deaths and three such sites were surveyed in the Trapping area but not in the Control areas.

Analysis considerations
The regional differences in intensity of parrot damage over time between the Controls was minimised by comparing the high and low damage sites separately (see regional analysis, section 3.3.1.2). The NW and SE Control sites were pooled together to include seven high damage Control sites (High to Moderately-high) and five low damage Control sites (Moderate to Low). These were compared with five high and five low damage Trapping sites respectively .

3.2.2.3 Tree damage
Variation in Tree Damage Between Sites
Tree damage rates varied greatly between sites (Appendix 7). Sites such as CT2, CT16, CT17, CT18 and CT19 generally recorded high levels of tree damage (occurrences and length rates) as well as a high percentage of trees with new damage each sample time (Appendix 8), while some sites (CT3, 4, 6, 15) recorded low average damage rates and percentage of trees with new damage.

In the SE Control area cumulative damage was highest at site CT2 (average of 38.3 occurrences of damage of average length 7.9 m per tree), but low in sites CT3, CT4 and CT6 (less than 10 damage occurrences and less than 1.0 m average damage length per tree, Appendix 9). Cumulative damage was at low to intermediate levels at Trapping area sites. In the NW Control area, cumulative damage reached its highest measured level of all sites at site CT16 (average of 49.8 occurrences of damage of average length 11.4 m per tree). Sites

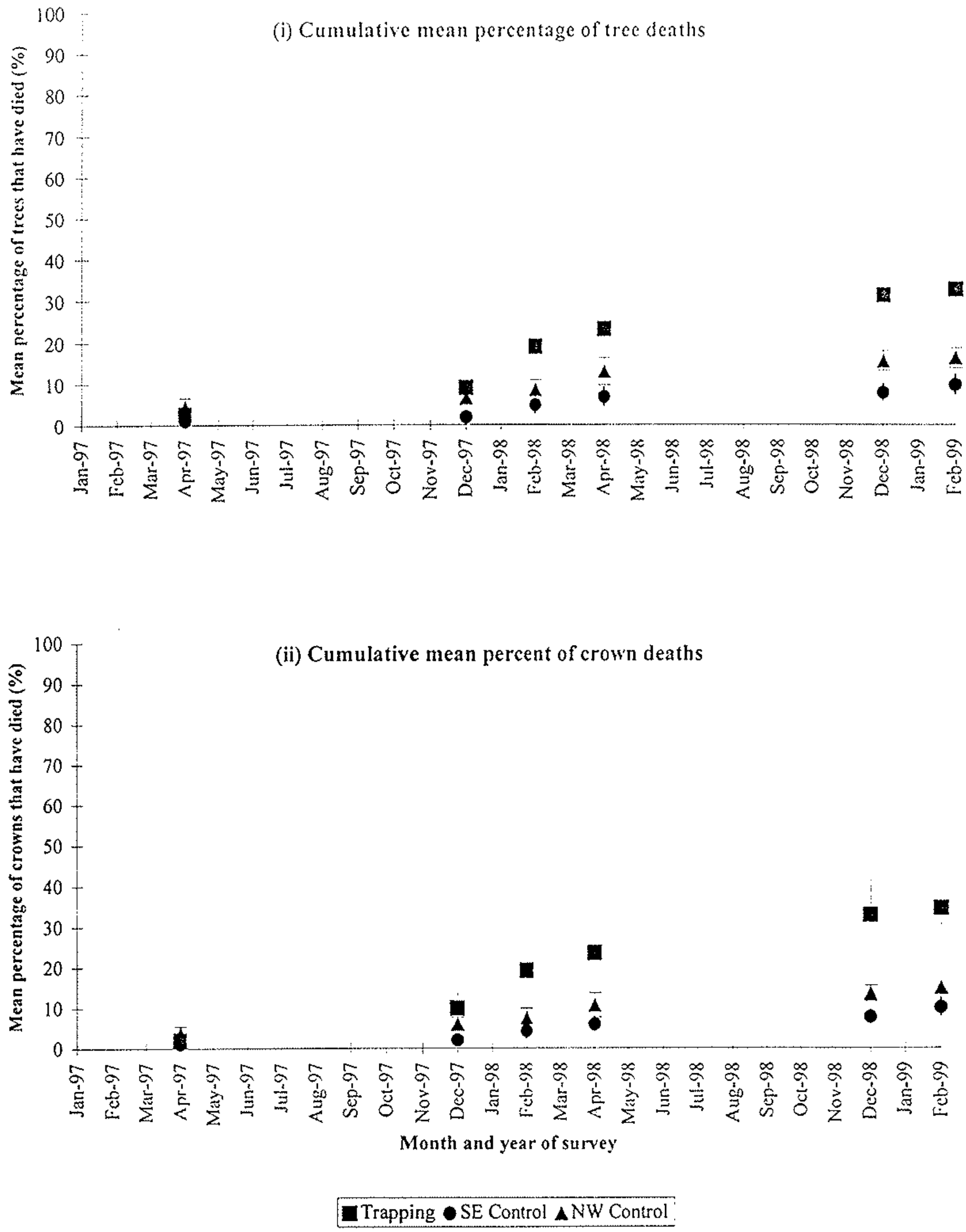

Figure 17 Cumulative mean percentage of tree or crown deaths, from February 1997 to February 1999, at the Trapping, SE Control and NW Control areas.

CT18 and CT19 also accumulated high damage levels, with only site CT15 recording low damage levels.

Sites were classified as being high or low damage intensity on the basis of pre-trapping (April 1997 survey) percentage of trees damaged, number of damage occurrences per tree and length of damage per tree (Figure 18). Damage levels used to define high and low damage classes were chosen that resulted in common sense groupings of sites. Other sites can be considered as having moderate damage.

High damage sites were defined as having, at the time of April 1997 survey:

- more than 80 % of trees with Twenty-eight Parrot damage;
- on average, more than 5 damage occurrences per tree
  AND
  on average, more than 100 cm of damaged stem per tree.

Low damage sites were defined as having, at the time of April 1997 survey:

- less than 60 % of trees with parrot damage;
- on average, less than 1.6 damage occurrences per tree
  AND
  on average, less than 20 cm length of damaged stem per tree.

Sites that met all the respective conditions were classified as either high or low damage.

Table 9 Pre-trapping classification of sites into high and low damage groups

Trial Area	Low Damage Sites (CT)			High Damage Sites (CT)		
	Conditions for Low Damage		Final Group	Conditions for High Damage		Final Group
	(i) <60% trees with new damage	(ii) < 1.6 damage occurrences per tree AND <20 cm stem damage per tree		(i) >80% trees with damage	(ii) > 5 damage occurrences per tree AND >100 cm stem damage per tree	
SE Control	3,4,6	3,4,6	**3,4,6**	1,2	1,2	**1,2**
Trapping	8,13,14	8,10,13,14	**8,13,14**	7,9,11	9,11	**9,11**
NW Control	15	15	**15**	16,17,18, 19,20	16,18	**16,18**

Table 9 shows the sites that met each of the conditions for high and low damage and the final grouping of sites into the high and low damage classifications. High and moderate damage sites were later analysed as part of the determination of any regional effect of trapping on Twenty-eight Parrot numbers and damage.

Comparison of Damage Levels in Control and Trapping Areas

Generally, the percentage of trees damaged was greatest in the NW Control area and lower in the Trapping and SE Control areas (Figures 19(a) and (b)).

(a)

(b)

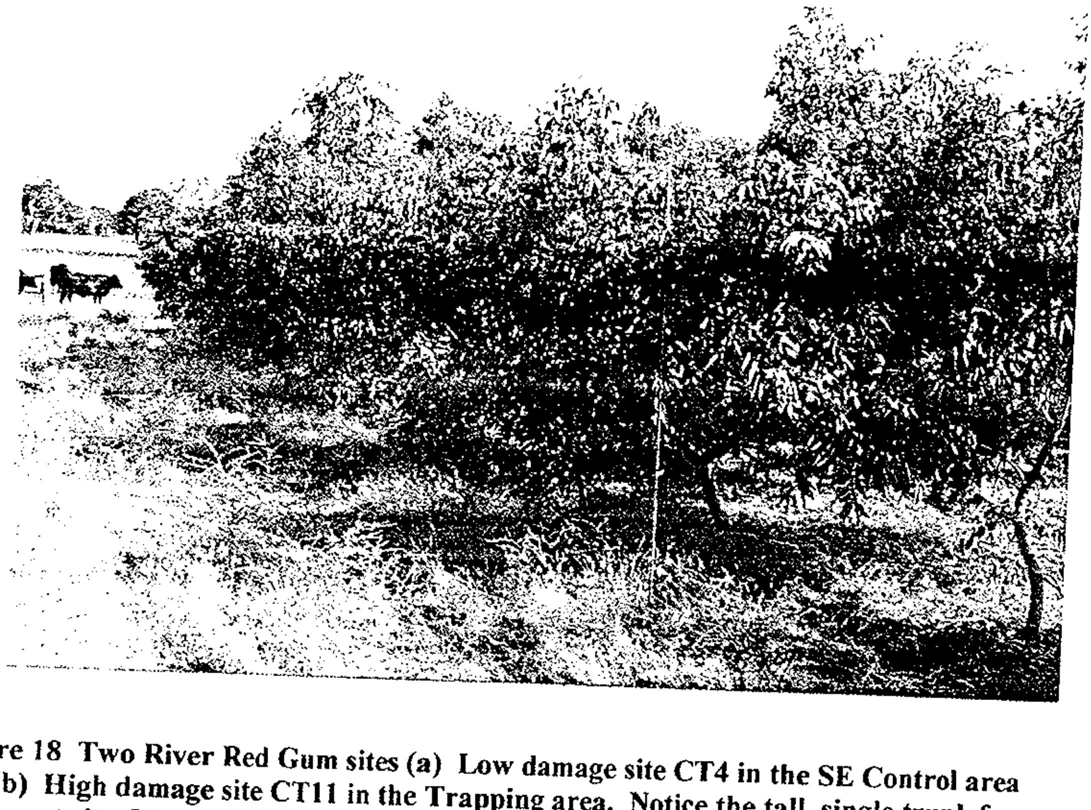

Figure 18 Two River Red Gum sites (a) Low damage site CT4 in the SE Control area and (b) High damage site CT11 in the Trapping area. Notice the tall, single trunk form of trees at site CT4 compared to the bushy appearance of trees at site CT11.

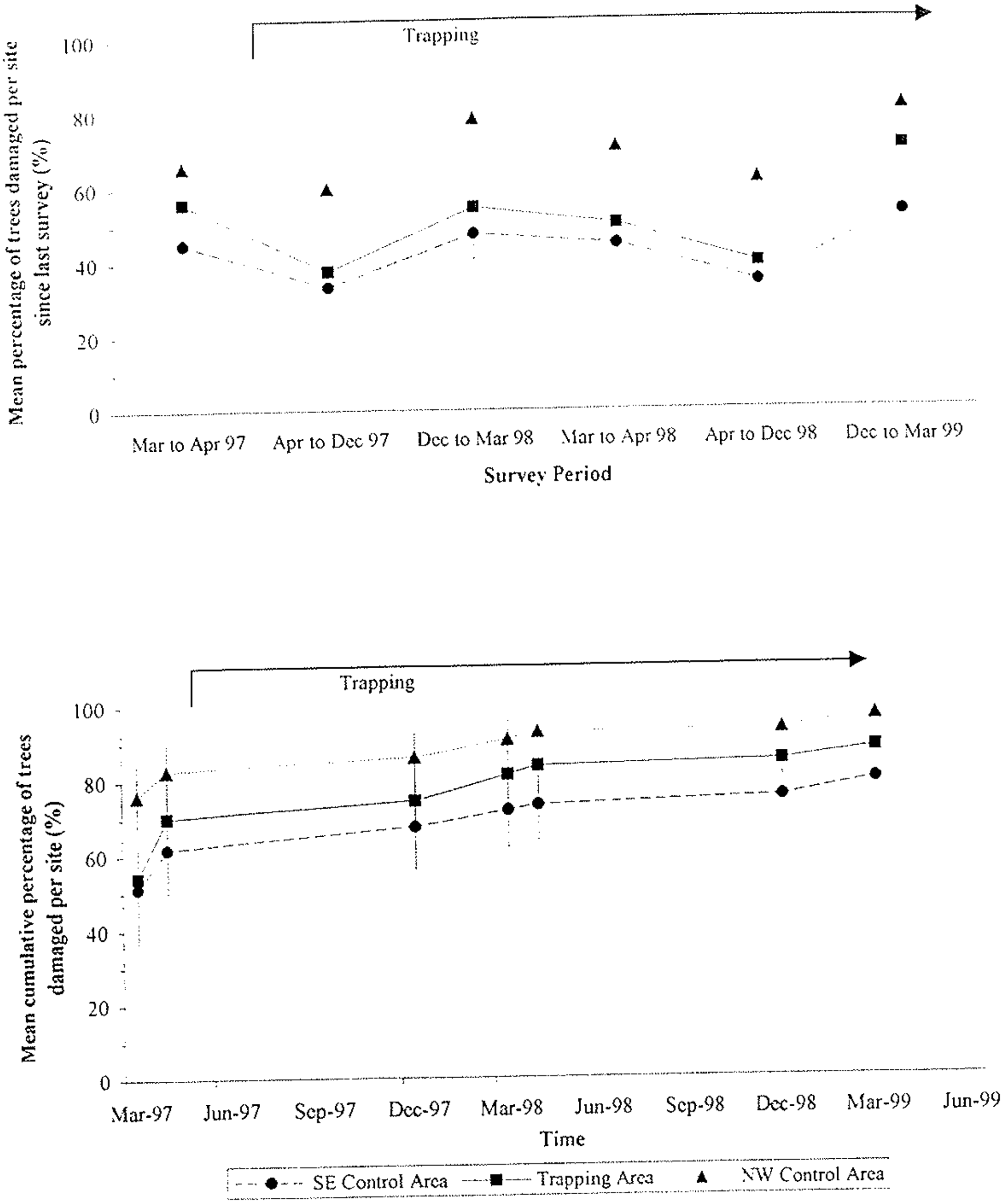

Figure 19 (a) Mean percentage of trees damaged per site since last survey
(b) Mean cumulative percentage of trees damaged per site (%).

Mean cumulative number of damage occurrences and length of damage per tree (Figure 20 (i) and (ii)) were greatest in NW Control area (accumulating to an average of 24.8 damage occurrences and 5.2 m of damaged stem length per tree in March 1999). Average cumulative damage per tree was similar in the Trapping and SE Control areas, with the Trapping area consistently having slightly lower levels (accumulating to an average 12.2 damage occurrences and 2.2 m damaged stem length per tree in March 1999). Pre-trapping tree damage rates in the three areas were similar.

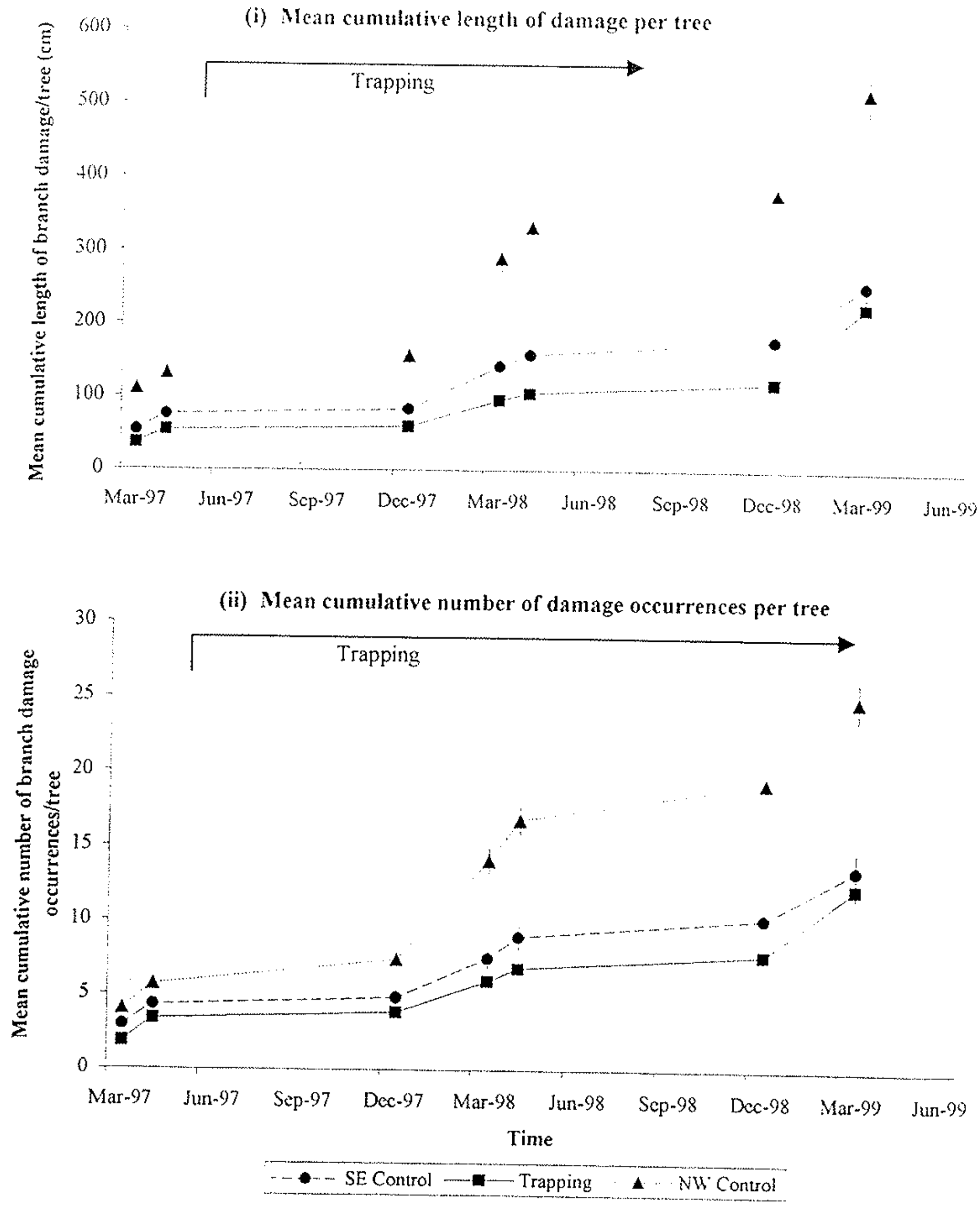

Figure 20 Mean cumulative number of River Red Gum damage occurrences and damage lengths per tree

3.2.3 Seasonality of parrot damage

As expected, Grasstree and tree damage was highly seasonal, with lowest damage occurring over the winter and spring months. Parrot counts were only recorded in the months of March and April and hence count data does not provide insight into any seasonal changes.

3.2.3.1 *Seasonality of Grasstree and River Red Gum damage*

Seasonality of Grasstree damage

Appendix 10 gives the net change in the index of crown damage for individual crowns between consecutive surveys. Increases in damage for individual crowns contributed to the positive mean value given (above the line) and decreases contributed to the negative mean value given (below the line) for each site.

At most sites there was a large decrease in the mean index of crown damage from April to December, as indicated by the large negative value for the mean index of change (Appendix 10). The decrease was due mainly to high frond growth in the spring months exceeding the much lower parrot damage (zero at some sites) during the winter and spring months (Appendix 10). This was followed by a large increase in damage between the December and February surveys. The summer months were a time of high parrot browsing activity. At most sites there was a further, but smaller, increase in damage between the February and April surveys.

Seasonality of Tree damage

The average River Red Gum damage rates were relatively high over the summer months, while average parrot damage rates during the late autumn, winter and spring period were at much lower levels (Figure 20). Lower winter and spring damage activity in the *E. camaldulensis* trees is also reflected in the percentage of trees with new damage recorded at each survey (Figure 19(a), Appendix 8). Typically, the percentage of trees damaged was lowest in the 'April to December' period, despite it being a much longer period of seven months (most easily seen in the bar charts for the treatment areas, Appendix 8).

Analysis considerations in regard to seasonality of Grasstree and Tree damage

Due to the seasonally low parrot browsing activity prior to the December survey, the February and April surveys were considered to be more important in detecting any decreases in parrot damage as a result of trapping on a regional scale. However, since most parrots were trapped during the winter months (see section 3.6.2.3) it is possible that any reductions in browsing activity may have occurred predominantly between the April and December surveys rather than during the summer. For this reason the December surveys were considered in a separate analysis.

3.2.3.2 *Effect of short term seasonal and unseasonal events*

In addition to the broad seasonal trends described above there were short term seasonal effects (e.g. flowering of eucalypts) and special events (e.g. unseasonal rain). *Recent damage* data, collected from Grasstree sites, provided a measure of parrot browsing activity during the two weeks prior to the survey and therefore is sensitive to these short term events.

There appeared to have been relatively low browsing activity at Grasstree crowns in February 1997. Evidence of this was the relatively large increase in *recent damage* from the February 1997 survey to the April 1997 survey (ie. parrot activity increased at Grasstree crowns after the Marri had finished flowering in February). This was most obvious at site X8 (Trapping area) and sites X4, X5 and X6 (SE Control area) (Appendix 11).

The Marri (*Corymbia calophylla*) flowers during February each year. The intensity of flowering for each tree, the number of trees flowering and the nectar flow can vary from year to year and from one locality to another (Ritson 1995). The Twenty-eight Parrot appears to forage on Marri blossom in preference to Grasstree fronds (McNee 1997) or the cambium of eucalypts (Ritson 1995).

Recent damage was unexpectedly low in April 1998 in the Trapping, SE Control and NW Control areas (Figure 21). It is suggested that this was the result of unseasonal rains in March and April 1998. Total rainfall for March 1998 was very high with 78.4 mm at Kojonup, 103.9 mm at Boyup Brook and 83.6 mm at Frankland (mean monthly rainfall for March is 22.5 mm, 21.6 mm and 19.8 mm respectively) (source: Bureau of Meteorology) (Figure 22). Total rainfall for April 1998 was approximately average (~30 to 40 mm) which may have been sufficiently high to have sustained any plant growth initiated in March. Low parrot browsing in response to early autumn rains may be due to either alternative food sources becoming available or that the content of the sap in the Grasstrees changes and is not as palatable.

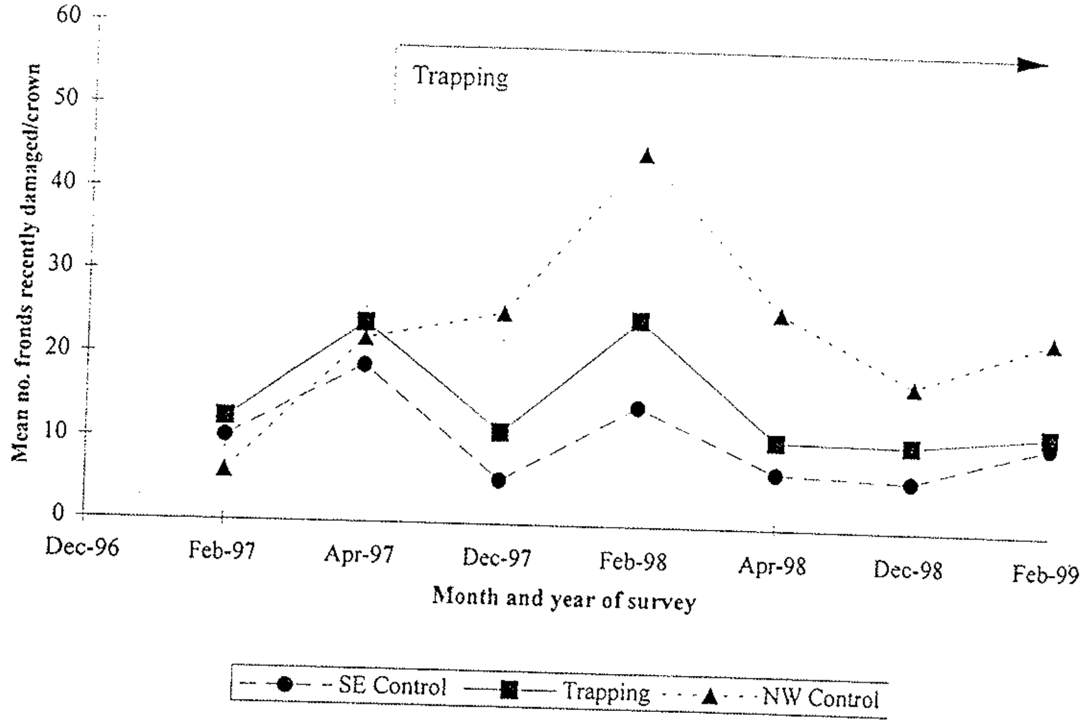

Figure 21 Comparing the mean number of fronds recently damaged per crown at the Trapping, SE Control and NW Control areas, for each survey.

Kojonup had an unusually high rainfall (138 mm) in April 1997, of which 118 mm had fallen by the time the April survey was conducted. By contrast, rainfall for April 1997 was very low in Boyup Brook and Frankland (Figure 22). Despite the high rainfall in Kojonup there was no discernable reduction in recent damage at any of the sites in the Trapping area. The effect of rains in April may not have been evident until a month later.

Analysis considerations for short term seasonal and unseasonal events

Due to differences in the effect of Marri flowering from year to year and the effect of unseasonal rain, the February and April surveys were not pooled together for analysis. However, trends could still be compared between treatments from year to year for the same months as the predominant effect of these events was observed at most sites in the Trapping and Control areas.

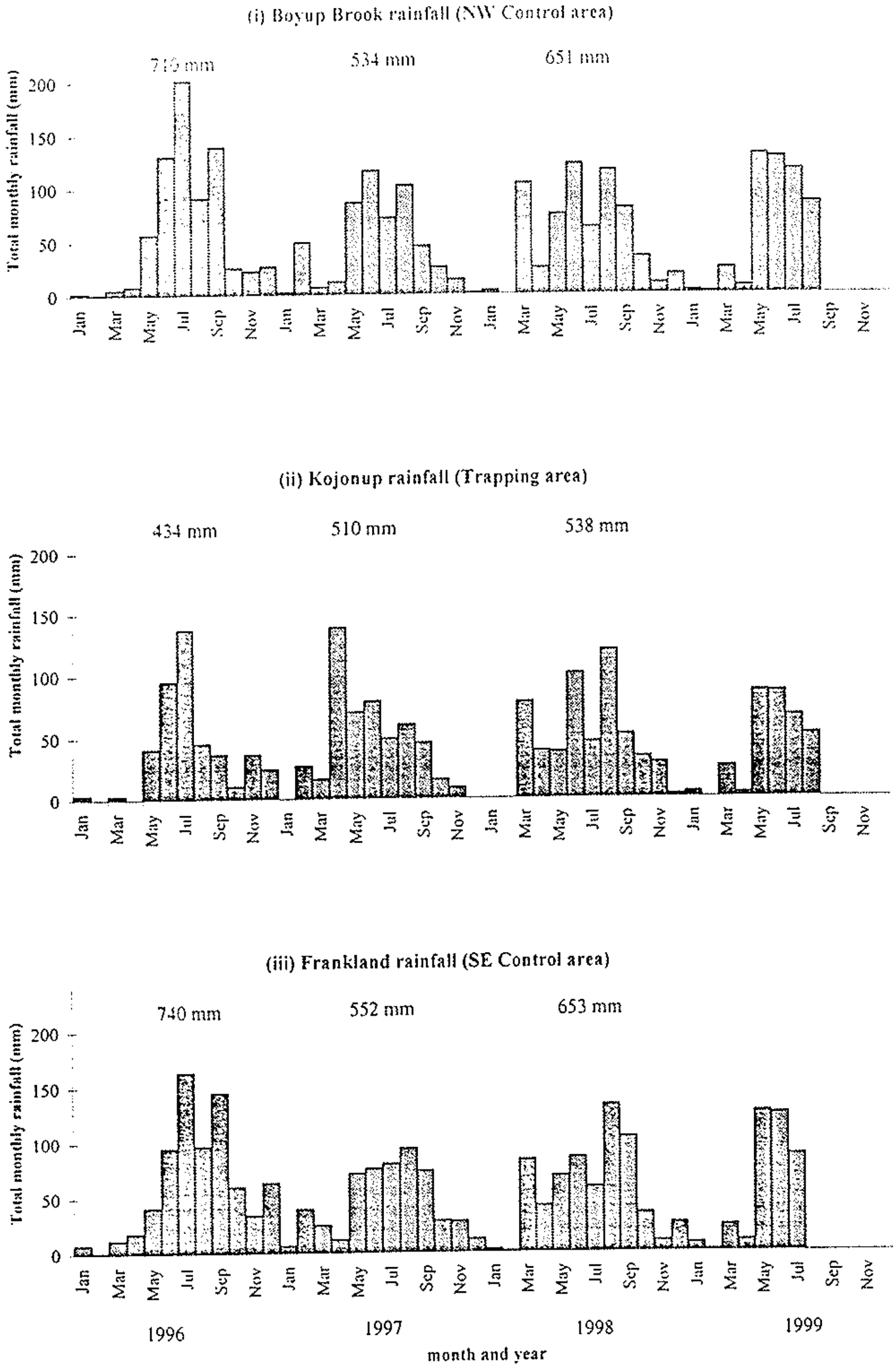

Figure 22 Total monthly rainfall for the Boyup Brook, Kojonup and Frankland areas from 1996 to July 1999 (source: Bureau of Meteorology).

3.3 IMPACT OF TRAPPING: REGIONAL PERSPECTIVE

Due to the seasonal nature of parrot browsing of Grasstrees and River Red Gums, data for the high damage months (February/March and April surveys) were analysed separately from the low damage period (December survey) (section 3.2.3.1 above). Parrot count data was only available for the high damage period.

Central to the statistical tests were comparisons of pre-trapping surveys (February/March and April 1997) with post-trapping surveys (those conducted after trapping had commenced on 1 May 1997 - December 1997 survey to March 1999 survey).

3.3.1 Analysis of March and April survey data - trends from the high damage survey period

3.3.1.1 Analysis of pre- and post-trapping parrot counts

Statistical treatment of the March 1999 SE Control area parrot counts

An initial ANOVA (Analysis of Variance) of mean parrot counts per transect in the three treatment areas identified the March 1999 SE Control count as a large outlier data point. The reliability of the March 1999 SE Control parrot counts, relative to the other parrot count data, was discussed in full in a preceding section (see section 3.2.2.1). It was decided that, in balance, the March 1999 SE Control parrot count is most likely anomalous and therefore should be excluded from the data set for the ANOVA. This treatment is important as it affects the conclusions from the analysis of parrot counts.

Regional analysis

Mean parrot counts per transect declined to significantly lower levels after trapping commenced ($F_{1,5}$=24.48, P=0.004, Table 10). This trend can be observed in Figure 10, with a small decline in SE Control parrot counts post-trapping (excluding March 1999), while Trapping and NW Control area parrot counts were greatest in April 1997 (pre-trapping) and then declined to their lowest levels in March 1999. A factor that may have contributed in some way to lower March 1999 counts was several days of unseasonal overcast conditions with some light drizzle during the count period. However, field survey staff considered the weather did not significantly affect counts and chose not to suspend counts.

Table 10 ANOVA table of effects of Trapping on log_{10} Twenty-eight Parrot counts along one kilometre transects.

Factors	df	MS	F value	P>F
Treatment Area	2	0.115	33.88	0.001
Before/After Trapping Commencement	1	0.083	24.48	0.004
Treatment*Before/After	2	0.001	0.16	0.859
Time(Before/After)	3	0.058	17.02	0.005
Error	5	0.003		

Importantly the trend of declining counts from pre-trapping to post-trapping levels was not significantly different between the Trapping and Control areas ($F_{2,5}$=0.16, P=0.859: Table 10, Figure 10). One possible explanation for the fall in parrot counts in <u>both</u> Control and

Trapping areas during the trapping period is that a reduction of parrot numbers in the Trapping area resulted in a net movement of parrots from the adjacent Control areas into the Trapping area where food, nesting and other resources were liberated by the parrot culling.

Mean parrot counts per transect were significantly lower in the SE Control area than the NW Control and Trapping areas ($F_{2,5}$=33.88, P=0.001; Table 10, Table11, Figure 10).

Table 11 Tukey comparison of means test for Twenty-eight Parrot counts per transect in three treatment areas.

Treatment Area	n	Mean
NW Control	5	17.6a
Trapping	5	15.9a
SE Control	5	12.0b

Seven of eight sites in the Trapping area (Appendix 4) showed a decline in parrot counts from March 1997 to March 1999, with even the eighth site (CT8) showing only modest increases. Six of eight NW Control sites showed a decline in parrot counts from March 1997 to March 1999 (Appendix 4).

3.3.1.2 Analysis of Grasstree damage, pre- and post trapping, in February and April

The high and low damage sites were analysed separately when determining whether there was an effect in reducing parrot numbers with the use of traps in the Trapping area (see section 3.2.2.2).

The pre- and post-trapping surveys compared were: February 1997 and February 1998, February 1997 and February 1999, and April 1997 and April 1998. In addition, February 1998 and February 1999 were compared to determine whether trends observed between February 1997 and 1998 continued.

Trends in the mean index crown damage

Figure 23 presents the changes in the mean index crown damage, from year to year, for February and April. Overall, there was a significant decrease in damage from 1997 to 1999 for the high damage sites in the Treatment and Control areas (Table 12).

Although not statistically significant, there was a decrease in damage levels from February 1997 to February 1998 in the Control areas and not in the Trapping area (Table 12, Figure 23). This can be largely attributed to the SE Control sites which showed a strong decline in 1998 (see Figure 14). Similarly for the increase observed from February 1998 to February 1999 for the Control.

To remove the effect of the SE Control sites the Trapping sites were compared with the NW Control sites only. In the Trapping area there was a significant decrease in damage from February 1997 to February 1999 (Table 13). By contrast, there was no change in damage levels in the NW Control area (Table 13). However, the decrease in the Trapping area from February 1997 to February 1999 was not large. It was therefore not unexpected that the mean index of damage in February 1999 for the Trapping area was not significantly lower than the NW Control area (Mann-Whitney U test; $Z = -1.138$, $P = 0.2553$).

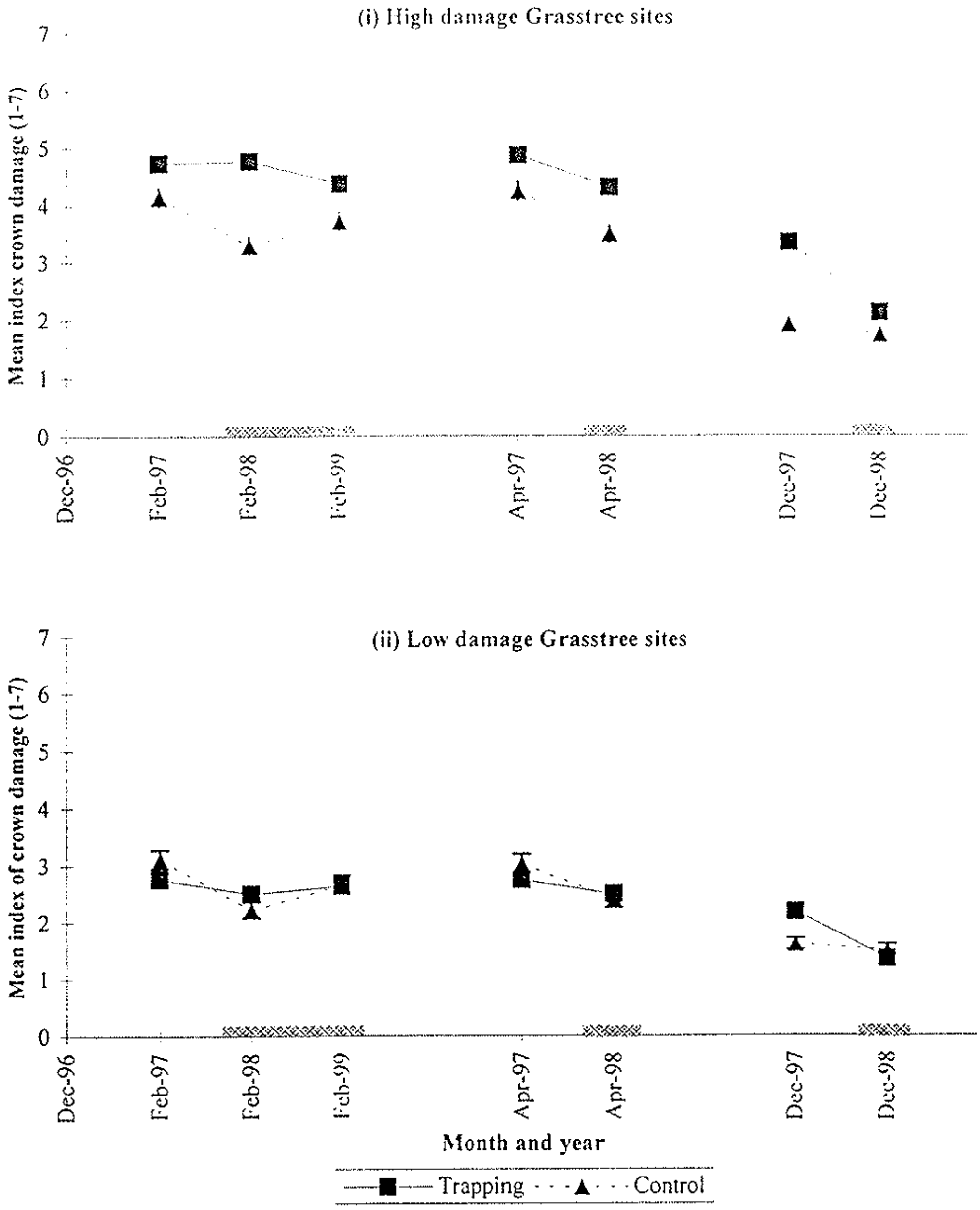

Figure 23 Comparing the mean index of crown damage for high and low damage sites between pre- and post-trapping surveys in the Trapping and Control areas. Shaded horizontal bars indicate post-trapping surveys.

Table 12 (i) Comparing the mean index of crown damage for the high damage sites in the Trapping area from year to year, including pre- and post-trapping surveys

Trapping area - high damage sites			ANOVA		Fisher's PLSD test	
Survey	Mean index crown damage	standard deviation	F-value	P-value (S or NS)$_a$	Surveys compared	P-value (S or NS)$_a$
Feb 1997	4.726	1.871	62.235	< 0.0001 S	Feb 97-98	0.8494 NS
Feb 1998	4.756	2.325			Feb 98-99	0.0309 S
Feb 1999	4.358	2.34			Feb 97-99	0.038 S
Apr 1997	4.856	1.843			Apr 97-98	0.0006 S
Apr 1998	4.298	1.986			Dec 97-98	<0.0001 S
Dec 1997	3.336	1.256				
Dec 1998	2.114	1.527				

a S = test significant when P < 0.05, indicates surveys compared had significantly different mean index of crown damage, NS = test not significantly different.

Table 12 (ii) Comparing the mean index of crown damage for the high damage sites in the Control area from year to year, including pre- and post-trapping surveys.

Control area - high damage sites			ANOVA		Fisher's PLSD test	
Survey	Mean index crown damage	standard deviation	F-value	P-value (S or NS)$_a$	Surveys compared	P-value (S or NS)$_a$
Feb 1997	4.133	1.842	80.030	< 0.0001 S	Feb 97-98	<0.0001 S
Feb 1998	3.289	2.039			Feb 98-99	<0.0001 S
Feb 1999	3.705	2.103			Feb 97-99	0.0079 S
Apr 1997	4.220	1.798			Apr 97-98	<0.0001 S
Apr 1998	3.474	1.931			Dec 97-98	0.2941 NS
Dec 1997	1.903	1.359				
Dec 1998	1.736	1.193				

a S = indicates that test is significant (when P < 0.05), thus surveys compared had significantly different mean index of crown damage, NS = test not significantly different.

Log ratios of the mean index of crown damage for February and April

The log ratios of the mean index of crown damage were used to determine whether the magnitude and direction of the decrease between pre- and post-trapping surveys were different between the Trapping and Control areas. A regional effect of trapping might be where the Trapping area had a decrease in damage while the Control areas had an increase in damage (Table 14). Log ratios can therefore be used to determine if there was a regional effect of trapping parrots on Grasstrees.

Statistical tests (t-test) of the log ratios for high and low damage sites in the Trapping and Control areas were not significant (Table 14) indicating that the differences observed between the Trapping and NW Control areas were very small. This test suggests that there is no regional effect of trapping parrots on reducing damage levels at Grasstrees. Log ratios of mean index crown damage for individual sites are given in Appendix 12. Each of the three areas included sites that increased, had no change or decreased in damage levels from year to year. Thus, there was no strong trend of sites decreasing (or increasing) in damage levels between pre- and post-trapping surveys.

Table 13 Comparing the mean index of crown damage for the Trapping area (all sites) and the NW Control area (all sites) from year to year, including pre- and post-trapping surveys.

Survey	Mean index crown damage	standard deviation	ANOVA		Fisher's PLSD test	
			F-value	P-value (S or NS)$_a$	Surveys compared	P-value (S or NS)$_a$
Trapping area - all sites						
Feb 1997	4.031	2.155	5.731	0.0033 S	Feb 97-98	0.1265 NS
Feb 1998	3.802	2.424			Feb 98-99	0.0545 NS
Feb 1999	3.489	2.318			Feb 97-99	0.0007 S
NW Control area - all sites						
Feb 1997	3.766	1.989	0.063	0.9385 NS	Feb 97-98	0.8784 NS
Feb 1998	3.737	2.119			Feb 98-99	0.7223 NS
Feb 1999	3.812	2.318			Feb 97-99	0.8361 NS

a S = indicates that test is significant (when $P < 0.05$), thus surveys compared had significantly different mean index of crown damage, NS = test not significantly different.

The decrease in damage levels from April 1997 to April 1998, as indicated by the negative log ratios, was probably in response to unusually high rainfall in March 1998 (see section 3.2.3.1). This was strongest in the Control areas.

Trends in the percentage of crowns at a site with 91-100% damage

The percentage of crowns at a Grasstree site which were severely damage (91-100% of crown damaged) was analysed as it was considered that it may be more strongly affected by changes in browsing intensity than the mean index crown damage. Not unexpectedly, the trends between the pre- and post-trapping surveys were the same for February and April as observed for the mean index damage (Figure 24). Overall there was a decline in damage between pre- and post-trapping surveys in Trapping and Control areas. The percentage of crowns with 91-100% damage had larger variance than the mean index crown damage.

Table 14 (i) Comparing proportional trends for changes in damage levels (log ratio of mean index crown damage) between the high damage Trapping sites and the high damage Control sites, pre- and post-trapping for February and April surveys.

Damage level/Treatment	Surveys compared	Log ratio mean index damage$_a$	standard deviation	t-value	P-value	Significance (NS or S)$_b$
High Trapping	Feb 97 - 98	-0.025	0.154	-1.228	0.2476	NS
High Control		-0.154	0.196			
High Trapping	Feb 98-99	0.012	0.116	0.763	0.4631	NS
High Control		0.056	0.084			
High Trapping	Feb 97-99	-0.012	0.115	-0.898	0.3901	NS
High Control		-0.098	0.189			
High Trapping	Apr 97-98	-0.063	0.103	-0.653	0.5297	NS
High Control		-0.13	0.211			

Table 14 (ii) Comparing proportional trends for changes in damage levels (log ratio of mean index crown damage) between the low damage Trapping sites and the low damage Control sites, pre- and post-trapping for February and April surveys.

Damage level/Treatment	Surveys compared	Log ratio mean index damage$_a$	standard deviation	t-value	P-value	Significance (NS or S)$_b$
Low Trapping	Feb 97 - 98	-0.053	0.094	-1.688	0.1298	NS
Low Control		-0.13	0.041			
Low Trapping	Feb 98-99	0.027	0.179	0.791	0.4517	NS
Low Control		0.092	0.048			
Low Trapping	Feb 97-99	-0.026	0.133	0.255	0.8051	NS
Low Control		-0.01	0.052			
Low Trapping	Apr 97-98	-0.039	0.092	-1.061	0.3198	NS
Low Control		-0.086	0.035			

a The negative log ratios indicate a decrease in damage and the positive log ratios an increase in damage. Log ratios close to zero indicate no or very little change in damage. The higher the value the greater the difference in damage level between surveys.
b **S** = test significant when $P < 0.05$, indicates that the Trapping and Control areas had significantly different log ratio of mean index of crown damage, NS = test not significantly different.

Log ratio of percentage of crowns 91-100%

The log ratios of percentage of crowns with 91-100% damage indicated that the direction and magnitude of the damage for the February surveys were not significantly different between the Trapping and Control areas (Table 15). However, among the low damage sites, the Control area had a significantly greater decrease in mean index damage from April 1997 to April 1998 than the Trapping area (Table 15 (ii)). Since no trapping was conducted in the Control areas and shooting rates appeared to be comparable between years, some other environmental factor must have caused a greater decrease in damage in Controls compared to Trapping area (which showed no real change) (Figure 24).

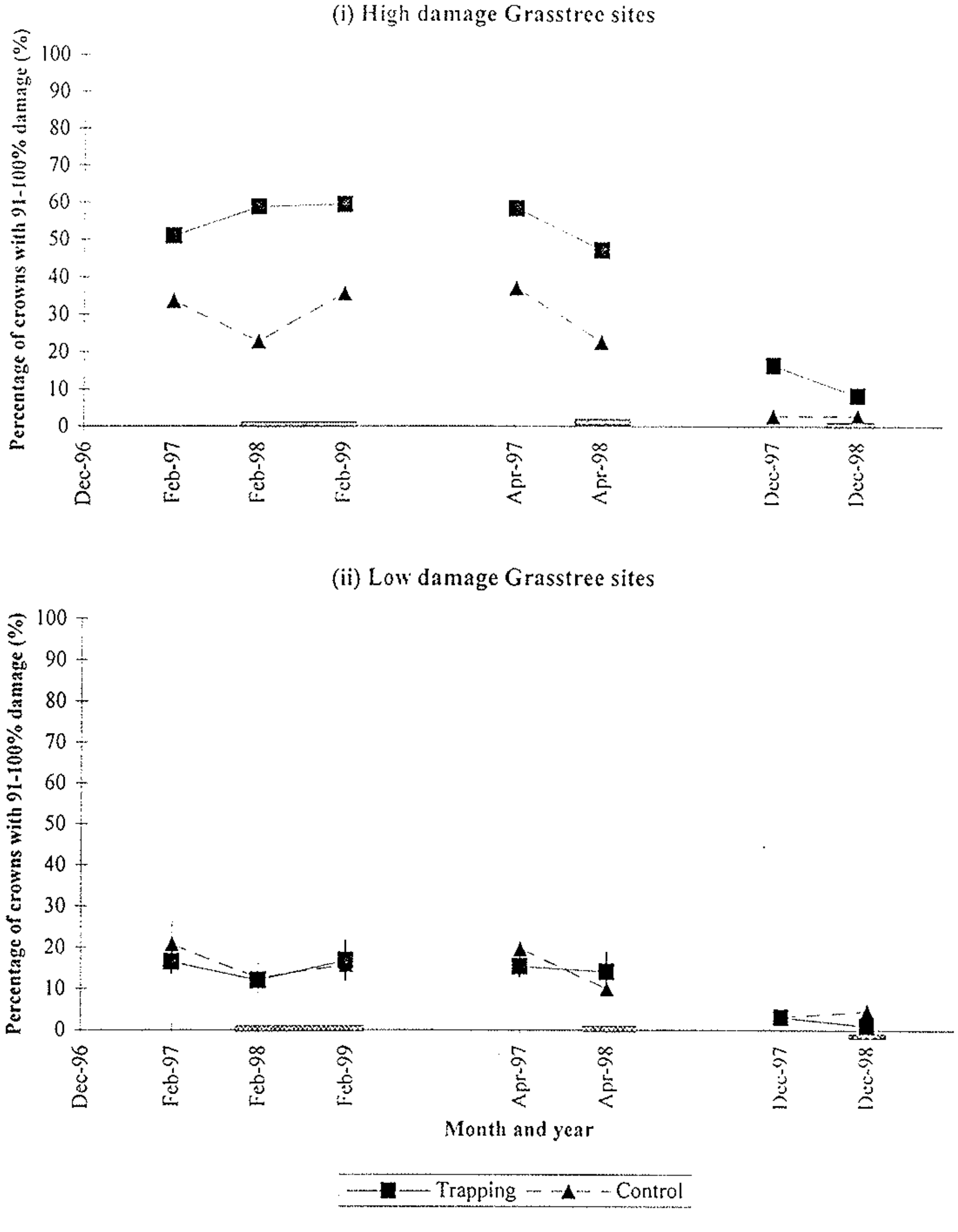

Figure 24 Comparing the percentage of crowns with 91-100% damage of high and low damage sites between pre- and post trapping surveys at the Trapping and Control areas. Shaded horizontal bars indicate post-trapping surveys.

Table 15 (i) Comparing proportional trends for changes in damage levels (log ratio of percentage of crowns with 91-100% damage) between the high damage Trapping sites and the high damage Control sites, pre- and post-trapping for February and April surveys.

Damage level/Treatment	Surveys compared	Log ratio percentage of crowns 91-100% damaged$_a$	standard deviation	t-value	P-value	Significance (NS or S)$_b$
High Trapping	Feb 97 - 98	-0.075	0.359	-0.901	0.389	NS
High Control		-0.333	0.559			
High Trapping	Feb 98-99	0.372	1.138	0.651	0.5295	NS
High Control		0.016	0.769			
High Trapping	Feb 97-99	-0.447	1.136	0.173	0.8661	NS
High Control		-0.348	0.846			
High Trapping	Apr 97-98	-0.266	0.324	-0.522	0.6132	NS
High Control		-0.418	0.588			

Table 15 (ii) Comparing proportional trends for changes in damage levels (log ratio of percentage of crowns with 91-100% damage) between the low damage Trapping sites and the low damage Control sites, pre- and post-trapping for February and April surveys.

Damage level/Treatment	Surveys compared	Log ratio percentage of crowns 91-100% damaged$_a$	standard deviation	t-value	P-value	Significance (NS or S)$_b$
Low Trapping	Feb 97 - 98	-0.125	0.141	-1.632	0.1413	NS
Low Control		-0.572	0.595			
Low Trapping	Feb 98-99	0.116	0.220	0.028	0.9784	NS
Low Control		0.135	1.506			
Low Trapping	Feb 97-99	-0.010	0.262	-0.831	0.4301	NS
Low Control		-0.437	1.119			
Low Trapping	Apr 97-98	-0.079	0.309	-2.427	0.0414	S
Low Control		-1.217	1.001			

a The negative log ratios indicate a decrease in percentage of crowns 91-100% and the positive log ratios an increase in percentage. Log ratios close to zero indicate no or very little change in percentage. The higher the value the greater the difference between surveys.
b **S** = indicates that test is significant (when $P < 0.05$), thus surveys compared had significantly different mean index of crown damage, NS = test not significantly different.

3.3.1.3 Analysis of pre- and post-trapping River Red Gum data in March and April

Comparison of all Trapping and Control Area sites

ANOVA analysis of all the River Red Gum parrot damage for March and April surveys pooled into pre- and post-trapping, found there was no significant difference between pre- and post-trapping damage rates ($F_{1,4}=0.003$, $P=0.959$ damage occurrences; F [illegible] $=2.317$, $P=0.203$ damage lengths: Table 16, Figure 25).

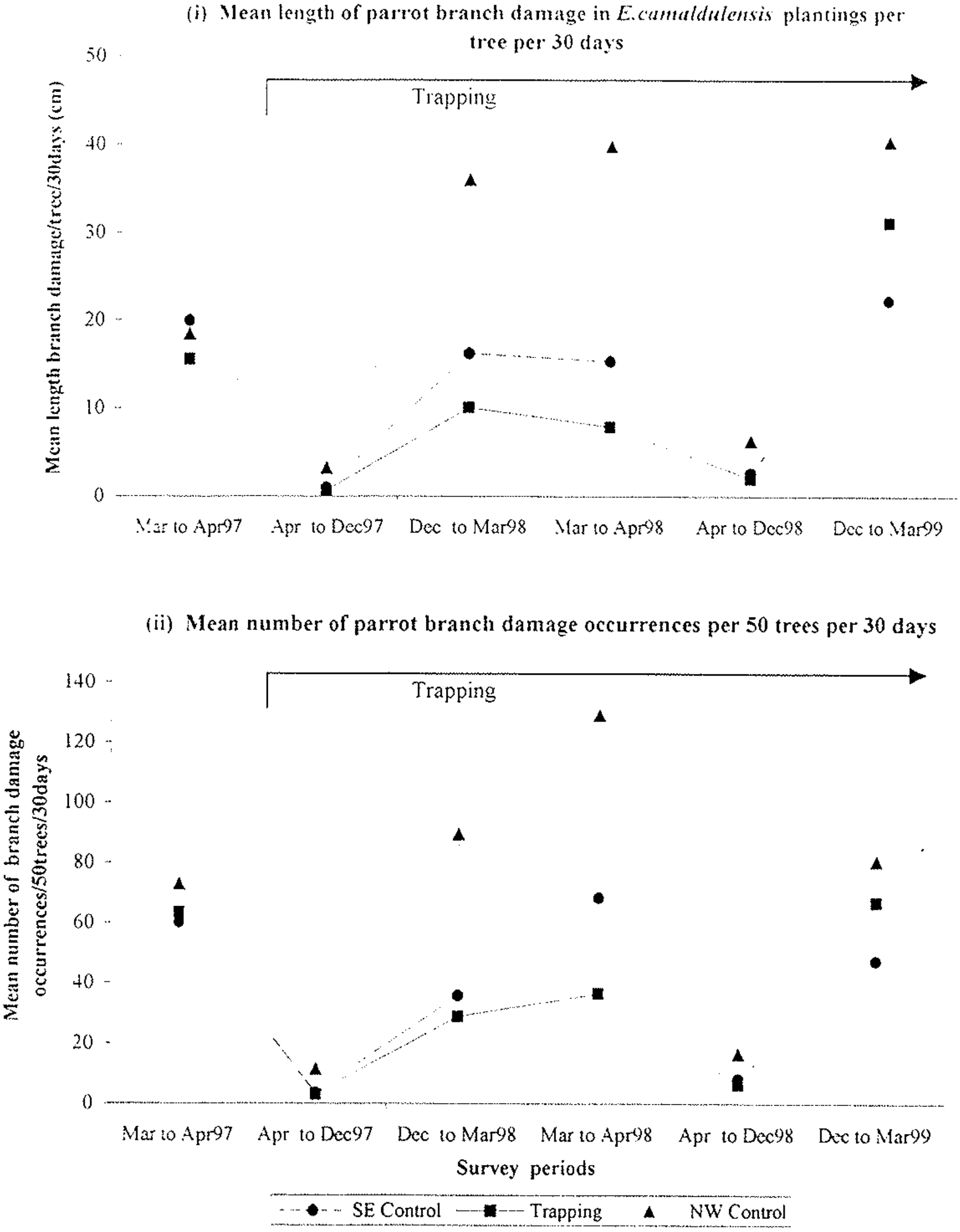

Figure 25 Mean length and number of occurrences of parrot stem damage per 30 days at River Red Gum sites.

Most importantly, when the ANOVA compared the Trapping and Control areas, there was no significant differences in trends between pre- and post-trapping damage rates ($F_{2,4}$=1.087, P=0.420 for damage occurrences; $F_{2,4}$=2.858, P=0.170 for damage lengths, Table 16, Figure 25). However, mean damage rates in the Trapping area were lower in the December 1997 to April 1998 period than in the pre-trapping period. Trends over the same period were similar in the SE Control area although not quite as low (Figure 25), while damage rates in the NW Control area increased. While there was an initial decline in damage rates in the Trapping area, damage rates increased in March 1999 to levels as high (damage occurrences, Figure 25(ii)) or higher (damage lengths, Figure 25(i)) than pre-trapping levels. The March 1999 Trapping area damage rates were similar to mean damage rates in the Control areas.

Post-trapping damage rates in six (seven if consider only damage lengths) individual Trapping area sites were similar or higher than pre-trapping damage rates (Appendix 7). Four of the NW Control sites reflected the overall NW Control area trend of a large increase in damage rates during the first summer of trapping from pre-trapping levels. Site CT15 had low damage rates throughout the trial. Site CT18 experienced a substantial decrease in damage rates in the second summer of trapping. Damage rates in the SE Control area declined with time after trapping at site CT1 (Appendix 7). However, this may have been related to poor health of the trees at a high water table site. At sites CT5 and CT2, summer damage rates during trapping were higher than pre-trapping levels. Damage at the other 3 sites were low throughout the trial.

Combining all March and April survey data, ANOVA determined there was no significant difference in mean damage rates between the Control and Trapping areas ($F_{2,4}$=2.47, P=0.200 damage occurrences; $F_{2,4}$=3.410, P=0.137 damage lengths, Table 16).

Table 16 ANOVA table of effects of Trapping on the rate of Twenty-eight Parrot damage to River Red Gum trees per 30 days (March and April survey data).

Dependent Variable	Source	df	MS	F value	P>F
i) Number of stem	Treatment Area	2	1005.077	2.47	0.200
damage occurrences	Before/After Trapping	1	1.192	0.003	0.959
per 30 days per tree	Treatment Area*Before/After	2	442.472	1.087	0.420
	Time(Before/After)	2	530.999	1.305	0.366
	Error	4	407.012		
ii) Length (cm) of stem	Treatment Area	2	131.152	3.41	0.137
damage occurrences	Before/After Trapping	1	89.120	2.32	0.203
per 30 days per tree	Treatment Area*Before/After	2	109.918	2.86	0.170
	Time(Before/After)	2	107.06	2.78	0.175
	Error	4	38.466		

Comparison of Core Control and Trapping Sites

The conclusions from an ANOVA of only the core Trapping and Control area sites (excluding boundary sites and hence any boundary effects) were the same as for the analysis of all sites for March and April surveys. There was no significant difference between pre- and post-trapping damage rates ($F_{1,4}$=0.009, P=0.930 damage occurrences; $F_{1,4}$=0.83, P=0.414 damage lengths, Table 17). Also, there was no significant difference in damage trends in the Trapping and Control areas from pre- to post-trapping periods ($F_{2,4}$=0.41, P=0.690 damage occurrences; $F_{2,4}$=0.74, P=0.531 damage lengths, Table 17).

Mean damage rates at core sites were highest in the NW Control area and lowest in the Trapping area. Damage rates in NW Control area were considerably higher post-trapping than pre-trapping, while damage rates in core sites in SE Control and Trapping areas were at similar levels pre- and post-trapping.

Table 17 ANOVA table of effects of trapping on the rate of Twenty-eight Parrot Damage to River Red Gum trees at core sites (March and April survey data).

Dependent Variable	Factor	df	MS	F value	P>F
i) Number of stem	Treatment Area	2	361.333	0.36	0.720
damage occurrences	Before/After Trapping	1	8.892	0.01	0.930
per 50 trees per 30days	Treatment*Before/After	2	413.292	0.41	0.690
	Time(Before/After)	2	1333.445	1.32	0.364
	Error	4	1012.655		
ii) Length (cm) of stem	Treatment Area	2	46.965	0.30	0.756
damage occurrences	Before/After Trapping	1	129.455	0.83	0.414
per tree per 30 days	Treatment*Before/After	2	116.526	0.75	0.531
	Time(Before/After)	2	119.008	0.76	0.525
	Error	4	156.354		

Comparison of high and moderate damage sites in Control and Trapping areas
An ANOVA of damage rates at high-moderate damage sites (see Table 9, section 3.2.1.3 above) in Trapping and Control areas arrived at the same conclusions as the ANOVA of all the sites and core sites. There was no significant difference between overall damage rates pre-trapping and post-trapping ($F_{1,4}$=0.027, P=0.877 damage occurrences; $F_{1,4}$=2.086, P=0.222 damage lengths; Table 18, Figure 26(i) and (ii)). Also trends from pre-trapping to post-trapping in the Trapping and Control areas were not significantly different ($F_{2,4}$=1.115, P=0.412 damage occurrences; $F_{2,4}$=2.873, P=0.168 damage lengths, Table 18).

Table 18 ANOVA table of effects of trapping on the rate of Twenty-eight Parrot damage to River Red Gum trees at high and moderate damage sites (March and April survey data).

Dependent Variable	Source	df	MS	F value	P>F
i) Number of stem	Treatment	2	1061.215	1.60	0.309
damage occurrences	Before/After	1	17.953	0.03	0.877
per 30 days per tree	Treatment*Before/After	2	738.887	1.12	0.412
	Time(Before/After)	2	1170.787	1.77	0.282
	Error	4	662.944		
ii) Length (cm) of stem	Treatment	2	195.418	3.47	0.134
damage occurrences	Before/After	1	117.483	2.09	0.222
per 30 days per tree	Treatment*Before/After	2	161.814	2.87	0.168
	Time(Before/After)	2	169.080	3.00	0.160
	Error	4	56.322		

High-moderate damage sites in the NW Control and Trapping areas showed similar trends to damage rates for all sites in these areas (Figure 25 and Figure 26). However, high-moderate damage sites in the SE Control area had higher damage rates, which were more similar to damage rates in the NW Control area. This reflects the greater number of low damage sites in the SE Control area which reduce the areas mean damage rates.

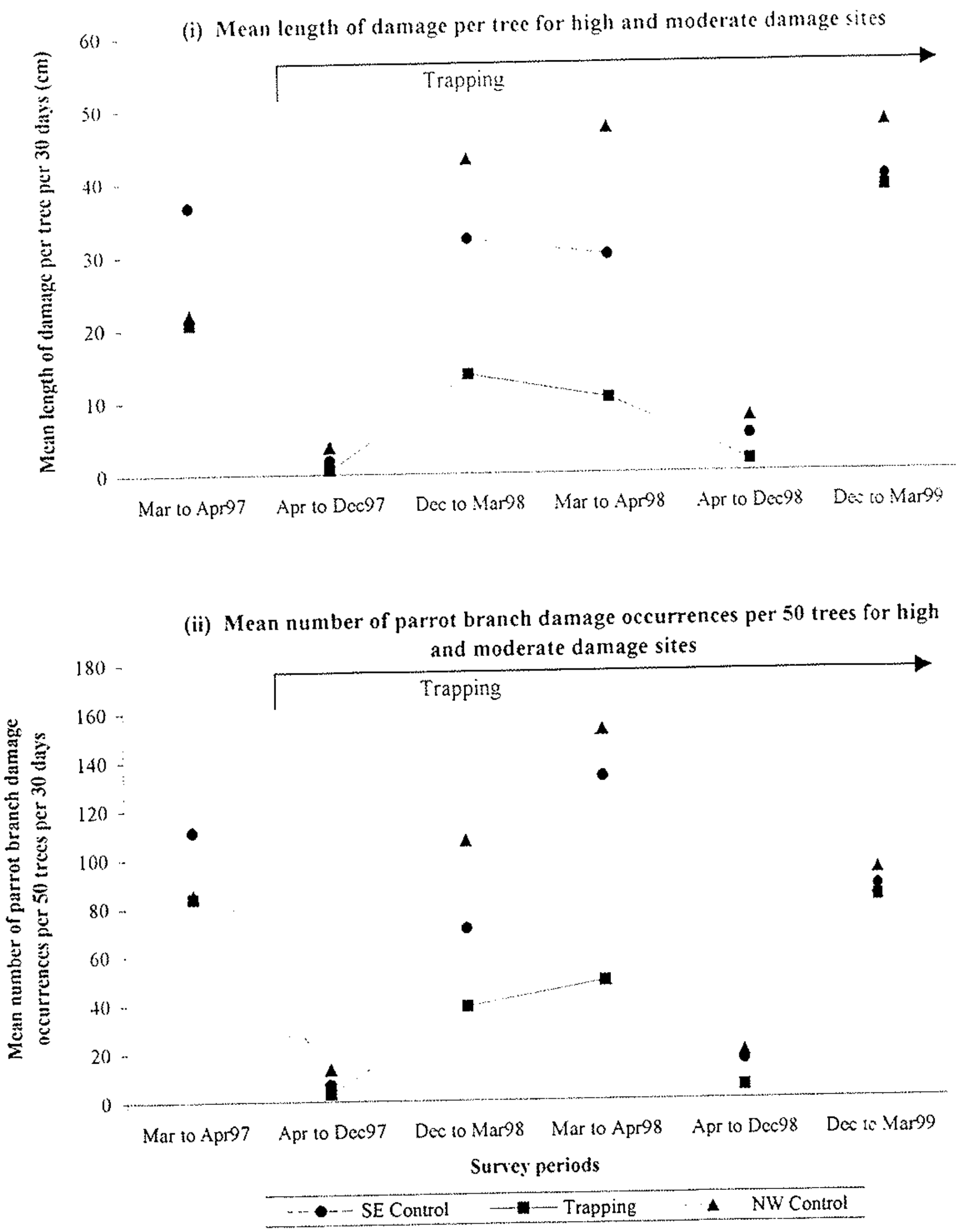

Figure 26 Mean length and number of occurrences of stem damage per 30 days in River Red Gum trees.

3.3.2 Analysis of December Survey Data - Trends of the Low Damage Season

Although the winter and spring months tend to be a time of low parrot browsing activity it is possible that trapping during the winter months could have further reduced parrot browsing activity at this time.

3.3.2.1 Comparing December 1997 and 1998 surveys for Grasstrees

The mean index crown damage in the Trapping area showed a strong decrease in damage from December 1997 to December 1998 for both high and low damage sites (Figure 23). This was in contrast to the Control area which had very little change in damage levels between the two December surveys. The decrease was from a mean index of crown damage which was significantly higher than the Control areas to a mean index that was similar to the Control areas.

The log ratio of the mean index crown damage for the Trapping area was significantly greater decrease in damage than the Control (Table 19). This was the case for the high and low damage sites.

Whether the large decrease in damage recorded for December 1998 could have been in response to trapping events needs to be considered. Particularly as this trend was not observed in the Control areas.

Table 19 Comparing proportional trends for changes in damage levels (log ratio of mean index crown damage) between Trapping and Control sites, pre- and post-trapping for December surveys.

Damage level/Treatment	Surveys compared	Log ratio mean index crown damage$_a$	standard deviation	t-value	P-value	Significance (NS or S)
High Trapping	Dec 97-98	-0.195	0.143	2.303	0.044	S
High Control		-0.01	0.134			
Low Trapping	Dec 97-98	-0.22	0.073	4.45	0.0021	S
Low Control		-0.02	0.069			

a The negative log ratios indicate a decrease in damage levels and the positive log ratios an increase in damage. Log ratios close to zero indicate no or very little change in crown damage. The higher the value the greater the difference between surveys.

Trends and log ratios of percentage of crowns 91-100%??

The trend from December 1997 to December 1998 was an overall decrease in damage among the Trapping sites and very little change among the Control sites (Figure 24). This follows the same trend as mean index crown damage.

However, there was no significant difference in the direction or magnitude of the change between the December 1997 and December 1998 surveys for the Trapping and Control areas according to the t-test (Table 20). The Trapping area had a very large variance for December 1998 among the high damage sites which meant that statistically the trend was less clear. The large variance was due to there being sites with a very large increase in the percentage of crowns with 91-100% damage and a few sites with an equally large decrease.

Table 20 Comparing proportional trends for changes in damage levels (log ratio of percentage of crowns with 91-100% damage) between Trapping and Control sites, pre- and post-trapping for December surveys.

Damage level/Treatment	Surveys compared	Log ratio percentage of crowns 91-100% damaged[a]	standard deviation	t-value	P-value	Significance (NS or S)
High Trapping	Dec 97-98	-0.178	1.883	-0.013	0.9896	NS
High Control		-0.190	1.252			
Low Trapping	Dec 97-98	-0.432	0.606	0.437	0.6735	NS
Low Control		-0.248	0.723			

a The negative log ratios indicate a decrease in percentage of crowns 91-100% and the positive log ratios an increase in percentage. Log ratios close to zero indicate no or very little change in percentage. The higher the value the greater the difference between surveys.

3.3.2.2 Comparing December 1997 and 1998 surveys for tree damage

Mean tree damage rates during April to December were greater in 1998 than in 1997 in both Control and Trapping areas, with the increase being least in the Trapping area (Figure 25). However, statistically there was no significant difference in the increase in December damage rates between Trapping and Control areas ($F_{2,17}$=0.131, P=0.878 damage occurrences; $F_{2,17}$=0.564, P=0.579 damage lengths; Table 21).

Table 21 ANOVA table of effects of trapping on the difference between December 1997 and December 1998 Twenty-eight Parrot tree damage rates.

Dependent Variable	Source	df	MS	F value	P>F
i) Number of stem	Treatment	2	0.003	0.13	0.878
damage occurrences	Error	17	0.024		
per 30 days per tree					
ii) Length (cm) of stem	Treatment	2	5.481	0.564	0.579
damage occurrences	Error	17	9.712		
per 30 days per tree					

An ANOVA on high-moderate damage sites in Trapping and Control areas also found there was no significant difference in the mean increase in December damage rates between Trapping and Control areas ($F_{2,10}$=0.588, P=0.573 damage occurrences; $F_{2,10}$=0.82, P=0.468 damage lengths; Table 22, Figure 26). However, the mean increase in damage rates from December 1997 to December 1998 levels was least in the Trapping area (Table 23).

Table 22 ANOVA table of effects of trapping on the difference between December 1997 and December 1998 Twenty-eight Parrot tree damage rates at high-moderate damage sites.

Dependent Variable	Source	df	MS	F value	P>F
i) Number of stem	Treatment	2	47.656	0.588	0.573
damage occurrences	Error	10	80.992		
per 30 days per tree					
ii) Length (cm) of stem	Treatment	2	10.550	0.82	0.468
damage occurrences	Error	10	12.858		
per 30 days per tree					

Table 23 Mean difference in December survey tree damage rates in high-moderate damage sites

Treatment Area	Mean Difference in December Damage rates (Dec_{98-97})	
	Mean Number of Damage Occurrences/50 trees	Mean Damage Lengths/tree (cm)
SE Control Area	9.3	3.2
Trapping Area	2.4	1.0
NW Control Area	6.4	3.8

3.4 IMPACT OF TRAPPING: LOCAL PERSPECTIVE

This project was designed to measure regional effects of Twenty-eight Parrot trapping rather than local effects. Monitoring sites were selected opportunistically in the Trapping area, wherever Grasstree stands and suitable River Red Gum plantings occurred. There was no attempt to coordinate or focus trapping at particular monitoring sites. In fact, most shooting and trapping was done around houses and sheds and not around tree planting or Grasstree stands. Consequently, few monitoring sites had large numbers of parrots culled within a 2 km radius (Table 24, Table 25, Figure 8(a),(b)).

3.4.1 Parrot Counts and Tree Damage

Sites CT7 and CT8 had in excess of 2,000 birds culled within about 2 km, while site CT14 also had large numbers of birds culled (1,393) within about 2 km (Table 24). There is some evidence for a local effect of trapping on damage rates at site CT7, while no conclusive local effect on damage rates or parrot counts was evident at sites CT8 and CT14.

The culling near site CT7 was associated with a steady decline in parrot counts (Appendix 4, Table 24) and a decline in tree damage from pre-trapping levels (Appendix 7, Table 24). Site CT7 was only one of two high-moderate damage sites to have all post-trapping damage rates lower than pre-trapping rates. The only other high-moderate damage site with this pattern of damage rates was CT1, which had a complicating factor of less vigorous trees on a high water table site.

Site CT8 had fairly consistent parrot counts and consistently low levels of damage until an increase during the last survey period. Nevertheless, that increase in damage was much less than sites CT9 and CT10 and a little less than sites CT11 and CT12 (Appendix 7). However, declining parrot counts were not unique to the sites with large culling within 2 km, as counts also declined at sites CT10, CT11 and CT12 (Appendix 4).

Site CT14 had consistently moderate parrot counts pre- and post-trapping (excepting one very large April '97 count, Appendix 4) and consistently low damage rates associated with fairly high cull rates (Appendix 7).

Table 24 Trends in parrot damage and counts at each monitoring site and estimated numbers of Twenty-eight Parrots culled within two km of each monitoring site.

Site	Tree Damage Level	Net General Trends				Estimated Cull Within 2 Km	
		Tree Damage$_a$		Parrot Counts			
		Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
SE Control							
CT1		Lge decrease	Stay low	Sml decline	Increase	?	?
CT2	High	Lge increase	Stay high	Same	Increase	100	100
CT3	Low	V low	Same	Same	Increase	?	0
CT4	Low	Sml decrease	Sml increase	Same (v low)	Sml Increase	0	0
CT5		Same	Increase	Same (v low)	Increase	0	0
CT6	Low	V low	Same	Same	Same	200	200
Trapping							
CT7		Decrease	Same	Decrease	Sml decrease	571	1600
CT8		Low	Increase	Same	Same	995	1186
CT9		Low	Increase	Same	Sml decrease	700	120
CT10		Same	Lge increase	Sml increase	Decrease	0	0
CT11		Decrease	Increase	Same	Same	50	50q
CT12		Same	Increase	Same	Decrease	0	0
CT13	Low	V low	Increase	Sml increase	Sml decrease	0	0
CT14	Low	V low	Same	Same	Same	521	872
NW Control							
CT15	Low	V low	V low	Sml decrease	Sml increase	0	0
CT16	High	Same	Increase	Sml increase	Same	600	100
CT17		Sml increase	Same	Same	Decrease	0	0
CT18	High	Lge increase	Lge decrease	Sml decrease	Decrease	0	0
CT19	High	Lge increase	Increase	Increase	Decrease	0	0
CT20		Low	Same	Same	Sml decrease	0	0

a Length of damage per 30 days per tree

3.4.2 Local perspective on Grasstree damage

Large numbers of Twenty-eight Parrots (>1,000) were culled within two kilometres of four of the 22 Grasstree sites. These were Grasstree sites, X4 in the SE Control and X11, X13 and X14 in the Trapping area (Table 25). Of these, X13 and X14 had no change in damage levels, X11 had a small increase in the mean index of crown damage by February 1999 and X4 had a large decrease in damage during 1998 followed by an increase by February 1999 (see Appendix 6 and Table 25).

This was in contrast to other sites which had a strong decrease (as observed at sites X1, X3, X6, X9, X16, X20 and X22) or increase (as observed at sites X2, X8, X10, X12 and X19) in damage levels (see Appendix 6 and Table 25). The remaining sites showed little change in damage levels.

Reducing large numbers of parrots adjacent to or very close (within 100-200 m) to Grasstree sites would be expected to reduce the intensity of parrot browsing at the site. Large numbers of parrots were removed from near two Grasstree sites. A total of 2,285 Twenty-eight Parrot numbers were trapped adjacent to site X11 or elsewhere on the property during May 1997 to February 1999. A total of 2,383 Twenty-eight Parrots were shot by Bunnings at a young Bluegum plantation within 100 m of site X4 during the same period (Table 25).

Evidence of recovery at Grasstree site X11

The large number of Twenty-eight Parrots removed adjacent to site X11 and elsewhere on the property was apparent later during 1997 when no Twenty-eight Parrots were flushed from the driveway or from tree lines in paddocks on the way to the site. This was in contrast to previous years (personal observations).

Grasstree site X11 had high damage levels during 1996 to 1999 (data for 1996 made available from another survey, McNee (1997)) (Figure 27). However, there was a decline in damage in 1997. This occurred in February and April 1997, prior to the commencement of trapping. Three crowns in particular had strong recovery of their crowns. The three crowns changed from 91-99% (index 6) crown damage during February to November 1996 to 34-66% (index 4) crown damage in February 1997. Crown recovery continued such that by February 1999 crown damage was only 1-10% (index 2).

A possible reason for the reduction in damage in February and April 1997 prior to trapping may have been that the site became less attractive to Twenty-eight Parrots with limited regrowth of crowns and fewer live crowns present. However, recovery of crowns did occur and would presumably have increased the attraction value to Twenty-eight Parrots during 1997 and 1998 although damage levels remained at the reduced level or slightly lower until February 1999. Trapping nearby may have reduced parrot browsing activity at this site. Certainly, it is unusual at a high damage site for recovery to be sustained over one or more years.

While the mean index crown damage at site X11 remained low, there was a greater decrease in the proportion of crowns with 91-100% damage and finally a reduction in the percentage of crowns with damage in December 1998. By the February 1999 survey, parrot browsing had increased. New birds may have moved in to the area during the summer at a time when little or no trapping had been conducted prior to this survey.

Table 25 Changes in damage levels at each site in the SE Control, Trapping and NW Control areas and the estimated number of Twenty-eight Parrots culled within two kilometres of each site.

Site	Initial - final Grasstree damage level	Change in damage level[a] for: % of crowns with *current damage* 1997-1998	1998-1999	index of *current damage* 1997-1998	1998-1999	percentage of crowns with *91-100% damage* 1997-1998	1998-1999	Estimated Cull within 2 km 1997	1998
SE Control area									
X1	Moderately-high - Low	decrease	sl increase	decrease	remained low	0	decrease	0	0
X2	Moderate - Moderatley-high	decrease	increase	0	increase	0	increase	0	0
X3	Moderately-low - Low	sl decrease	remained sl lower	decrease	remained sl lower	decrease	remained lower	0	0
X4	High	sl decrease	increase	decrease	sl increase	large decrease	large increase	1357	1026
X5	Moderately-low	0	0	0	0	0	0	0	0
X6	Moderately-low	decrease	sl increase	decrease	remained lower	decrease	remained lower	0	0
Trapping area									
X7	Moderate - Moderately-low	decrease	sl increase	0	0	0	0	0	0
X8	High	increase	remained high	increase	remained high	small increase	remained higher	0	0
X9	Moderately-high - Moderately-low	0	decrease	0	sl decrease	0	decrease	0	0
X10	High	increase	remained high	increase	remained high	increase	remained high	0	800
X11	High	0	0	0	sl increase	sl decrease	sl increase	1478	807
X12	Moderately-low	0	increase	0	0	sl decrease	remained lower	21	372
X13	Low	0	0	0	0	increase	decrease	130	1042
X14	Moderately-low - Low	0	0	0	0	0	increase	130	1042
X15	Moderate - Moderately-high	0	0	0	0	increase	decrease	0	0
X16	Moderately-high - Moderate	sl decrease	remained lower	decrease	remained lower	decrease	sl decrease	0	46
NW Control area									
X17	Moderate	0	0	0	0	0	sl decrease	0	0
X18	Moderately-high - Moderate	0	0	0	0	0	0	0	0
X19	Moderately-high - High	increase	remained higher	increase	remained higher	sl increase	sl increase	0	0
X20	Moderate - Low	decrease	remained lower	sl decrease	remained lower	sl decrease	sl decrease	0	0
X21	High	0	0	0	sl increase	0	increase	0	0
X22	Moderately-high	0	0	sl decrease	remained sl lower	0	0	0	0

a Compares February and April surveys only; 0 = no change in damage level from first survey; sl = slight

Sites shaded showed an overall decrease in damage over the two years.

Evidence of recovery at Grasstree site X4
Grasstree site X4 (SE control area) was a High damage site (at the lower end of the scale) which still had a relatively low death rate (17% of crowns). There was a decrease in damage levels during 1998, however, this was followed by an increase in damage in 1999. It must be noted that these trends were also observed at a number of the SE Control sites although not to the same degree (Appendix 6). Figure 28 presents the number of Twenty-eight Parrots shot each month together with the percentage of crowns with 91-100% frond damage and mean index damage. The percentage of crowns with 91-100% crown damage showed the greatest change between surveys (followed by the index of crown damage) and is likely to be the most sensitive to reduced browsing activity by parrots.

A large number of parrots (1,075) were removed during December 1997 to February 1998. This was from a time of low parrot browsing activity in December 1997 (0% of crowns with 91-100% damage) through to the more active time in January and February 1998. The decrease in the number of severely damaged crowns was very dramatic when comparing February 1997 and 1998 or April 1997 and 1998.

During the following year, from December 1998 to February 1999, fewer parrots were shot (149). No parrots were removed during December 1998 and shooting was only conducted during one day in January and one day in February. A total of 91 parrots were removed on 3 March, just prior the Grasstree survey on 4 March. The increase in the number of severely damaged crowns may reflect the lower numbers of parrots shot and the reduced frequency of shooting activity, particularly during December and most of January and February. In addition, 1999 may have been a year when parrot browsing activity was more intensive (due to an unknown environmental factor and not necessarily related to parrot abundance).

In conclusion, there appears to be a strong correlation between shooting effort and parrot damage at Grasstree site X4. There is then the question of whether these trends were different from trends observed at the remaining five Grasstree sites in the SE Control.

Trends observed at the other five SE Control sites included some subtle variations such as, an overall decrease in damage in 1998 sustained in to 1999 (sites X1, X3 and X6), similar levels of damage each year (site X5) or an increase in damage in 1999 (site X2) (Appendix 6).

It is possible that parrot damage at many of the Grasstree stands surveyed in the SE Control area was unusually high during 1996 and early 1997. For example, site X6 was grazed by cattle for two weeks in June 1996 (not grazed prior to this date) due to there being no feed in the paddocks. Food availability, particularly green feed, may also have been low for the Twenty-eight Parrots during the summer and autumn of 1996. Although total rainfall was not that low for 1996 (with the exception of Kojonup) (Figure 22), the first significant wet season rains were very late and did not arrive until mid-June. This would have produced a particularly long high intensity parrot browsing season. Pasture and Grasstree growth were also very slow during the spring months of 1996 (McNee 1997). These factors may explain the apparent high parrot damage levels at many Grasstree sites in the SE Control area by Feb 1997 which could have eased off to more 'normal' levels during 1997 and 1998.

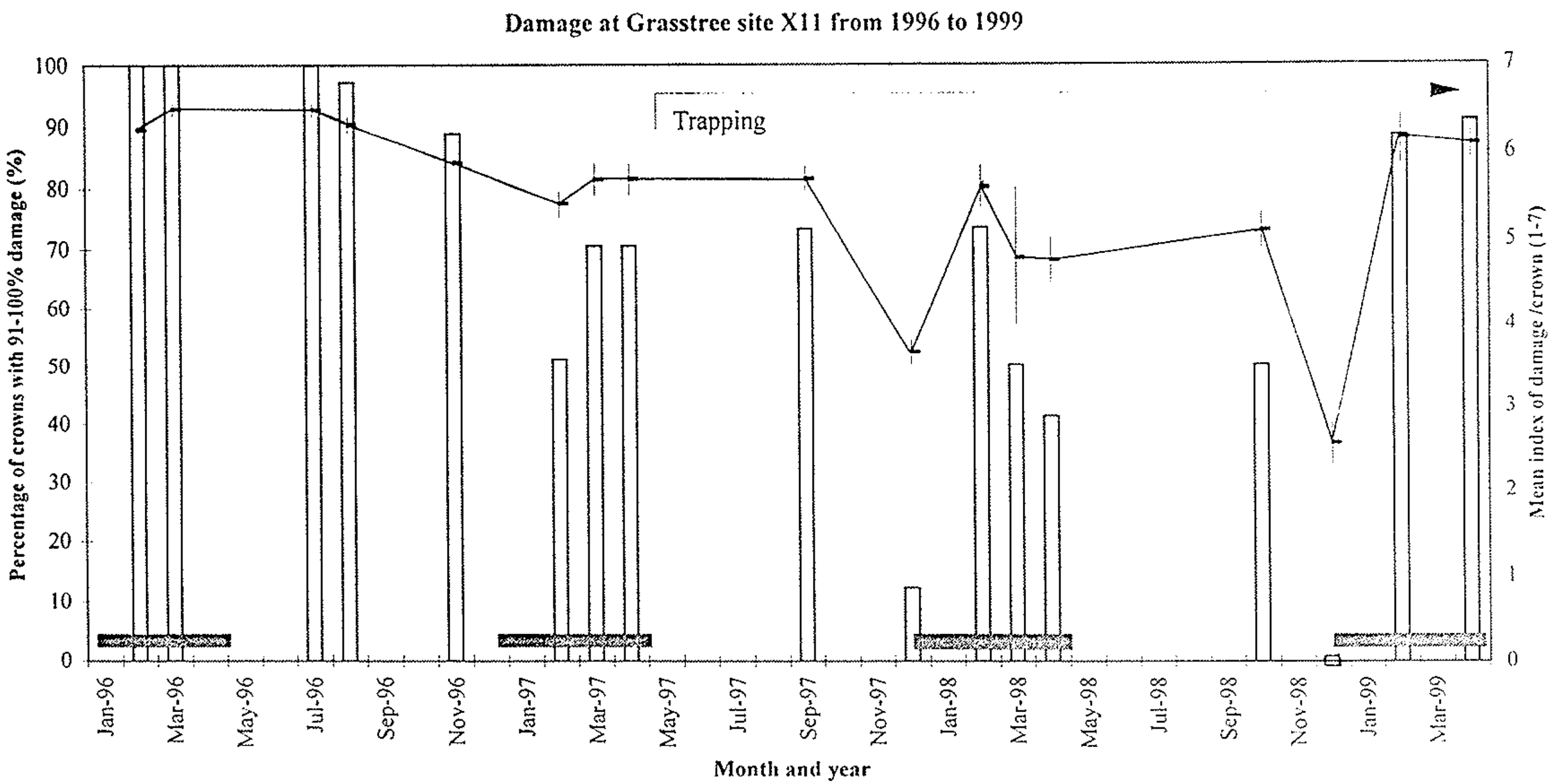

Figure 27 Damage at Grasstree site X11 from 1996 to 1999 showing the percentage of crowns with 91-100% damage (bar graph) and the mean index of crown damage (line graph). Shaded horizontal bars indicate periods of high damage (December to April each year).

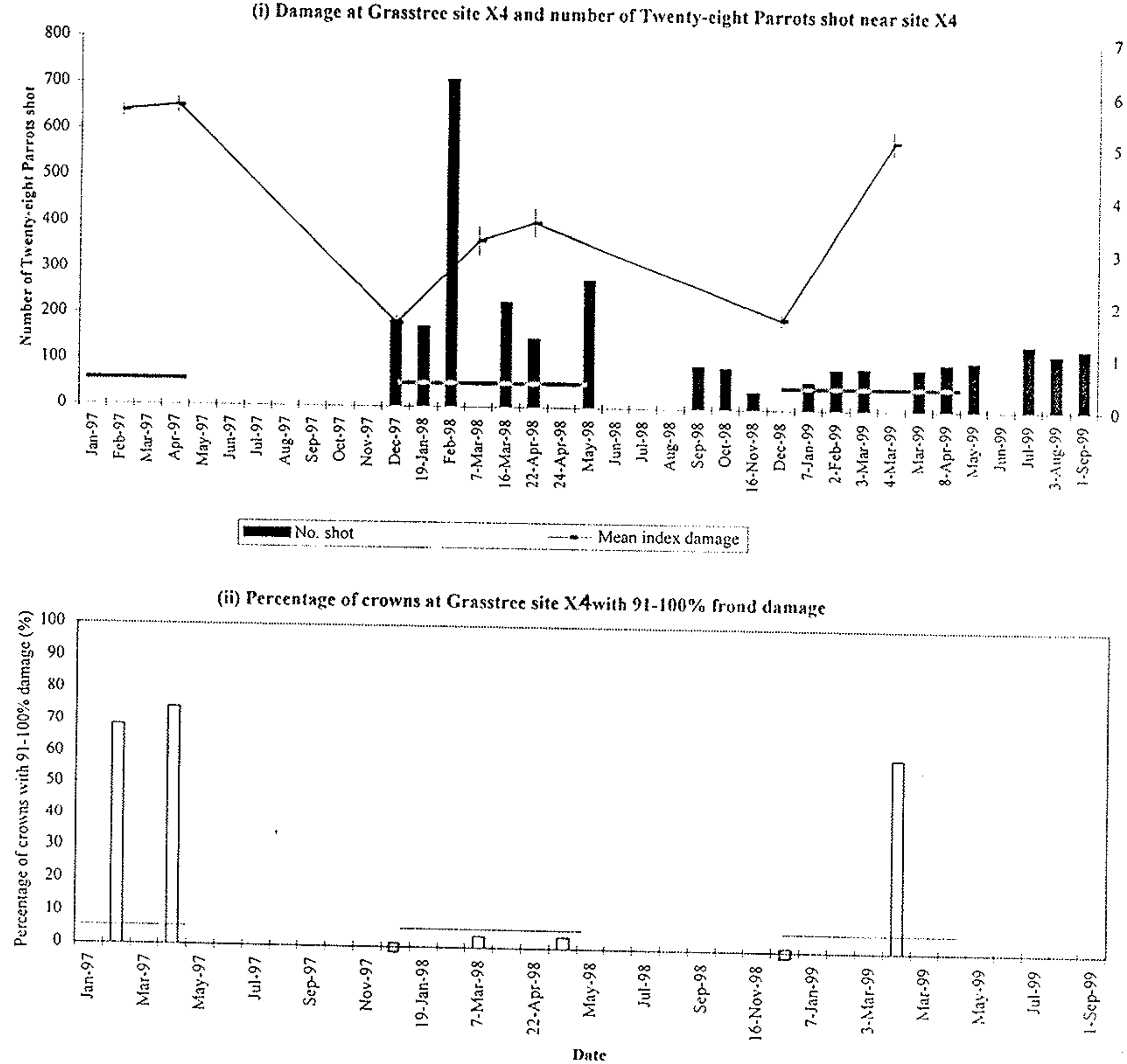

Figure 28 Damage at Grasstree site X4 from 1997 to 1999 showing (i) the number of Twenty-eight Parrots shot and the mean index of crown damage and (ii) the percentage of crowns with 91-100% damage. Shaded horizontal bars (i) and horizontal lines (ii) indicate periods of high damage (December to April each year).

3.5 OTHER OBSERVATIONS FROM TRAPPING PROGRAM

3.5.1 Correlation between parrot counts and tree damage rates

There was little correlation between Twenty-eight Parrot counts per transect and River Red Gum damage rates. When only pre-trapping data was considered (April 1997 samples), the Pearson correlation coefficient between parrot counts and damage rates was -0.09 (occurrence rates) and -0.13 (damage length rates). If both the April 1997 and 1998 surveys are analysed, the Pearson correlation coefficients are -0.04 (occurrence rates) and -0.04 (damage length rates).

The poor correlation can probably be best explained by the fact that parrot counts were conducted on four mornings at the end of the one month survey period, while the tree damage rates represent the tree damage accumulated over the entire one month period.

3.5.2 Estimates of Twenty-eight Parrot abundance

Notwithstanding the limitations of using the parrot counts per transect (an indicator of parrot abundance) as simple estimates of parrot abundance, the pre-trapping abundance estimate for the Trapping area was 0.96 parrots/hectare (Table 26). Other estimates of parrot abundance for the three treatment areas, pre-trapping and post-trapping, are also shown in Table 26. Lower post-trapping abundance estimates reflects the declining trend in mean parrot counts per transect after trapping commenced (Figure 10). It should be noted that the abundance estimates are based on parrot counts conducted along transects which were located to optimise counts rather than give the best overall estimate of parrot abundance for the area. Against this, the counts were conducted at walking pace and would tend not to represent a complete count of the population within the transect area (eg. don't include undisturbed parrots hidden in tree crowns etc). Furthermore, some counts at each area were conducted at sub-optimal times (section 2.3.3.1).

Table 26 Mean parrot counts

Parrot Count Period		Parrot Counts			
		SE Control	Trapping	NW Control	All Areas
Pre-Trapping	**Mean Counts/ transect ±SE**	10.3±1.06	19.2±2.02	20.6±2.29	17.0±1.15
	per ha	0.51	0.96	1.03	0.85
Post-Trapping	**Mean Counts/ transect ±SE**	8.5±1.04$_a$	13.7±1.36	15.7±1.36	13.2±1.36$_a$
	per ha	0.42$_a$	0.68	0.78	0.68$_a$

a Post-trapping counts do not include March 1999 counts for the SE Control area (see section 3.2.2.1).

3.6 PARTICIPANT OBSERVATIONS AND OPINIONS: PHONE SURVEY RESULTS

3.6.1 Observations on Twenty-eight Parrots

3.6.1.1 Trapping Area

About half or more of interviewees offering an opinion considered that Twenty-eight Parrot numbers and damage remained similar to or greater than pre-trial levels (Table 27). About 45% of 91 interviewees thought that there was no change or an increase in parrot numbers. Just over 50 % thought that there had been a decrease, while about four percent thought there had been a large decrease in parrot numbers.

With regard to garden damage, 59 % of interviewees thought that damage levels had not changed or had increased. In the case of farm tree damage, many of those interviewed were not aware of canopy damage in non-commercial tree stands, but rather tended to relate the question to damage of young seedlings (nipped-off or pulled out of the ground). Of the 53 people offering observations on farm tree damage, 68 % thought there was no change in damage or there was an increase. Again, many people did not have *Xanthorrhoea preisii* stands on their farms or did not plant crop or had simply not closely observed Twenty-eight damage of this kind, but of the 44 and 67 respectively who had, 79 % and 84 % thought there was no change in the damage levels or that damage levels had increased.

3.6.1.2 Control Areas

All control area people interviewed who made observations on the parrots thought that Twenty-eight Parrot numbers and activity had 'no change' or increased. No respondent thought that parrot numbers or damage had declined during the trial period.

3.6.2 Trapping acceptance and assessment

3.6.2.1 Preference of trapping as a tool for controlling Twenty-eight Parrot numbers and damage

Of those who did trap and responded to the question, more than 80 % indicated a preference for trapping over shooting for controlling Twenty-eight Parrots. A further 13 % of those responding gave 'both' as their preference. Only 4 of the 69 responding trappers said they preferred to shoot. Eighteen of those preferring to trap commented that they thought it easier to trap while there were twenty six comments to the effect that trapping was quicker or more efficient. Seven said that trapping yielded bigger numbers of Twenty-eight parrots. Three commented that trapping was cheaper, while four did not like guns or simply did not shoot.

Almost 100 % (66 of 67) Trapping area respondents said they would, if permitted, use trapping for control of Twenty-eight Parrots in the future.

Of the 22 in the treatment area who did not trap, 86 % said that if permitted they would trap in the future. Ten indicated that they had not trapped because they were 'too busy' or 'had not got around to it'. Eight said they had 'not been given a trap' or had 'not got around to getting a trap' or simply 'did not know it was on'. Three commented that they did not trap because they 'did not like killing them' or did not like killing native animals.

Eighty five percent (12 of 14) non-trappers who were asked if they would use trapping to control Twenty-eight Parrot numbers in the future if permitted, said they would.

Table 27 Participant observations on Twenty-eight Parrot numbers and activities during the trial.

Treatment Area		Numbers around farm (Nos)	Garden damage (Nos)	Farm tree damage (Nos)	Grass tree damage (Nos)	Crop damage (Nos)
Trapping	Large Increase	6	5	1	4	2
	Increase	18	18	18	17	21
	No change	17	29	17	14	33
	Decrease	46	29	16	6	9
	Large Decrease	4	7	1	3	2
	Did not know	2	0	11	10	11
	No problem	0	0	4	0	5
	Not applicable	0	5	25	39	10
	Total	93	93	93	93	93
SE Control	Large Increase	3	3	3	1	0
	Increase	5	1	1	1	4
	No change	0	2	2	2	1
	Decrease	0	0	0	0	0
	Large Decrease	0	0	0	0	0
	Did not know	0	0	0	3	1
	No problem	0	0	0	0	1
	Not applicable	0	2	2	1	1
	Total	8	8	8	8	8
NW Control	Large Increase	3	4	1	2	0
	Increase	5	0	3	2	3
	No change	1	4	2	2	6
	Decrease	0	0	0	0	0
	Large Decrease	0	0	0	0	0
	Did not know	0	0	2	1	0
	No problem	0	0	0	0	0
	Not applicable	0	1	1	2	0
	Total	9	9	9	9	9

3.6.2.2 Effectiveness of trapping as a tool for controlling Twenty-eight Parrot numbers and damage

Sixty nine interviewees from the treatment area who had trapped were asked if they thought the Twenty-eight Parrot trapping program had been effective in controlling parrot numbers and the damage they cause. Sixty five percent (45) thought it had been effective while another 14 % gave a qualified 'yes'. Qualified 'yes' comments (22) were of the type 'must have helped, but :

- still a lot of parrots,
- need to do more
- need to keep it going
- controlled parrots but they are still causing damage.

Five people commented that they thought it had a very localised effect 'mainly around the garden' with one interviewee commenting that the effect was 'very localised and for a very short time - soon more move in'.

Sixteen percent concluded that the trapping had not been effective in controlling the parrots. Their comments included 'they just keep moving in' 'same damage and plenty of parrots' and 'not enough caught in a large enough area (very localised effect).

3.6.2.3 Trapping techniques and parrot handling

Trap type and numbers

Of the 67 people who trapped and provided information on the trap they used, 57 people used the tall walk-in traps that were developed over the first winter by P. Coffee. Many people changed over from the initial small round traps to the tall traps after the first winter of the trial or by the second winter. Ten used only small traps throughout.

A number of people were not happy with the small traps, some not bothering to use them, some mentioning the difficulty in killing Twenty-eight Parrots quickly in those traps and difficulty in releasing non-target species from them.

Five trapping participants used more than one trap.

Trap location and movement

About 50% of people who trapped said they moved their traps as numbers of trapped Twenty-eight Parrots fell. Most of those offering information said they located the traps mainly around the house or silos and sheds and the traps were moved just within these areas. A few said they tried trapping in paddocks but failed and others moved their trap, but not regularly or moved it between two farm houses. The comment was made that trapping numbers increased greatly if the traps were moved as soon as trap numbers began to fall.

Trapping and season

About 49 people who trapped Twenty-eight Parrots observed a preferred or more productive trapping season. Eighty seven percent of these people found they trapped most parrots from autumn to the end of spring, some suggesting the trapped numbers were directly related to food availability ('can trap them until harvest grain available' or 'could only trap in winter when parrots hungry'). Autumn was mentioned among best trapping season(s) by 39% of the 49 people, winter by 45%, spring by 22% and summer by 10%. However, 10 % of people also said they could not trap birds during summer.

Figure 29 shows trapping numbers each month for the 11,458 Twenty-eight Parrots and 1,863 other birds recorded as trapped by those participants who kept and returned trapping records. While the numbers recorded are not a true indication of total numbers trapped and probably reflect poorer record keeping in the second half of the trial (fewer reported birds trapped), the charts do show that most Twenty-eight Parrots were trapped in the period of June to

September, and especially during June and July. A small peak in numbers trapped occurred during the summer months of December 1997 January 1998.

Two people interviewed said they trapped more around harvest when canola grain was around. Another person suggested they 'trapped lots straight after rain'.

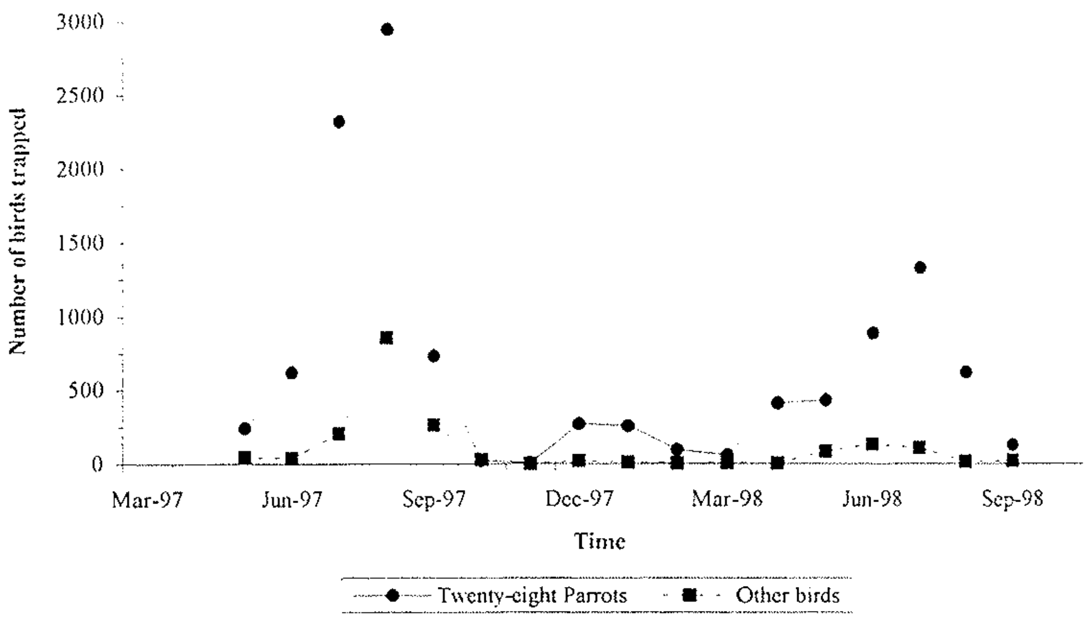

Figure 29 Number of Twenty-eight Parrots reported trapped in detailed farmers records by time of trapping.

Suggestions for increasing trapping numbers
Suggestions for increasing numbers of Twenty-eight Parrots trapped included using canola grain as a lure, trapping when there was no grain around (after harvest and minimising spillage) and moving traps to a variety of places. A green lure (green oat stalks and head) was something that was found to be successful in a one-off case during summer. One practice that several interviewees thought attracted more parrots to traps was the use of a 'squawker', an individual Twenty-eight Parrot not cleared from the cage and left in the cage to 'call' other birds.

Catch and release of non-target species
Detailed trapping records kept by some participants indicate that considerable numbers of non-target bird species were trapped (Table 28). Of the 13,321 birds reported trapped in complete farm records, 1863 were non-target species (14.0 %).

The number of non-target species trapped by participants varied greatly. Indeed, 15 people interviewed who trapped, said they only caught a few non-target species or none. One trial participant reported trapping 103 Black-faced Woodswallows and 66 Twenty-eight Parrots in the same day (more than one trap release). The next day 61 Black-faced Woodswallows were trapped along with 27 Twenty-eight Parrots. Large numbers of Black-faced Woodswallows were not trapped after that (P. Clements, *pers. comm.*). However, there were other reports of repeated trapping of non-target individuals who found the reliable grain source in traps a big attraction.

Ninety six percent (66) of interviewees who trapped said they were easily able to release non-target bird species from the traps. Two people however said that they had difficulty releasing birds from the small traps. Only 29 non-target species deaths were recorded from the handling of 1863 non-target species recorded in the detailed trapping data (Table 28, Figure 30). In the case of the flocks of Black-faced Woodswallows referred to above, the large numbers of non-target birds were easily released from the tall trap by simply opening the trap door. Twenty-eight Parrots also in the trap at the time continued to cling to the wire as the Black Woodswallows followed each other through the open trap door (P. Clements, *pers. comm.*). Clement (*pers comm.*) found Bush Pigeons too were easily released from the traps without losing trapped Twenty-eight Parrots by simply lifting one side of the tall trap. Unlike the Twenty-eight Parrots which were clinging to the wire walls of the trap, the Bush Pigeons stood on the ground and simply walked out when the trap was lifted.

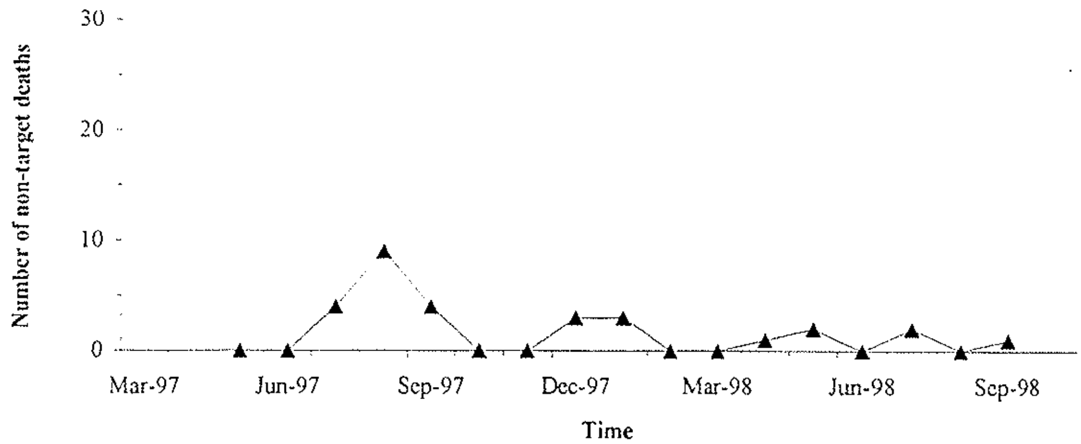

Figure 30 Number of non-target bird deaths reported in detailed farm records by time

Attention was drawn by several people interviewed to the need for regular monitoring of traps as people and dogs around sheds and silos scare the birds and they can injure themselves in the cages. Hawks were also noted as a problem by a couple of people.

Non-target species reported trapped included Magpies, Ravens, Kookaburras, Willy Wagtails, bronzewing pigeons, Black-faced Woodswallows, Western Rosella's, Regent Parrots (Smokers), Red-capped Parrots (King Parrots) and Mudlarks.

Humane handling of trapped Twenty-eight Parrots

Ninety three percent of trapping participants who were interviewed stated that they were able to humanely kill the birds. Most killed the birds with a firm, quick blow to the head. A number of people commented that they thought a quick blow to the birds head was very humane. Only two people reported a questionable method of killing the birds.

Some people suggested gassing the birds (carbon monoxide).

Table 28 Numbers and types of birds trapped and recorded on detailed data sheets handed-in by some trapping participants

	Twenty-eight Parrots	Other Parrots	Bush Pigeons	Other	Total Birds Trapped	Total Non-targets	Non-Target Deaths
Number of Birds Trapped	11458	1250	326	287	**13321**	1863	29

3.6.3 Grain availability

3.6.3.1 Trapping Area

Almost all respondents in the treatment area had on-farm grain storage, usually silos, which were the source of some grain spillage (Table 29). A similar number of farmers hand fed grain to sheep in the autumn which was also available to parrots. About 45% of interviewees used open grain storage (bunkers, open grain sheds and open silos) on their farms and 21 interviewees nominated open grain stores as major attractants of Twenty-eight parrots. Self-feeders, cereal hay and fodder crops were other sources of grain, which some reported as attractants while others did not.

Of 93 people interviewed only 7 did not venture an opinion as to factors contributing to numbers of Twenty-eight Parrots in the area. Seventy one nominated grain availability as a factor contributing to parrot numbers with 19 referring to increased cropping in the district over recent years as a factor. Nine people commented on the current lack of natural predators.

While 76% of interviewees (71) nominated grain availability as a factor in Twenty-eight Parrot numbers in the district, only 38 respondents were able to suggest practical on-farm measure(s) to reduce grain available to Twenty-eight Parrots. Cost was a prohibitive issue for three respondents. Twelve of these 38 suggested replacing open grain bunkers/sheds with silos or covering the grain. Two more also suggested this, but thought the cost prohibitive. Nineteen suggested reducing grain spillage or cleaning up spillage. Several people noted that giving stock access to the shed/silo areas could clean up spilt grain. Three others suggested poisoning, while also acknowledging that it was not a practical option because of its non-specific nature (could result in death of any grain-eating birds). Some suggested specific treatment (trapping) for stands of Grasstrees.

3.6.3.2 Control Areas

The pattern of grain availability was similar for those interviewed outside the treatment area. Silos and hand feeding were important grain handling operations on those farms and again open grain bunkers/grain sheds were present on about 50% of interviewees properties.

Fourteen of seventeen (82%) respondents thought that grain availability was a factor contributing to numbers of Twenty-eight Parrots in the district. Only 7 (41%) thought there were practical measures that could be undertaken on the farm to reduce the amount of grain/feed available for Twenty-eight Parrots. Three nominated covering open grain stores or replacing them with silos and three interviewees suggested reducing or cleaning up grain spills. In one special case, a farmer near Qualeup CBH grain bins saw them as a problem source of grain supply for parrots.

Table 29 Occurrence of farm practices and facilities that may relate to grain or feed availability for Twenty-eight Parrots

Participant Area	Response	Self-feeders		Feed Lots		Cereal Hay		Fodder Crops		Hand Feeding		Silage		Open Grain Stores		Silos	
		Year 1	Year 2	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Treatment	Yes	42	30	10	9	59	40	34	28	88	69	4	0	42	41	87	80
	No	49	61	82	83	33	52	58	64	4	22	88	92	50	51	2	9
	Don't Know/n.a.	2	2	1	1	1	1	1	1	1	2	1	1	1	1	4	4
Control	Yes	6	6	2	1	12	5	5	3	16	12	3	0	8	8	16	12
	No	11	11	15	16	5	12	12	12	1	5	14	17	9	9	1	5
	Don't Know/n.a.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

4.0 DISCUSSION AND RECOMMENDATIONS

River Red Gum stem and branch damage was characteristic of Twenty-eight Parrot browsing. The Twenty-eight Parrot was the only species associated with damage activities at Grasstree or River Red Gum stands during the trial. The extent of damage from the browsing activity of these parrots was widespread and very variable.

The percentage of crowns at Grasstree sites, damaged by parrots, ranged from 18.2 to 100.0 %. Eighteen of the 22 sites had Grasstree deaths. At the most severely damaged sites, the percentage of Grasstrees that died ranged from 41% to 75% over the two year period. The high death rates support the observation that within remnants of vegetation whole stands of Grasstrees can be lost as a result of parrot browsing.

At a River Red Gum site which had the highest damage, a three and a half year old tree had on average accumulated 50 separate damage occurrences over a total stem and branch length of 11.4 m. At this site, 100 % of the trees had some parrot stem/branch damage. These trees typically had a roundish, 'bushy' form rather than the tall, rounded conical form of single-trunked damage-free trees. More than 90 % of trees at twelve of the twenty River Red Gum monitoring sites were parrot damaged by the completion of the trial. These high damage levels at the River Red Gum sites is an indicator of the degree of Twenty-eight Parrot browsing in eucalypts.

Parrot damage to Grasstrees and River Red Gums was principally incurred during the summer months (December to April) and followed trends described by Ritson (1995) and McNee (1997). There was evidence that the intensity of parrot browsing on these plant species could vary from year to year. Parrot browsing on Grasstrees in the SE Control, for example, produced significantly lower levels of damage in 1998 compared to 1997 or 1999. There was also evidence that parrot damage levels at three Grasstree sites surveyed in 1996 (prior to this trial) were higher in 1996 compared to 1997 (McNee 1997). Short term seasonal (Marri flowering) and unseasonal events (high rainfall) could also have an effect.

Although the distribution of parrot damage on Grasstrees or River Red Gums was patchy in all three areas, overall the NW Control appeared to have the greatest number of parrots and highest browsing activity, while the SE Control appeared to have the lowest parrot browsing activity, particularly for Grasstree sites.

One factor that may have contributed to the large range in damage activity between River Red Gum sites within treatment areas is the apparent preference of Twenty-eight Parrots for certain River Red Gum provenances (Bennett and George, 1996). The Silverton provenance was the most commonly planted on the monitoring sites. A provenance provided by a local farm nursery from seed collected in South Australia was also common as was the Lake Albacutya provenance. However, provenance type at one-third of the sites could not be confirmed. While the affect of provenance was not determined in this study, it should not have affected trends in damage rates over time. Analysis of damage rates at high and moderate damage sites would also have negated the influence of parrot preference for different provenances.

4.1 DID THE TRAPPING PROGRAM HAVE A REGIONAL EFFECT ON PARROT ABUNDANCE OR PARROT DAMAGE?

Changes in parrot abundance and parrot damage were observed during the trial period Overall, however, these changes could not be strongly and/or exclusively associated with an effect of trapping. A strong regional effect of trapping would have been reflected in large decreases in parrot counts and damage in the Trapping area, relative to Control areas. This was not observed. In part, the variability in parrot abundance and parrot damage activity among sites, within Trapping and Control areas. made it more difficult to identify significant effects.

It was therefore concluded, that at a regional level, the culling of an estimated 63,400 Twenty-eight Parrots from the 1st May 1997 to the 31st March 1999 did not greatly reduce parrot counts, tree damage or Grasstree damage.

Nevertheless, there were, some interesting trends which may or may not have been due to trapping efforts. These are considered below.

4.1.1 Decline in parrot counts

Twenty-eight Parrot counts per transect were significantly lower after trapping than pre-trapping. However, a definitive statement that trapping caused a significant decline in parrot counts cannot be made. Firstly, the decline in parrot counts occurred in both the Trapping and Control areas. Therefore, the decline in counts may have been caused by widespread 'natural' events rather than by trapping.

Secondly, weather conditions could have affected the reliability of the March 1999 parrot counts. It was the low value of this count which made the decline in parrot counts significant. During March 1999 there were unseasonal, overcast conditions with occasional drizzle. At the time of the survey, field staff continued the counts as programmed as they felt that counts would not be affected, but did raise the issue on completion of the survey. The lower parrot counts were not supported by trends in River Red Gum and Grasstree damage levels. It is suggested that a change in field staff and differences in individual perception and methods, were most likely responsible for the magnitude of increase (three fold) in March 1999 parrot counts in SE Control.

4.1.2 Changes in parrot browsing damage

Regardless of whether there was a decline in parrot abundance on a regional scale, the damage caused by parrots showed no sustained or strong decrease in the Trapping or Control areas.

There was a decline in River Red Gum damage rates in the SE Control and Trapping areas after the first year of trapping but this did not continue and become part of a significant trend. A similar trend was observed at the Grasstree sites in the SE Control area which was followed by an increase in damage during 1999.

A possible regional effect observed when comparing Trapping and NW Control areas, was a small decline in the mean index of Grasstree crown damage each year in the Trapping area. However, although the decline in the Trapping area was significant from February 1997 to February 1999, it was not large enough to indicate a significantly different trend from the NW Control area.

Also among the Grasstree sites in the Trapping area, there was a large decline in the damage levels between December 1997 and December 1998. This trend was significantly different from the Control areas. The December surveys coincide with the time of year when most trapping activity occurred (May to October), and the decrease in damage in December 1998 was during the second year of trapping when participation had increased (from 49% to 72%).

Interpreting these results, however, is complicated by the fact that damage in the Trapping area was much higher in December 1997 (prior to the decrease) than in the Controls. It was not known why this was so. In addition, the intensity of parrot browsing activity from May to December can be affected by rainfall patterns and therefore be higher in some years than others (McNee 1997). The effect of rainfall patterns may be quite variable throughout the study area and therefore not have a consistent effect on parrot behaviour. Interestingly, River Red Gum damage rates in the Trapping area did not increase as much as those in the Control areas from December 1997 levels to December 1998 levels, although the difference in the trends was not significant.

Regardless of these factors, the decline in damage by December 1998 was strong and consistent among the individual Grasstree sites in the Trapping area and it may be possible that trapping efforts contributed to these results.

It may be that parrot abundance and parrot damage activity is only loosely connected. Conceptually, it may be possible to have a decline in parrot numbers but increased grazing per individual. In such a case, a decline in parrot counts may be associated with a smaller or no decline in tree and Grasstree damage. Other factors such as food availability and weather may influence parrot browsing activity at Grasstrees and River Red Gums. There is also the question of whether the trapping technique is removing the parrots which are doing the browsing activity.

4.1.3 Observations made by participants

Observations of interviewed participants in the trapping area support the finding that there was no conclusive decline in parrot abundance and parrot damage levels due to trapping. Many thought the number of parrots was similar or greater after the trapping trial and that damage levels were greater. Many participants also indicated that while they thought trapping was effective, there were still large numbers of parrots.

4.2 DID TRAPPING INCREASE THE NUMBER OF TWENTY-EIGHT PARROTS REMOVED FROM THE TRAPPING AREA?

A total of 63,400 Twenty-eight Parrots were removed from the Trapping area by trapping and/or shooting. This represents a significantly higher number of parrots removed than in pre-project years under open shooting seasons. Eighty four percent of participants thought they had culled more Twenty-eight Parrots than in pre-trapping years (57 % thought they had culled many more). It is estimated that within the Trapping area, prior to the trapping trial, shooting culled about 10,000 to 13,000 Twenty-eight Parrots per year. The trapping probably resulted in a 2.5 to 3.3 fold increase in the number of parrots removed per year.

This increase in the number of parrots removed was perhaps less than might have been expected. The average number of parrots culled per hectare was 0.17 parrots/ha during the first 12 months and 0.22 parrots/ha during the final 11 months. This compares with an estimate of Twenty-eight Parrot abundance from parrot counts of one parrot/ha in the Trapping area (160,000 ha). A word of caution is that the parrot counts are likely to underestimate parrot abundance. Studies in forested areas of south-west Western Australia have estimated Twenty-eight Parrot abundance between 0.12 and 0.74 parrots per hectare (Halse, 1986).

It is difficult to put into context the impact of culling 63,400 Twenty-eight Parrots over a twenty three month period without information on their base population, the rate at which they are breeding and their mobility. Certainly, the fact that culling over 60,000 parrots within 23 months did not significantly reduce Twenty-eight Parrot counts or rates of parrot damage in the Trapping area relative to the Control area, indicates there is a very large parrot population base. Long (1984) found the average breeding rate was 3.8 fledglings per year. With the possibility of more than one clutch per year if conditions are right, there is the possibility that enormous numbers of Twenty-eight Parrots can be added to the area each year.

It can only be concluded that the cull of about 63,400 Twenty-eight Parrots was insufficient over the two year trial period to cause a significant regional fall in population or a regional reduction in damage levels. The effective mobility of Twenty-eight Parrots in response to improved food and nesting resources, is critical to determining the adequacy of a 40 km x 40 km area in affecting a regional trapping effect on parrot abundance and browsing activity. The fact that it made no difference whether all sites or just the core sites of the Trapping and Control areas were compared, could have been because the trapping and shooting effort was insufficient to significantly reduce parrot numbers and damage throughout the Trapping area relative to the Control areas or because the parrots readily moved distances greater than the 20 km to 30 km from the edge of the Trapping area to its centre and so effectively replaced culled parrots. If the latter is true, then a larger trapping area would be required to observe any effects of parrot shooting and trapping. However, thr efficiency (number of traps/ha) of trapping probably gets less the bigger the trapping area. Coordinating trapping efforts also becomes more difficult.

4.3 SEASONALITY OF TRAPPING

Most participants put most effort in to trapping during the autumn and winter months when trapping rates were highest. The winter and spring months are usually the lowest months for parrot damage and includes the time when parrots are nesting. Trapping efforts were usually low at the time juveniles fledged (October to December) (presumably a time when the population of parrots increases dramatically), and at the time when parrot browsing activity is highest (December to April).

The effect of trapping during the autumn and winter months may be limited in its effect on reducing damage of plant species when the following summer is a high parrot browsing activity year. This may have been the case where damage rates increased in February-March 1999 at some sites in the Trapping area relative to damage levels in 1998.

4.4 HOW TO MAXIMISE THE EFFECTIVENESS OF TRAPPING EFFORTS IN REDUCING TWENTY-EIGHT PARROT ABUNDANCE

Several factors need to be considered to maximise the effectiveness of a regional trapping program. There is the need for a high trapping participation rate. Trapping participation rates for the trial, overall, were quite high (76 %). However, in the first year (1st May 1997 to 30th April 1998) participation rates were much lower (49 %) and this was reflected in lower trapping numbers for that year. The adoption and development of large, easy to use walk-in traps that became available by the second year of the trial were instrumental in raising participation. Obviously the time commitment to operate a trap means some prioritisation and strong motivation is required to participate effectively. While a number of people expressed some distaste at the trapping process, few people interviewed were against trapping in principle, with 98.5 % saying they would use trapping to cull Twenty-eight Parrots if allowed.

There is also a need for participants to trap a large number of parrots each to achieve a large regional reduction in parrots. About 70 % of all people interviewed in the Trapping area culled less than 500 birds per year. The results from this project indicate that a cull of at least 1,000 Twenty-eight Parrots was necessary to cause a noticeable local impact on Twenty-eight Parrot damage (depending on the intensity of trapping by others in the locality).

Other factors which limited the success of trapping during the project were:

i) Poor success of traps in summer months. Most participants found that trapping was most successful from autumn through winter until October and that few Twenty-eight Parrots could be lured into traps in summer which is when most damage occurs.

ii) The sparsity of trap locations in the Trapping area due to relatively sparse population (about one trap per 1,900 ha) which resulted in a reduced intensity of trapping. Most participants (excepting 5) operated only one trap. Ability to use more than one trap over a wide area would considerably increase the numbers caught.

iii) Initial traps used were of a conventional design - small round traps which many people reported difficult to use. Some did not initially trap because of the awkwardness of using the small trap. The refined larger trap became available by late spring in 1997.

iv) Many people did not relocate their trap as the number of parrots caught declined. Regularly moving the trap increased the catch greatly (P Coffee, *pers. com.*).

Trapping was embraced by the great majority of farmers in the trial area (98.5 % said they would trap in the future if it was permitted). Most found trapping easier and quicker than shooting, with the capacity to cull much larger numbers of birds. This is reflected in the larger number of parrots culled with the use of traps (~ 2.5 to 3.3 times greater).

4.5 EVIDENCE OF LOCALISED EFFECTS FROM TRAPPING EFFORTS ON REDUCING PARROT DAMAGE LEVELS AT GRASSTREE AND RIVER RED GUM SITES

While the project was not designed to determine the effectiveness of trapping in controlling Twenty-eight Parrot numbers and damage at a 'local' level, some evidence for a local effect was derived.

Trapping/shooting was intensive near a few monitoring sites (River Red Gum sites CT7, CT8 and Grasstrees sites X4 and X11). Site CT7 and CT8 had more than 2000 parrots culled within 2 km during the trial. Site CT7 had all post-trapping damage rates lower than pre-trapping rates and apart from SE Control, site CT1, was the only high-medium damage site to have continuing decline in damage rates after trapping commenced. The damage trends at site CT8 were not as supportive of a trapping effect.

Trends were not conclusive for Grasstree site X11. Mean index of crown damage remained low and there was a large decrease in proportion of crowns with 91-100 % damage and a reduction in percentage crowns with damage by December 1998. However, while diminished summer damage rates and Grasstree recovery were observed during the first year after trapping, it followed a trend begun in February 1997, before trapping commenced. Parrot browsing increased at X11 by February 1999. The increase may have been due to a combination of a higher parrot browsing year at Grasstrees and a reduced trapping effort or effectiveness, for the summer of 1999.

More compelling is the case for Grasstree site X4 in the SE Control area and adjacent to a Bluegum plantation. There was a strong correlation between numbers of parrots shot and parrot Grasstree damage. Following a large shoot in the period December to February 1998, there was a very large decline in the number of severely damaged Grasstree crowns by February 1998. This same trend did occur at other SE Control sites at the time, but not as strongly as at X4. The following summer much fewer parrots were shot and a large increase in the number of severely damaged crowns occurred.

A number of participants, when asked about the effectiveness of the trapping, commented in their interview that trapping had been locally effective (at least for a period of the trial). For most, effectiveness locally was related to the farm garden ('got fruit for the first time in years' or 'roses flowered for the first time for years') or reduced damage to Grasstree sites and commercial trees (P. Coffee, *pers. comm.*). Others commented on the improvement 'locally' (around the house), although it was not sustained as waves of Twenty-eight Parrots flew in.

Some of the companies with large investments in Bluegum plantations in the south-west of Western Australia have been able to achieve some level of local control of Twenty-eight Parrots at many sites through regular intensive shooting throughout the year. Control of Twenty-eight Parrot damage in this case does require that shooting commences before the site is planted (R. Quaiffe, *pers. comm.*). At a few sites, regular intensive shooting has not been successful in controlling damage levels. Characteristic of 'local' control of Twenty-eight Parrot damage is the need for ongoing culling. Specific purpose trapping licences are an option to help protect commercial plantings of trees, vineyards and other crop assets as well as Grasstree stands to achieve 'local' parrot control.

While there is evidence supporting a local effect on parrot damage from intensive trapping/and shooting, local protection of sites from parrot browsing seems to be limited by the need to maintain the trapping/shooting effort. This is further compounded by the increased effort required to remove parrots after the first year (low return for effort), such as where parrots are in lower numbers or parrots become trap/shooting shy.

4.6 OTHER FACTORS WHICH COULD BE CONSIDERED TOWARDS MANAGING/REDUCING THE ABUNDANCE OF TWENTY-EIGHT PARROTS

Many participants identified increased cropping in the Kojonup district as an important factor behind the increasing Twenty-eight Parrot problem. Grain is very readily available to Twenty-eight Parrots during the summer and to a lesser extent autumn seasons. Grain is available during the normal course of cropping in the form of the standing crop prior to harvest, spillage when transporting grain, spillage at silos, open grain storage in sheds and bunkers, grain or hay hand fed to sheep during the later summer months until the first winter rains, self-feeders, and fodder crops (standing crop harvested, but left for sheep to graze). Other particular sources of grain in the district are intensive feed lots and seed processing plants and District grain handling facilities (eg. Qualeup).

About 45 % of interviewees reported having open grain storage 'in their immediate area'. There were many reports of large numbers of Twenty-eight Parrots feeding at open grain stores. Several people nominated open grain stores at neighbours as attracting parrots away from their properties or attracting more parrots into the district. One participant in the vicinity of Qualeup grain storage facilities felt strongly that available grain had concentrated the parrots in their locality (highest River Red Gum damage site in the project).

The issue arises as to whether minimising available grain on-farm could place some feeding pressure on the Twenty-eight Parrot population. Twenty-eight Parrots are very generalised feeders, with a diet including cultivated grain and wild seed, nectar, plant stem bark, many insects, Grasstree leaves and grasses (Ritson, 1985; Long 1984; McNee 1997; E. Shedley, *pers. comm.*). Over the summer months grain is the dominant part of the diet (E Shedley, *pers comm.*; Long 1984). Damage from parrot attacks on tree stem bark and Grasstree fronds is, as we have seen, highest in summer months and generally low from May to the end of December.

The removal of some of the accessible bulk sources of grain, in summer and autumn, may apply some feeding pressure on the Twenty-eight Parrot population. Limiting available grain to parrot populations may have the greatest effect during the autumn when food alternatives are more limited, rather than in the spring and early summer months.

Erica Shedley (*pers. comm.*) raises the issue as to whether, if grain supplies are reduced, the parrots wont actually increase grazing on alternatives such as trees and Grasstrees. Minimising available grain could apply a food pressure ceiling to the parrot population. The outcome of this would depend on the role of grain verses Grasstree frond or tree tissue in the parrot's diet. The role of tree and Grasstree plant tissue in the Twenty-eight Parrot's diet is not known. If they are a supplement (perhaps as a protein or vitamin boost), to the main summer diet of dry grain, then a restriction on available grain may provide a food ceiling such that parrots go elsewhere to find food and feeding pressure on Grasstrees and tree tissue is thereby reduced. If Grasstree and tree tissues provide, in some part, an <u>alternative</u> food source from that of grain, then restricting grain availability may focus the parrots more on Grasstree and tree browsing. Ritson (*pers. comm.*) reports observing a large increase in parrot browsing on Bluegums immediately following restriction of access to a large open bunker of grain adjacent to the Bluegums and considers that erratic supplies of grain (feast and famine) could be an important part of the parrot damage problem.

However, an increase in the amount of grain available does seem to have been associated with an increase in Twenty-eight Parrot browsing activity and an increase in their abundance in at least the Kojonup area. Open bulk grain sources have also been observed to attract large numbers of parrots. Therefore, limiting the grain available to parrots would seem to offer a practical solution if means to this end can be found.

Perhaps the issue of grain availability could be initially taken on board as a trial by a farm group such as an LCDC. The main sources of easily accessible grain that could be considered are open grain stores in sheds and bunkers, and intensive grain handling centres such as feed lots and bulk storage facilities and unregulated grain supplies such as self-feeders. Some observations on parrot feeding preferences would be a good point to start.

4.7 TRAPPING PROTOCOL

All but a few participants seemed to handle the birds well. There were a couple of reports of inhumane treatment of birds which is of concern, although this might be related to the use of the small traps. Nevertheless, most respondents seemed aware of the need to kill the parrots in a responsible manner and there seemed little difficulty in releasing non-target species. An important area of concern in managing traps is the need to check them daily. A temptation may arise in times when few parrots are being trapped, to leave the traps active but only check them every few days or once a week. This could be alleviated where water and shade is provided inside the trap during the hot summer months or simply 'Turning the trap off' by leaving the trap door open or turning the trap on its side.

Another concern raised by participants was trapped birds hurting themselves when scared by dogs, foxes or hawks.

4.8 CONCLUDING REMARKS AND RECOMMENDATIONS

This parrot trapping trial did not demonstrate that regional trapping could greatly reduce Twenty-eight Parrot numbers or their Grasstree and tree browsing activities. There is not a definitive explanation of why trapping did not have a great effect on parrot abundance and damage activity. The most likely explanation, however, is that the trapping effort of this community-based program was insufficient given the base parrot population size, breeding rates and /or mobility. Trapping effort was limited by the relative sparsity of landowners and the time and motivation required to trap effective numbers of parrots. Again, there is insufficient understanding of parrot mobility to know whether the size of the Trapping area was sufficient for a large parrot cull to effect a 'durable' large change in parrot abundance.

Additional surveys would have been useful to confirm the trend of declining parrot counts per transect. Perhaps the trend of a decline of parrot counts and Grasstree damage would have decreased to more substantial levels if trapping had continued for longer. However, it needs to be remembered that the trend of declining parrot counts in the Trapping area was also recorded in the NW Control area and there were indications of an increase in parrot browsing activity in the Trapping area in February 1999.

There is evidence that some measure of local control of parrot damage can be achieved by ongoing intensive site shooting/trapping of at least 1000 parrots per year. However, there is no guarantee that ongoing culling will be successful in managing parrot damage in high damage areas or during 'high damage years'.

Interpreting the results of this trapping trial has been particularly challenging as there is not enough known about the environmental cues the Twenty-eight Parrots are responding to. For example, the environmental factors which affect the intensity of browsing activity at a particular month from year to year. There is some indication that rainfall is a factor, however, other factors may also be important.

Some particular questions that need to be addressed that will assist in better understanding the dynamics and behaviour of the Twenty-eight Parrot population and factors that determine the effectiveness of trapping on parrot abundance and parrot browsing intensity are:

- What environmental factors affect browsing intensity?
- What age group are the parrots which do the damage to Grasstrees, eucalypts and other plant species
- What is the age profile (particularly with reference to sexual development) of trapped parrots?
- What are the sources of food used by Twenty-eight Parrots at different times of the year?
- Are the fronds of Grasstrees and cambium of eucalypts a supplement to Twenty-eight Parrots diet of dry grain or are they an alternative food source to grain?
- What factors affect breeding success (with particular reference to their potential for controlling population recruitment)?
- How mobile are the parrot populations?
- Are there effective, low cost means of estimating parrot abundance or browsing activity at specific sites/plant species?
- Do parrots become trap shy?

For an understanding of these issues in the Kojonup area, answers need to be developed for the hybrid form of *Barnardius zonarius* that occurs there.

4.8.1 Recommendations

The following recommendations have been made in relation to the use of trapping programs to manage Twenty-eight Parrot abundance and hence damage to the conservation estate, commercial tree plantings and horticultural and other assets.

1. To maximise the effectiveness of trapping in reducing parrot abundance it is suggested that participants aim to trap, given the current population levels, at least 1,000 Twenty-eight Parrots per year. This could be achieved using the following techniques:

a) Participants use more than one trap on their property .

b) Traps are moved to different sites within the property to ensure a high trapping rate is maintained (ie. not just around the house or at sheds and silos).

c) Intensive shooting be conducted during the summer months to compliment trapping if trap capture rates are low.

2. Alternative approaches to broad scale regional trapping that could be considered are:

(a) Focusing trapping efforts to specific locations which are in need of protection from parrot

browsing activity, whether for commercial or conservation purposes. To be most effective, traps would need to be located adjacent to these sites.
AND/OR
(b) As a development of (a) above, focusing trapping efforts through groups of motivated adjacent landowners with the aim of increasing localised effect of trapping.

Neither of the above alternatives offer a guarantee for successful parrot damage management, especially in very high damage areas or during high damage years. They do, however, serve to enhance accountability of trap operators in relation to trapping protocols and enhance the purposefulness of the trapping activity.

3. That parrot abundance be periodically monitored as part of any broad scale trapping program.

4. That alternative means of managing/controlling Twenty-eight Parrot abundance and damage activity be investigated. For example, although reducing grain availability may be more difficult to achieve, it may be more effective in the long term. This could be tested on a small scale, either on an individual farm basis or among a group of adjacent landowners.

5. That further research work be undertaken to better understand the basic biology of Twenty-eight Parrots and hence better understand the relationship between trapping and parrot abundance/damage and the potential for other control strategies.

5.0 ACKNOWLEDGEMENTS

Peter Coffee and the Kojonup LCDC have been the principle drivers of the project. Peter in particular has contributed a lot of his time in coordinating the project, publicising project schedules and other information among residents in the trail area, adopting and refining the design of a trap and organising its construction and supply, as well as processing trapping records during the project. Special acknowledgements are due to John Bartle for his role in making the project happen, Peter Ritson for his initial work in designing the project and to Gordon Wyre and Peter Mawson of Department of Conservation and Land Management, Wildlife Branch, for provision of permits and constructive advice on many aspects of the project. Thanks to those in the trial area who participated in the trapping project and for their comments and data records. Special thanks to Ian Neville, Sue Beckert, Warrick Armstrong and Adelle Alvarez Detoledo who undertook much of the field work, in particular Ian Neville for being the mainstay of field data collection throughout the project and Sue Beckett for her help with field work, helping out with accommodation and undertaking the grueling phone interviews at project completion.

Special thanks also to the hospitality and support of Betty and John Beatty, Sue and Paul Ayers, Kath, John and Dan Mathwin, Jan and Peter Coffey, Leanne and Mick Mathwin, and Betsy and Mike Watkins who provided accommodation during the Grasstree surveys. The interest, knowledge and experience shared by many local people was greatly appreciated, with special thanks to Frank Smith.

Special recognition goes to Matt Williams for his statistical advice. Thanks also to Erica Shedley for helpful discussions regarding Twenty-eight Parrots, Ron Quaiffe for discussion and information on parrot damage control and the Kojonup Landcare Coordinator of the time, Patrick Gillespie, for logistical support. We would also like to acknowledge the Dept of CALM and Steve Jones for providing digital base map files.

Finally, thanks to the Commonwealth Farm Forestry Program, the primary funding agency for the project and the Department of Conservation and Land Management and Bunnings Treefarms for their financial assistance.

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Appendix 1 Farm Trapping/Shooting Records

Control of Ringneck Parrot Damage - Kojonup

Farm Records

Name: ______________________ **Property :** ____________________

Date	Time (Hrs.min)			Birds Shot (Nos)	Trap Location	Birds Trapped					Comments/Observations	Non-Target Deaths (Nos)
	Start	Fin	Tot			28's (Nos)	Other parrots (Nos)	Bush pidgeon (Nos)	Magpie & crows (Nos)	Other (Nos)		

Control of Ringneck Parrot Damage - Kojonup

Keeping Farm Records of Shooting and Trapping

To evaluate this project and determine if it is successful in controlling ringneck parrot numbers and the damage they cause, we need a record of numbers of birds shot or trapped and the length of time shooting took place or traps were open. From this we will calculate average number of birds shot/trapped per hour of shooting trapping. This is an index of the parrot population in the area, and a measure of the success of the control effort. We need to collect this data throughout the 2-year project.

Please make an entry every time traps are cleared or you have done some shooting

Recording the trap location may be useful in showing, over time, the most effective position for traps. As well as recording numbers of ringneck parrots trapped, please show numbers of other bird types captured.

Also make note in the comments column any other observations that may

- help us understand patterns in the data (eg weather)
- help improve trap design, effective placement etc
- help us understand ringneck parrot behaviour

Finally, please record the number of deaths of any non-target species (birds other than "28's").

Please send completed forms to Peter Coffey, RMB 316 Kojonup 6398 at the end of each quarter until project completion!

Thank you for you help!

Shooting and Trapping

1. Please release birds other than 28's caught in traps!
2. Please kill birds humanely (with a single blow)!
3. Please check set traps at least once every 24 hours!

Appendix 2(a) **Twenty-eight Parrot Trapping Trial Questionnaire : Treatment Area Questionnaire**

Twenty-eight Parrot Trapping Trial

May 1997 to April 1999

Treatment Area
(13/4/99Update)

Interviewees Name: ______________________ **ID Nos:** ____ **Ph Nos** __________
Property Name: ____________________ **Location Nos** ______________
Date: ____________ (District Conservation Map)

I OBSERVATIONS

Q1 Have you observed any changes in -

(a) Numbers of Twenty-eight Parrots around farm

	Large Increase	Increase	No Change	Decrease	Large Decrease
Overall	______	______	______	______	______
May'97 - Apl'98	______	______	______	______	______
May'98 - Apl'99	______	______	______	______	______

(b) Garden damage by Twenty-eight Parrots

	Large Increase	Increase	No Change	Decrease	Large Decrease
Overall	______	______	______	______	______
May'97 - Apl'98	______	______	______	______	______
May'98 - Apl'99	______	______	______	______	______

(c) Farm tree damage by Twenty-eight Parrots

	Large Increase	Increase	No Change	Decrease	Large Decrease
Overall	______	______	______	______	______
May'97 - Apl'98	______	______	______	______	______
May'98 - Apl'99	______	______	______	______	______

(d) Grass tree damage by Twenty-eight Parrots

	Large Increase	Increase	No Change	Decrease	Large Decrease
Overall	______	______	______	______	______
May'97 - Apl'98	______	______	______	______	______
May'98 - Apl'99	______	______	______	______	______

(e) Crop damage by Twenty-eight Parrots

	Large Increase	Increase	No Change	Decrease	Large Decrease
Overall	______	______	______	______	______
May'97 - Apl'98	______	______	______	______	______
May'98 - Apl'99	______	______	______	______	______

II PARTICIPATION IN TRIAL

Q2 Did you trap Twenty-eight Parrots as part of this trial (YES/NO)?

May'97 - Apl'98 ______________
May'98 - Apl'99 ______________

If 'YES' go to section III, If 'NO' go to section IV

III TRAPPING

(Confirm Update all trapped numbers recorded on Peter Coffey database)
(Confirm Update all shooting numbers recorded on Peter Coffey database)

QE1 Do you have a preference for either trapping or shooting Twenty-eight parrots to control their numbers? If so, why? ____________________

____

____

QE2 Do you think you shot/trapped
- much more ____
- more ____
- same ____
- less ____
- much less ____

Twenty-eight parrots per year during the trial (May'97 to April'99) than before the trial? (*Tick one of the options*).

QE3 Do you think that trapping parrots has been effective in controlling parrot numbers and any damage the parrots cause? (YES/NO) ____________________

____

____

____

QE4 If permitted, would you use trapping as a tool to limit parrot damage in future?

____

____

Q3 Trapping techniques :

(a) How many traps did you use? ____________________

(b) Where did you place the trap (show approx. % of total trapping time, below)?

	Distance trap from :		
Distance (m)	**Farm House**	**Farm Sheds**	**Other**
<100 m	______	______	______
100 - 500 m	______	______	______
>500 m	______	______	______

(c) Please indicate main trap location(s) on map? (*Interviewer to please use code T=, where = = participant number*).

(d) Were any traps located near a monitoring site (YES/NO)? (*Interviewer to check if monitoring site near farm*).

	(YES/NO)	**Site Nos**	**Approx. Distance (m) from Mon. Site**
May'97 - Apl'98	______	______	______
May'98 - Apl'99	______	______	______

(e) How many days per week (on average) were your traps active during

May'97 - Apl'98:	winter	______________
	spring	______________
	summer	______________
	autumn	______________
May'98 - Apl'99:	winter	______________
	spring	______________
	summer	______________

(f) Did you move your trap to new locations as numbers of trapped Twenty-eight Parrots fell?

(g) If you did not trap at least winter 1997 and winter 1998, what was the reason for not trapping during those times? *(NB new traps weren't readily available in first winter (1977)).*

(h) Did you observe any trends in the numbers of parrots you trapped during the different seasons (winter/spring/summer/autumn)?

(i) Do you have any suggestions for increasing numbers of Twenty-eights Parrots trapped during different times of the year?

(j) Were you able to easily release non-target bird species that you trapped (non-28's)?

(k) . Do you have any comments on problems with releasing non-target bird species form traps using the present methods, or of ways of making this easier?

(l) Were you able to humanely kill trapped birds?

Q3(cont) (m) Do you have any suggestions on how trapped Twenty-eight Parrots could be disposed of in a more humane way (quickly, less distress on bird and trapper)?

____

____

____

(n) Do you have any other comments or suggestions regarding trapping Twenty-eight Parrots?

____

____

____

____

IV NO TRAPPING

Q4 Were Twenty-eight Parrots shot on your property during the trial? (YES?NO)? __________

(Confirm all shooting numbers recorded on Peter Coffey database or update database, recording data by day OR month OR season, and year)

If YES,

(a) Were Twenty-eight Parrots shot near a monitoring site (YES/NO)? (*Interviewer to check if monitoring site near farm*).

	(YES/NO)	Site Nos	Approx. Distance (m) from Mon. Site
May'97 - Apl'98	______	______	______
May'98 - Apl'99	______	______	______

[Please indicate main shooting location(s) on map? (*Interviewer to please use code S=, where = = participant number*).]

(QE5) Do you think you shot

- much more ____
- more ____
- same ____
- less ____
- much less ____

Twenty-eight parrots per year during the trial (May'97 to April'99) than before the trial? (*Tick one of the options*).

Q5 What were your main reasons for not trapping Twenty-eights' during the trial?

____

____

____

____

Q6 If permitted, would you use trapping as a tool to limit parrot damage in future?

____

____

____

VI GRAIN AVAILABILITY FOR TWENTY-EIGHT PARROTS ON-FARM

Q7 Were there other significant sources of grain in your immediate area during the trial, to which Twenty-eights had access

Source	Period Available (season+year, May'97 to Apl'99))
i) self-feeders	__________
ii) piggeries/cattle feed lots	__________
iii) cereal hay	__________
iv) fodder crops	__________
v) hand feeding	__________
vi) silage	__________
vii) open grain silos	__________
viii) silos	__________
v) other - __________	__________
- __________	__________
- __________	__________
- __________	__________

Q8 What factors, if any, do you think contribute to the numbers of Twenty-eight Parrots in your district? ____________________

____

____

____

Q9 Are there any practical measures that could be undertaken on the farm to minimise the amount of grain/feed available for Twenty-eights?

____

____

____

____

FINISH

Questionnaire

Twenty-eight Parrot Trapping Trial

May 1997 to April 1999

Control Area

(13/4/99Update)

Interviewees Name: ______________________ **ID Nos:** ____ **Ph Nos** ____________
Property Name: ______________________ **Location Nos** ______________________
Date: ____________ (District Conservation Map)

I OBSERVATIONS

Q1 Have you observed any changes in -

(a) Numbers of Twenty-eight Parrots around farm

	Large Increase	Increase	No Change	Decrease	Large Decrease
Overall	______	______	______	______	______
May'97 - Apl'98	______	______	______	______	______
May'98 - Apl'99	______	______	______	______	______

(b) Garden damage by Twenty-eight Parrots

	Large Increase	Increase	No Change	Decrease	Large Decrease
Overall	______	______	______	______	______
May'97 - Apl'98	______	______	______	______	______
May'98 - Apl'99	______	______	______	______	______

(c) Farm tree damage by Twenty-eight Parrots

	Large Increase	Increase	No Change	Decrease	Large Decrease
Overall	______	______	______	______	______
May'97 - Apl'98	______	______	______	______	______
May'98 - Apl'99	______	______	______	______	______

(d) Grass tree damage by Twenty-eight Parrots

	Large Increase	Increase	No Change	Decrease	Large Decrease
Overall	______	______	______	______	______
May'97 - Apl'98	______	______	______	______	______
May'98 - Apl'99	______	______	______	______	______

(e) Crop damage by Twenty-eight Parrots

	Large Increase	Increase	No Change	Decrease	Large Decrease
Overall	______	______	______	______	______
May'97 - Apl'98	______	______	______	______	______
May'98 - Apl'99	______	______	______	______	______

II REDUCTION OF TWENTY-EIGHT PARROT NUMBERS ON FARM PROPERTY

Q2 Were any Twenty-eight Parrots removed/culled from your property during the time period of the trapping trial (May 1997 to April 1998) (YES/NO)? ____________________

If NO, go to Q4

If 'YES', did you remove/cull Twenty-eight Parrots near a monitoring site (YES/NO)?
(*Interviewer to check if monitoring site near farm*).

	(YES/NO)	Site Nos	Approx. Distance (m) from Mon. Site
May'97 - Apl'98	________	________	________
May'98 - Apl'99	________	________	________

Q3. How many Twenty-eight Parrots would you estimate had been removed?

	Adjacent to monitoring site	Other locations
May'97 - Apl'98:	________	________
May'98 - Apl'99:	________	________

QE1 Do you think you removed

much more____
more ____
same ____
less ____
much less ____

Twenty-eight parrots per year during the trial (May'97 to April'99) than before the trial? (*Tick one of the options*).

Q4. Are you aware of significant culling of Twenty-eight Parrots on neighbouring properties during May 1997 to April 1999 (YES/NO)? ____________ (*This information may help us explain trends in the trial*).

	Name/Ph
Neighbour	________________
	________________
Other	________________
	________________

QE2 If permitted, would you use trapping as a tool to limit parrot damage in future?

____

____

____

VI GRAIN AVAILABILITY FOR TWENTY-EIGHT PARROTS ON-FARM

Q5 Were there other significant sources of grain in your immediate area during the trial, to which Twenty-eights had access

Source	Period Available (season+year, May'97 to Apl'99)
i) self-feeders	______
ii) piggeries/cattle feed lots	______
iii) cereal hay	______
iv) fodder crops	______
v) hand feeding	______
vi) silage	______
vii) open grain silos	______
viii) silos ______	______
x) other - ______	______
- ______	______
- ______	______

Q6 What factors, if any, do you think contribute to the numbers of Twenty-eight Parrots in your district? ______

______

______

______

Q7 Are there any practical measures that could be undertaken on the farm to minimise the amount of grain/feed available for Twenty-eight's??

______

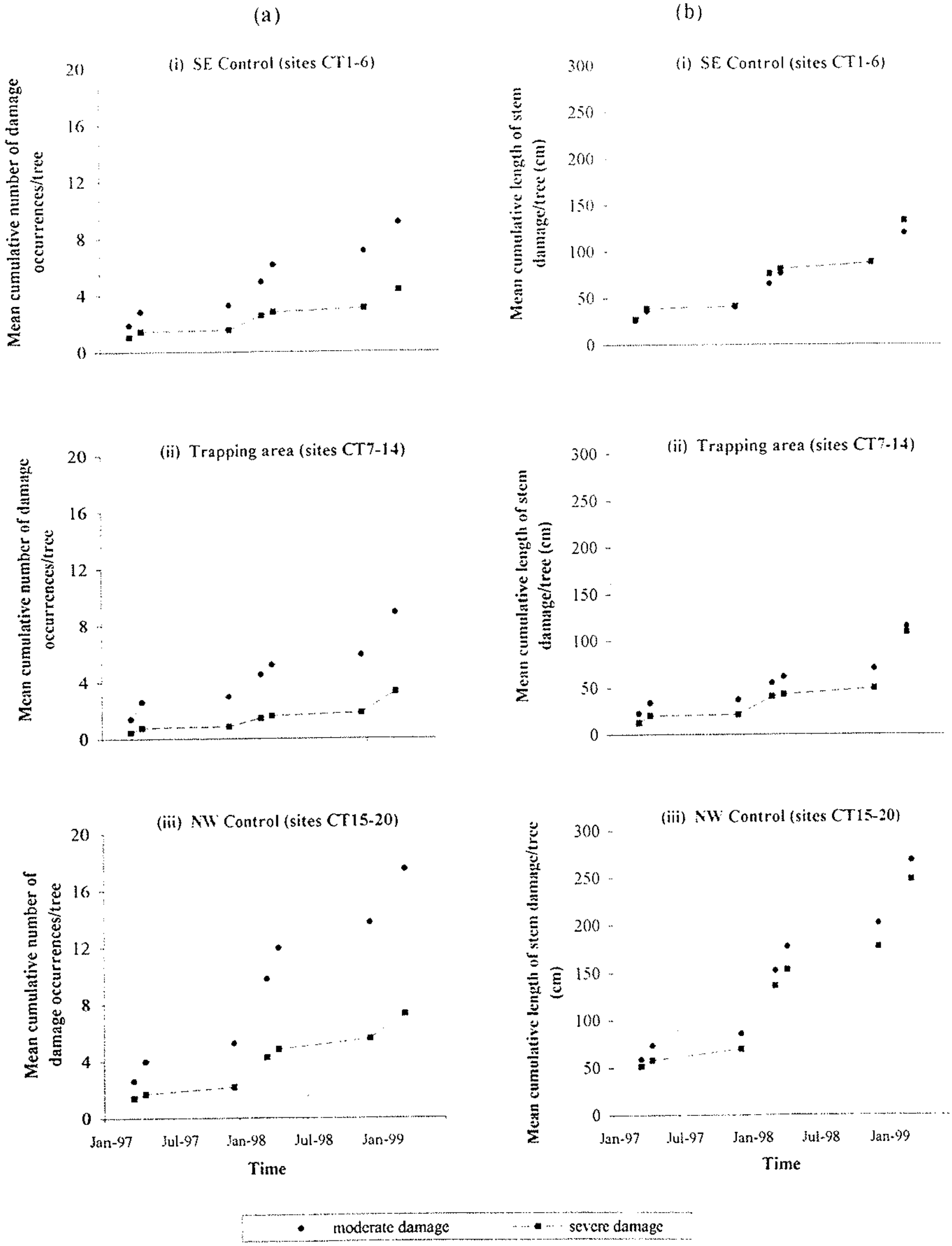
______

______

______

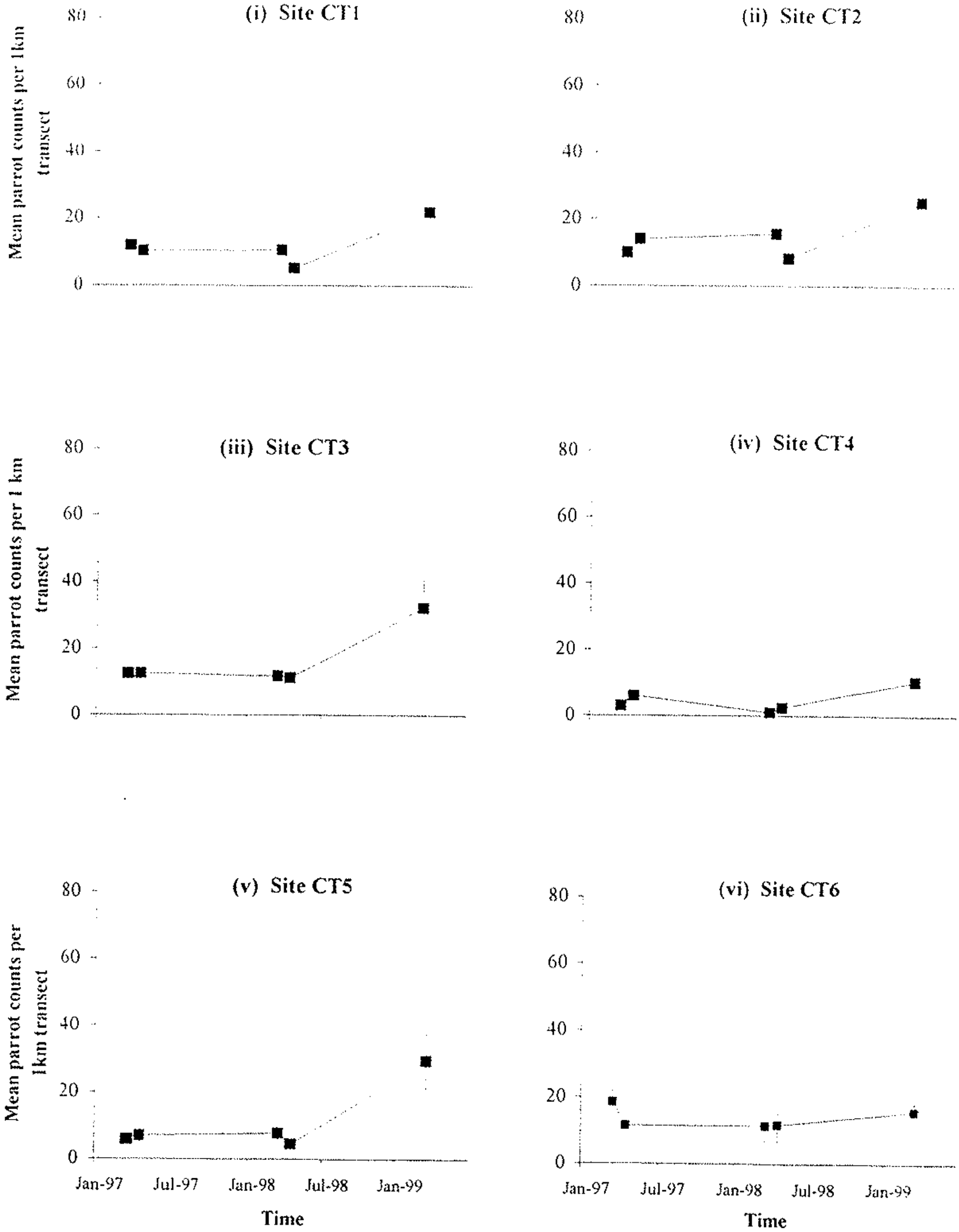
FINISH

Appendix 3 Cumulative moderate and severe stem damage to River Red Gums:
(a) Number of damage occurrences per tree.
(b) Length of stem damage per tree.

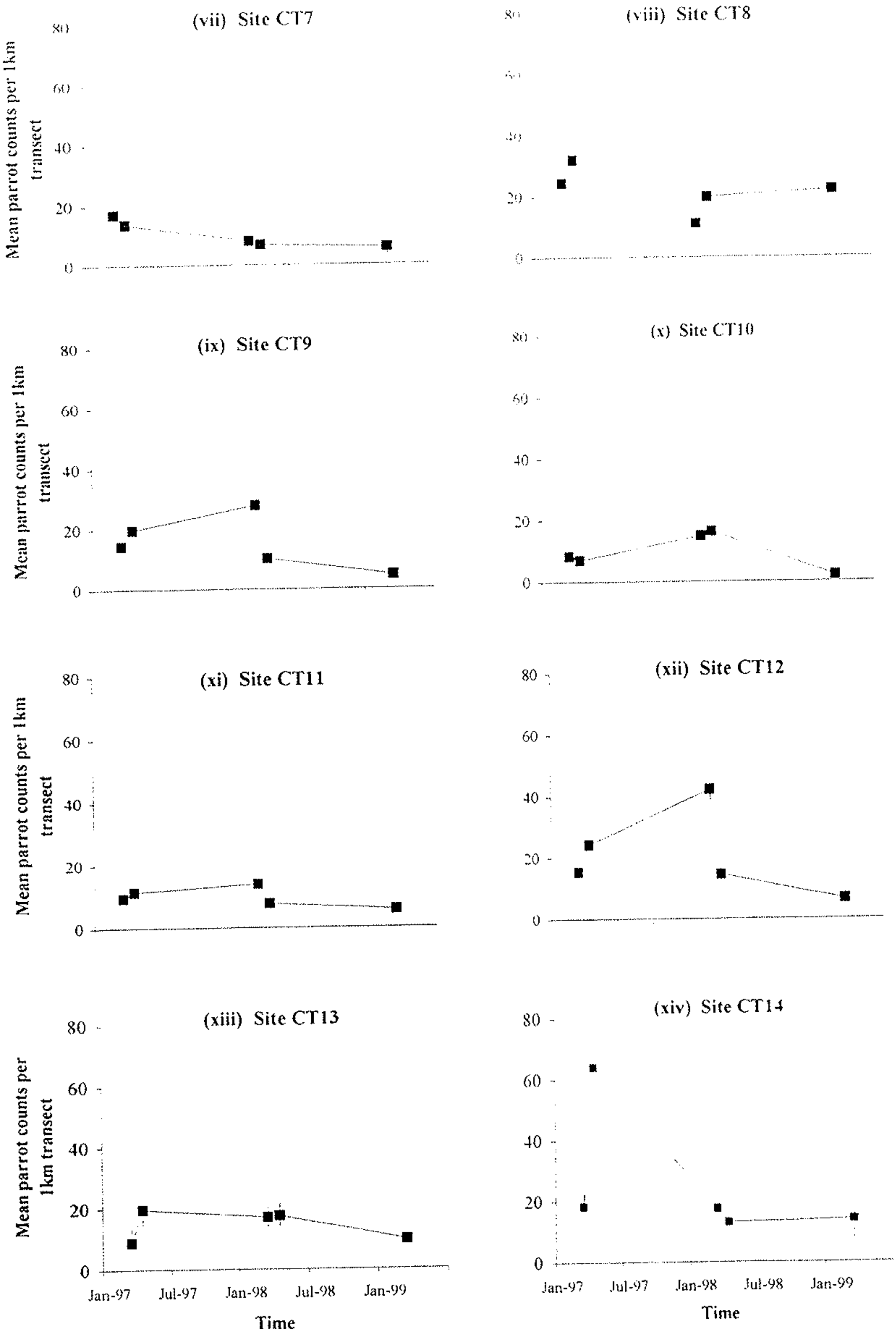


Appendix 4 Mean parrot counts per transect by survey time for each site.

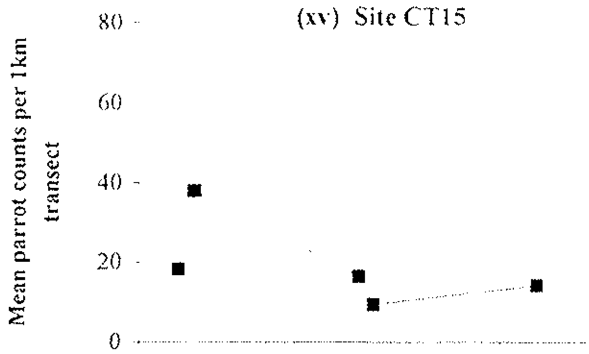
SE Control area (sites CT1 to 6)

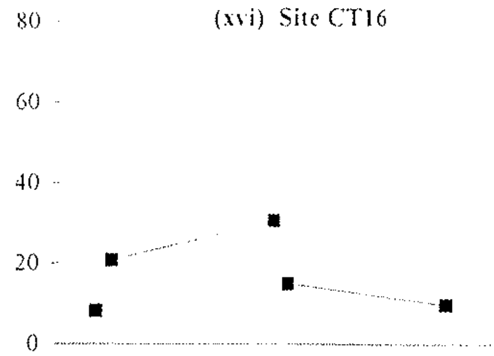


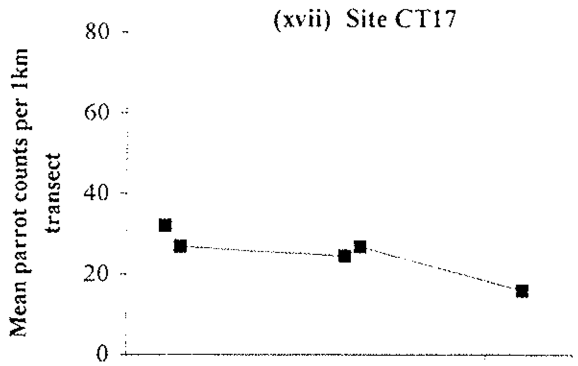
Appendix 4 (cont). Trapping area (sites CT7 to 14)

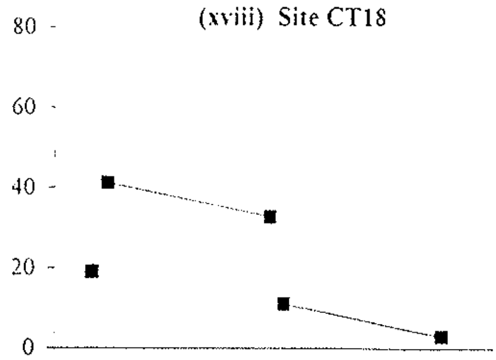


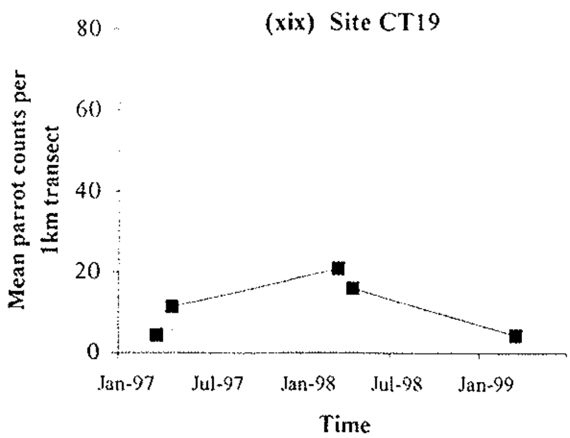
Appendix 4 (cont). NW Control area (sites CT15 to 20)

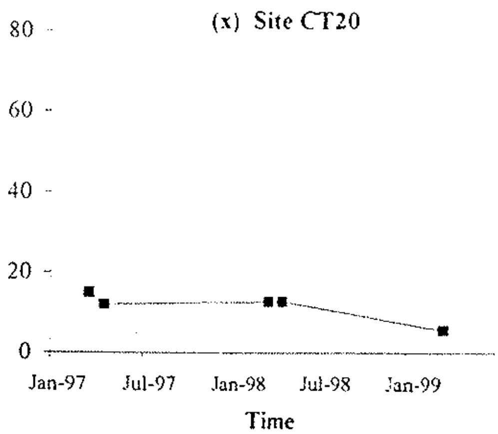




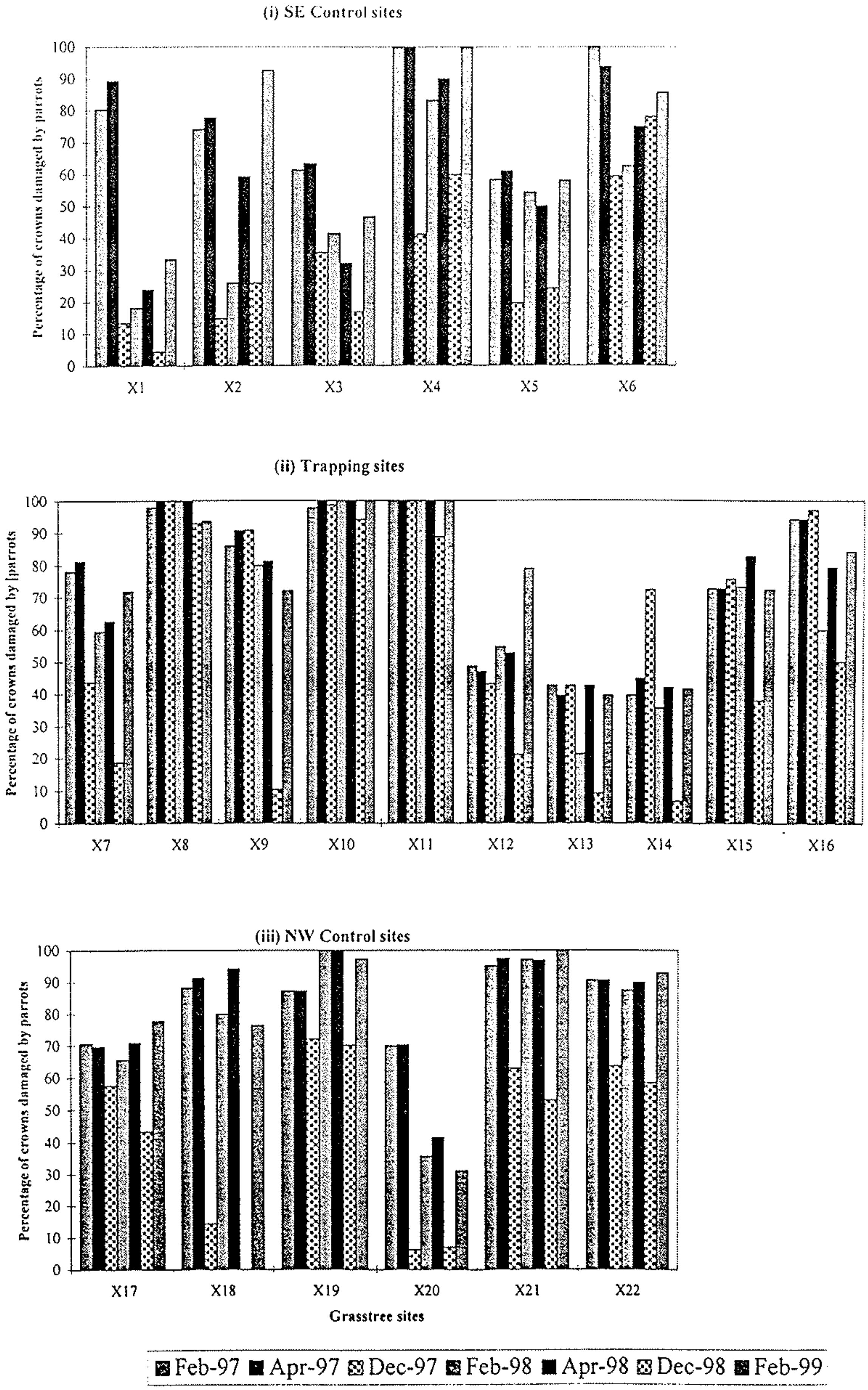




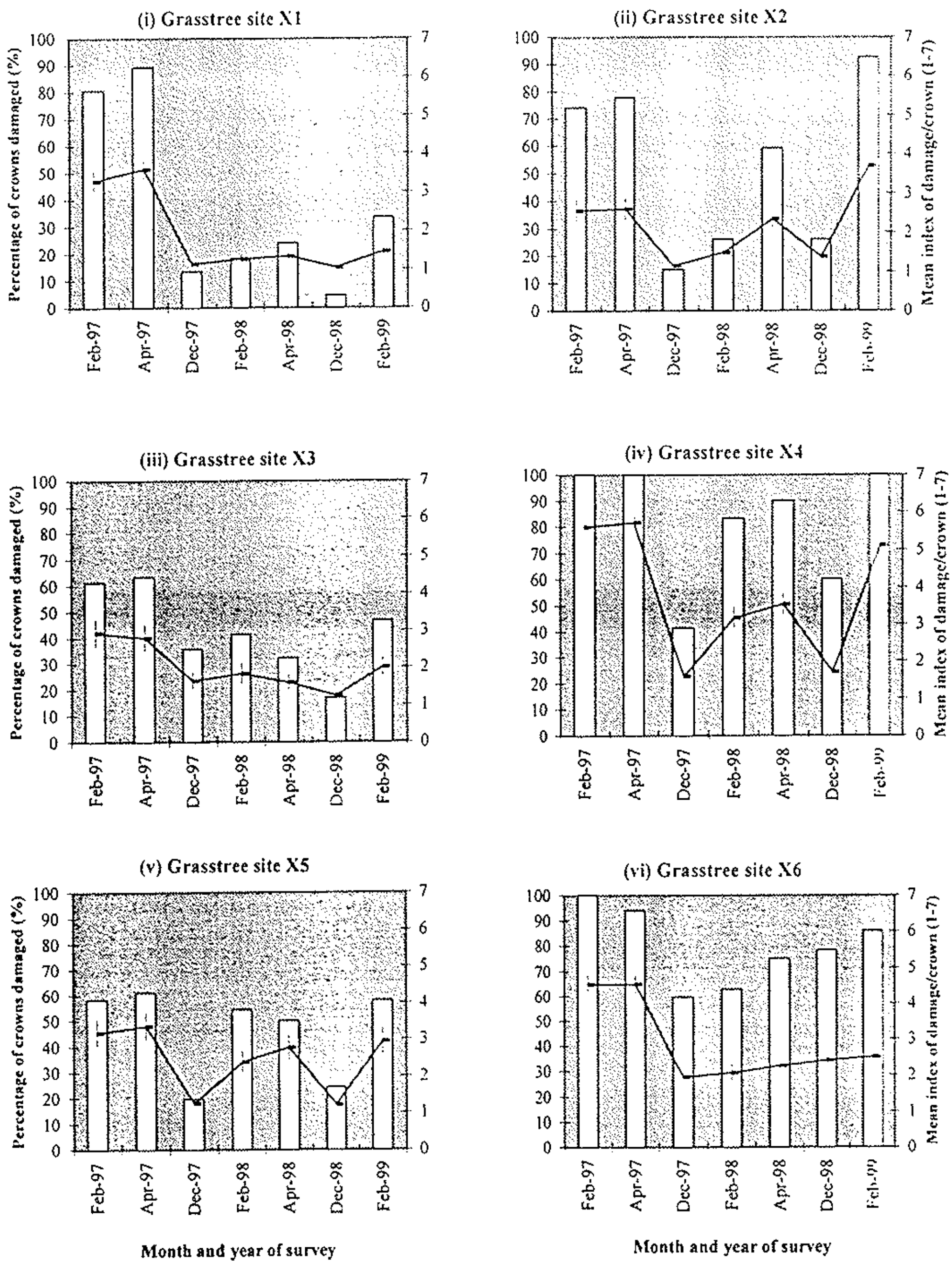




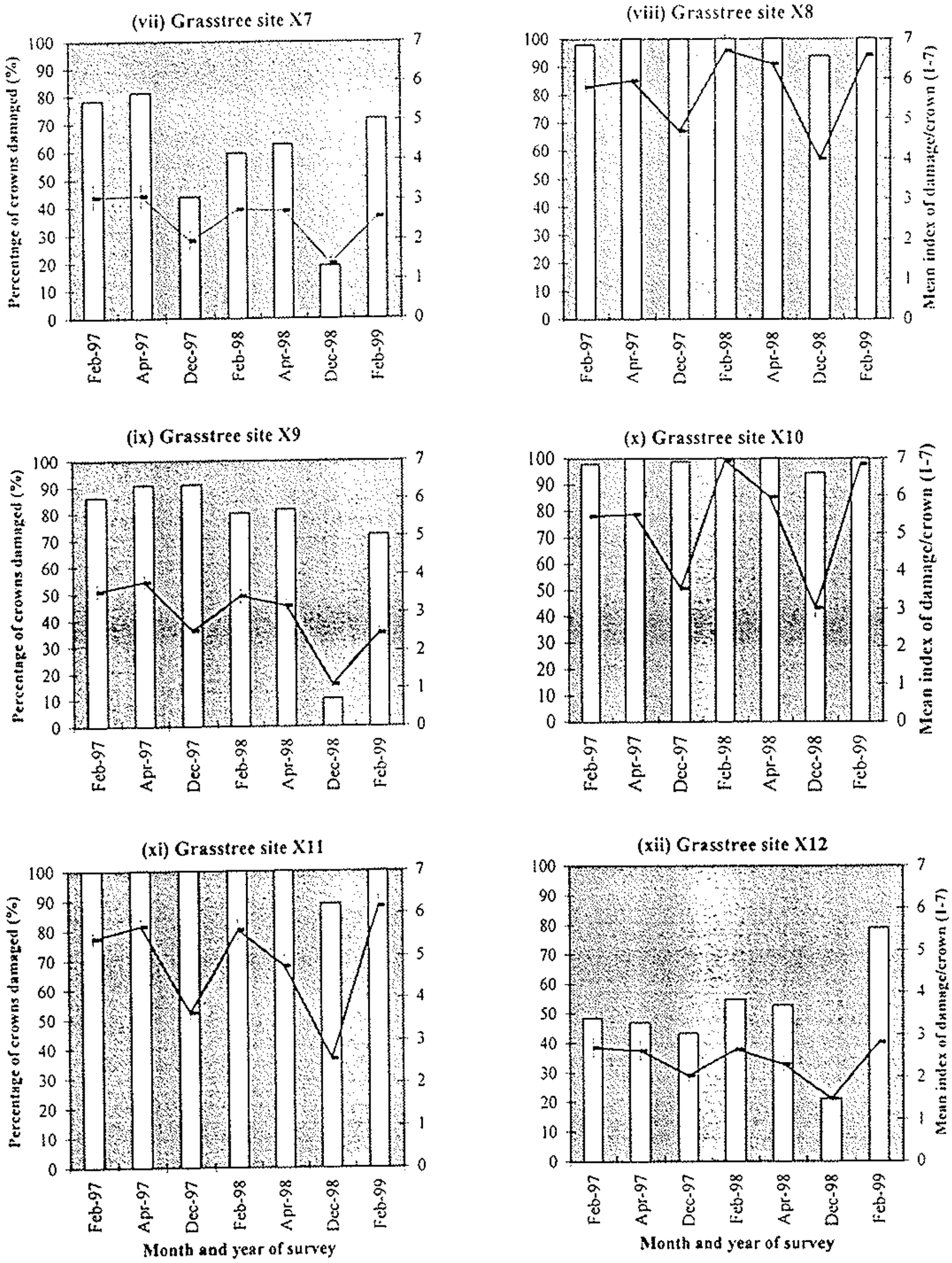
Appendix 5 Percentage of crowns damaged by parrots at each site for each survey at the (i) SE Control, (ii) Trapping and (iii) NW Control areas. The three February surveys have been given the same shading, as have the two April surveys and the two December surveys. Surveys are presented in chronological order for each site (February 1997 to February 1999).



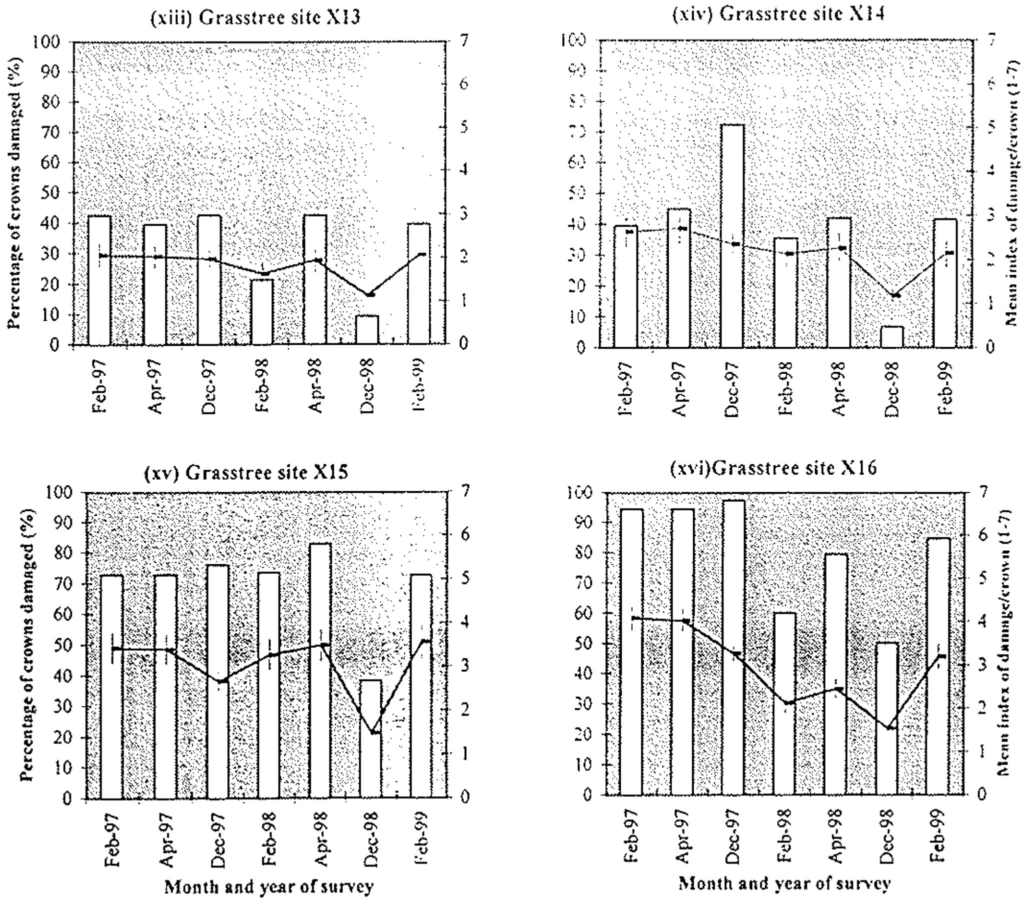
Appendix 6 Percentage of crowns with *current damage* and mean index of crown damage for each SE Control site. White bars = percentage of crowns damaged, line graph = mean index of crown damage.



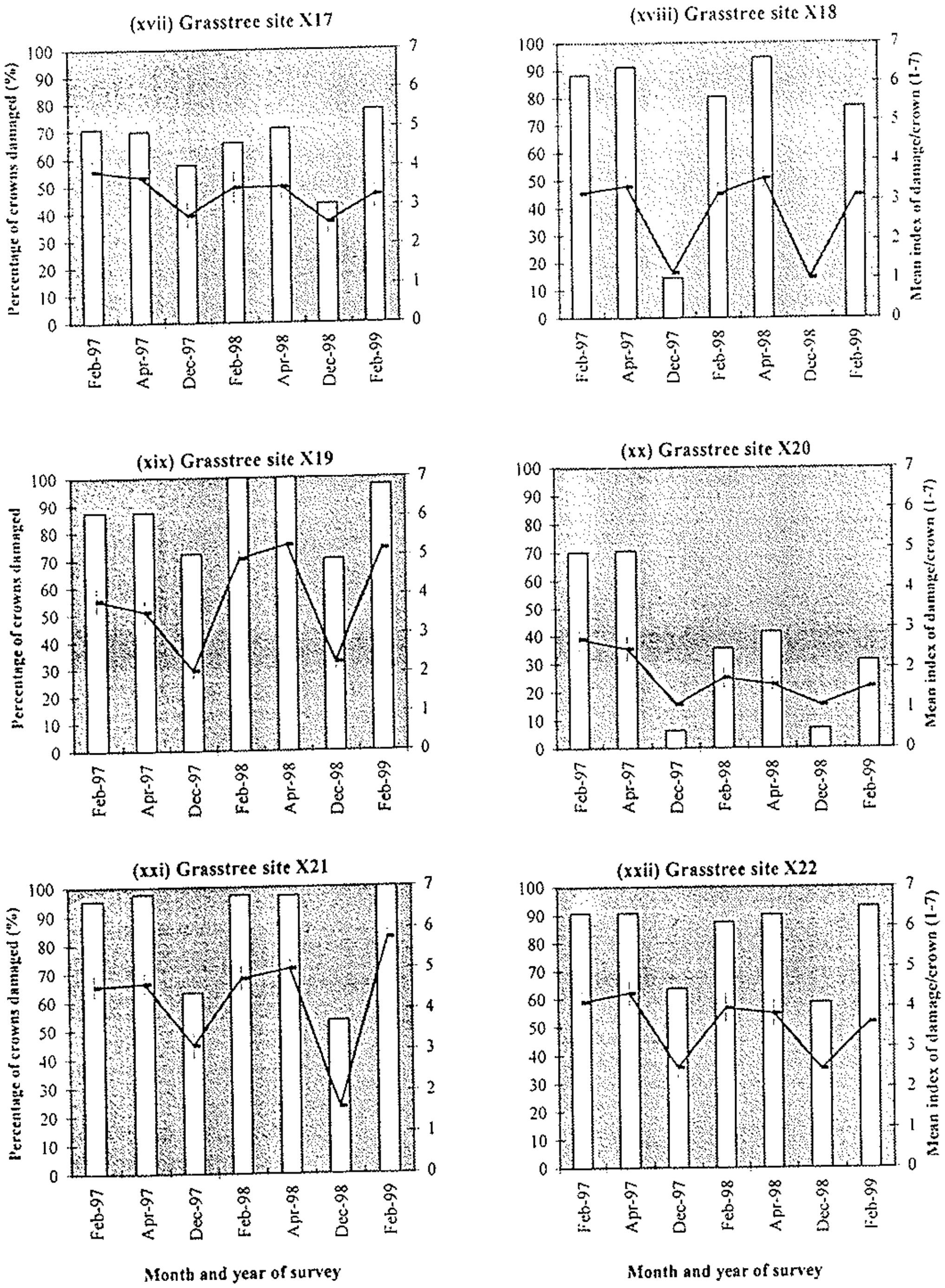
Appendix 6 (cont). Percentage of crowns with *current damage* and mean index of crown damage for each Trapping site. White bars = percentage of crowns damaged, line graph = mean index of crown damage.



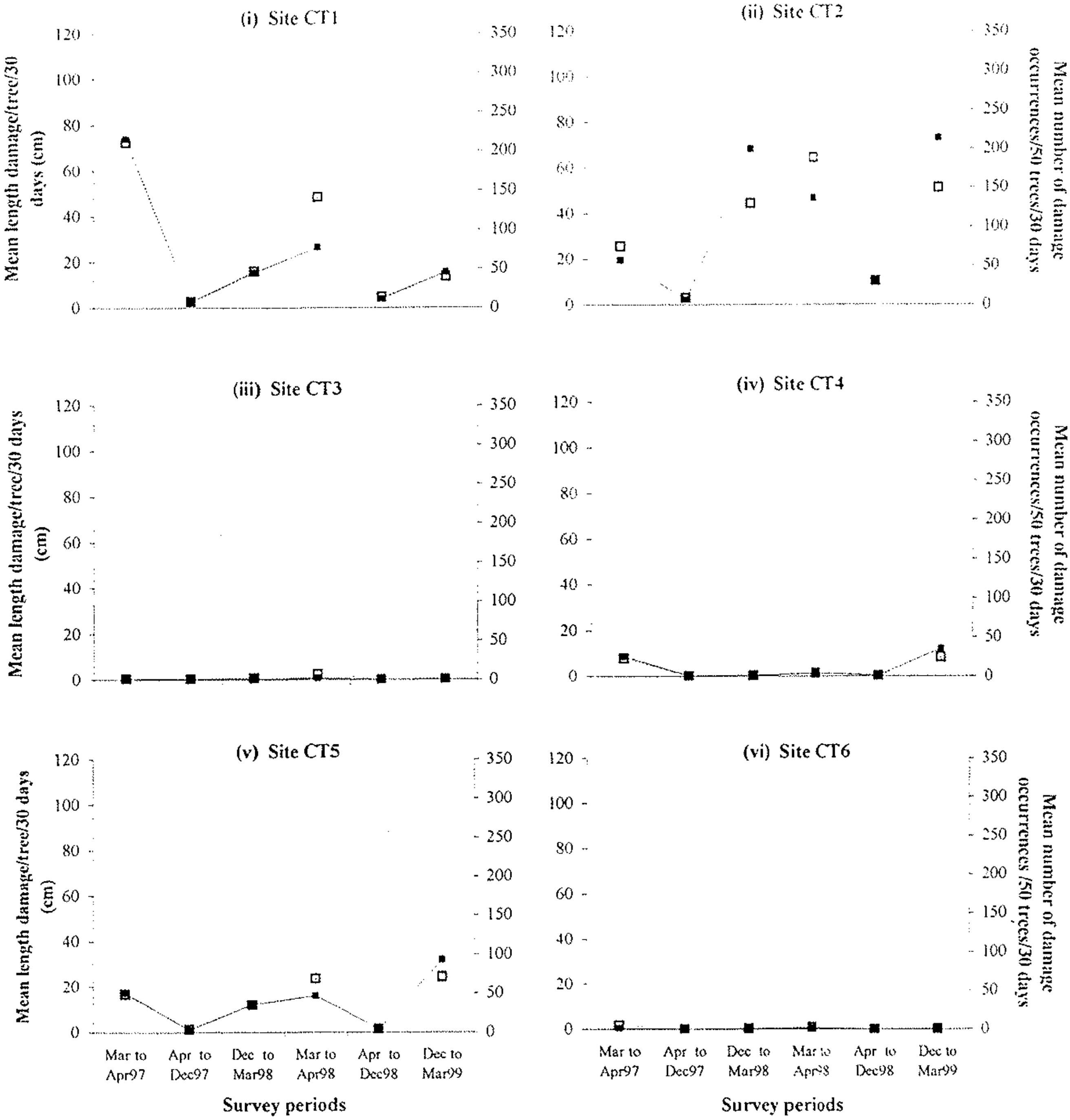
Appendix 6 (cont). Percentage of crowns with *current damage* and mean index of crown damage for each Trapping site. White bars = percentage of crowns damaged, line graph = mean index of crown damage.



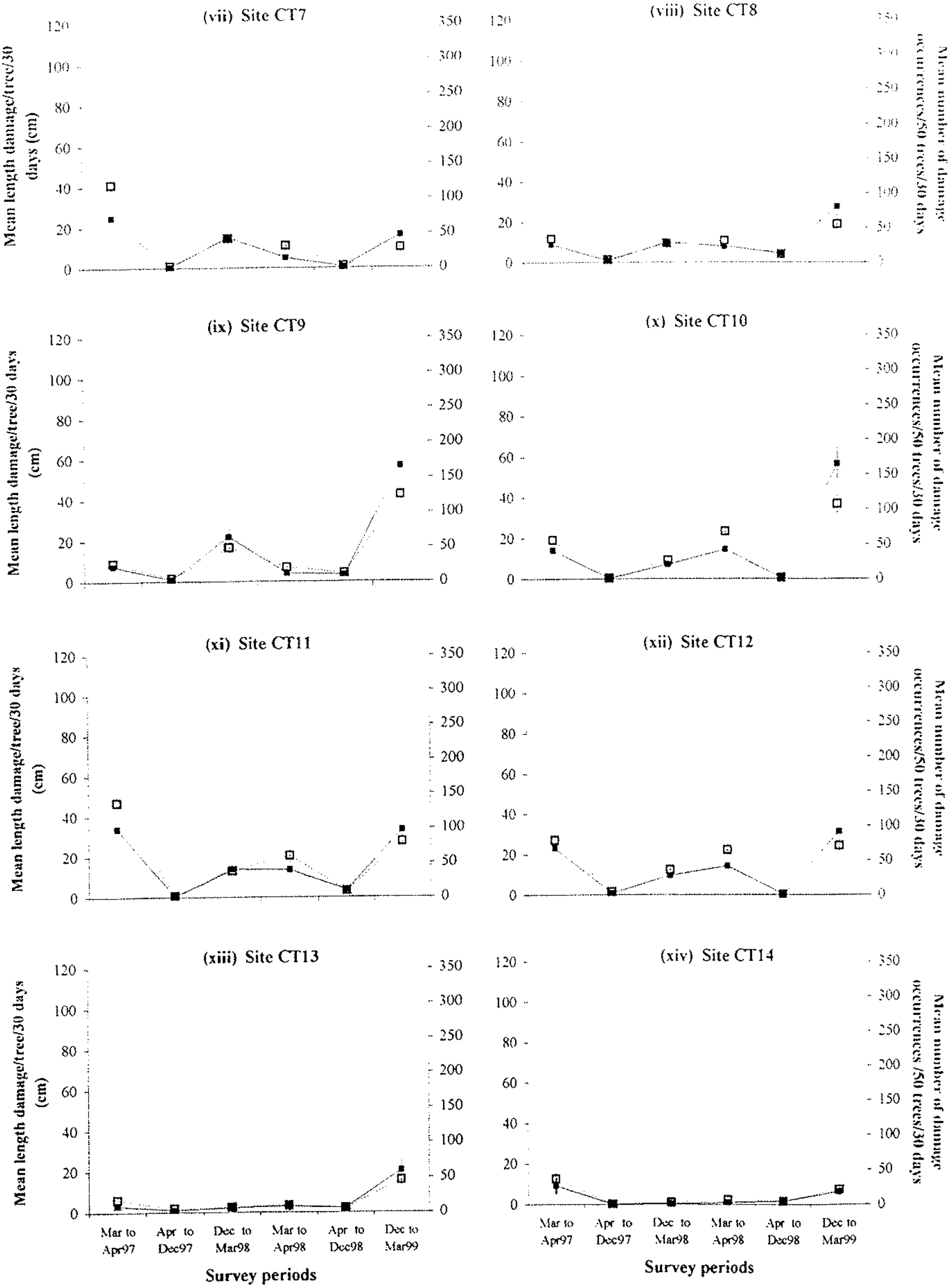
Appendix 6 (cont). Percentage of crowns with *current damage* and mean index of crown damage for each NW Control site. White bars = percentage of crowns damaged, line graph = mean index of crown damage.



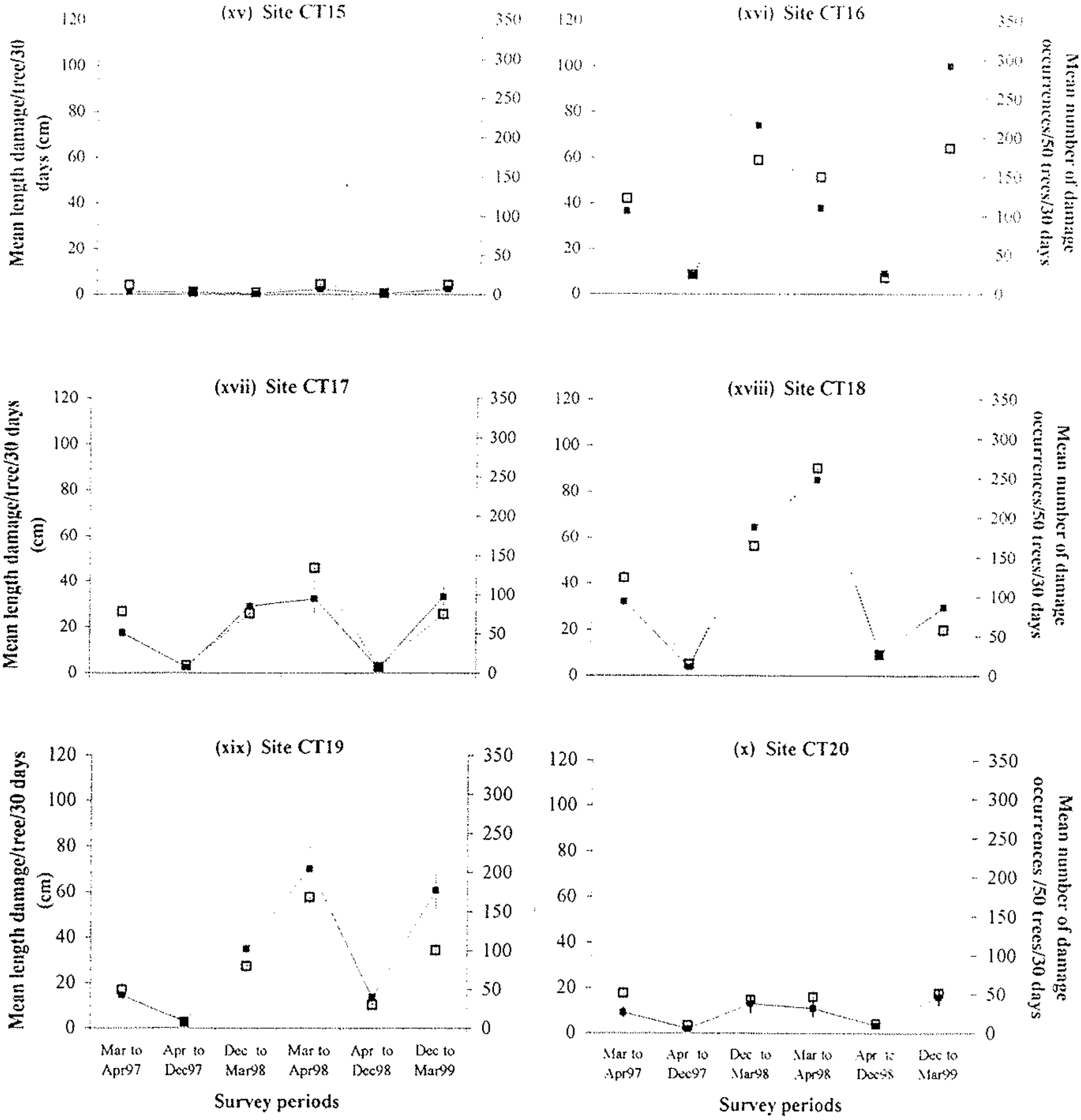
Appendix 7 Mean number of damage occurrences and mean length of stem damage at River Red Gum sites. SE Control area sites CT1 to 6.



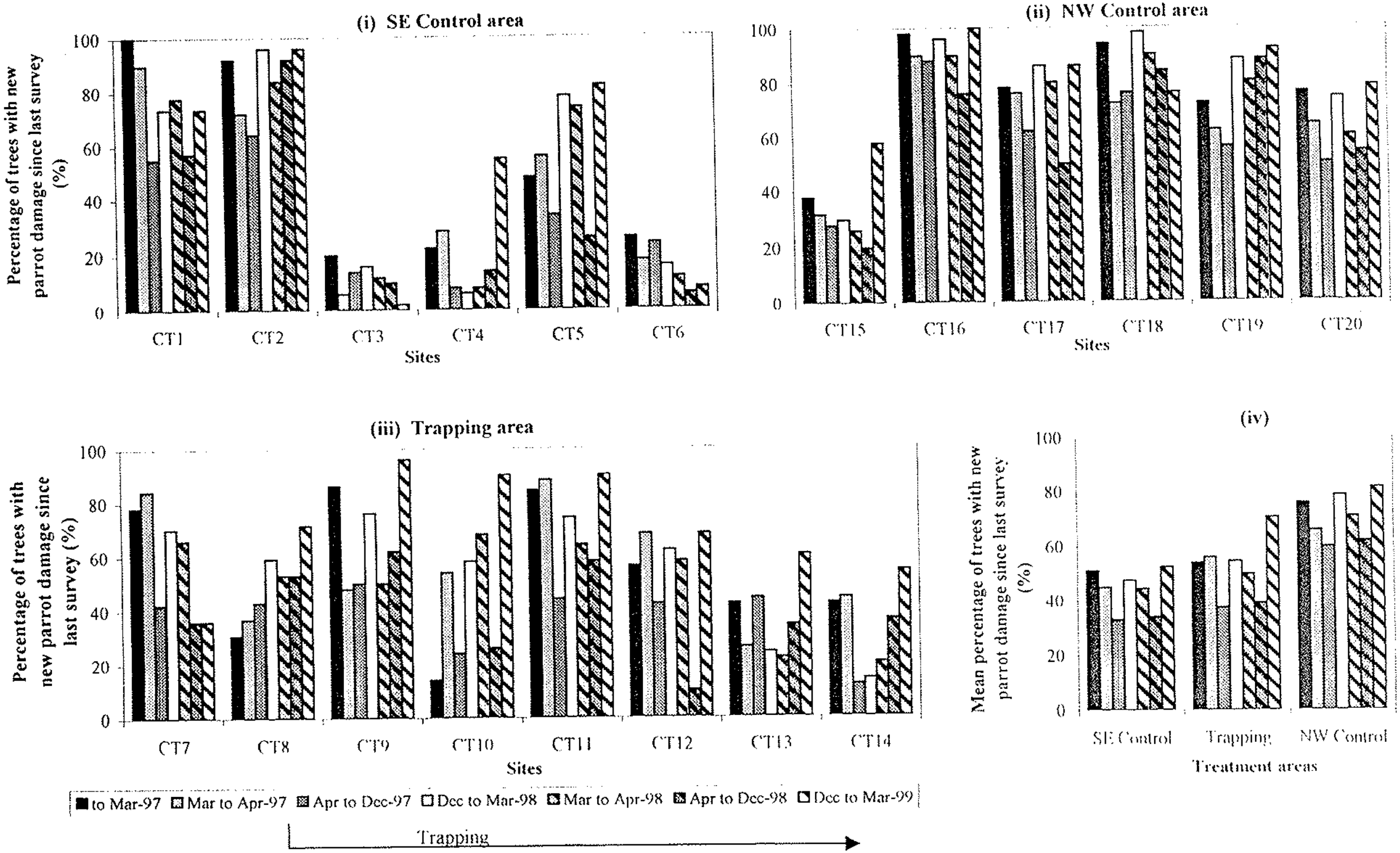
Appendix 7 (cont).Mean number of damage occurrences and mean length of stem damage at River Red Gum sites. Trapping area sites CT7 to 14.



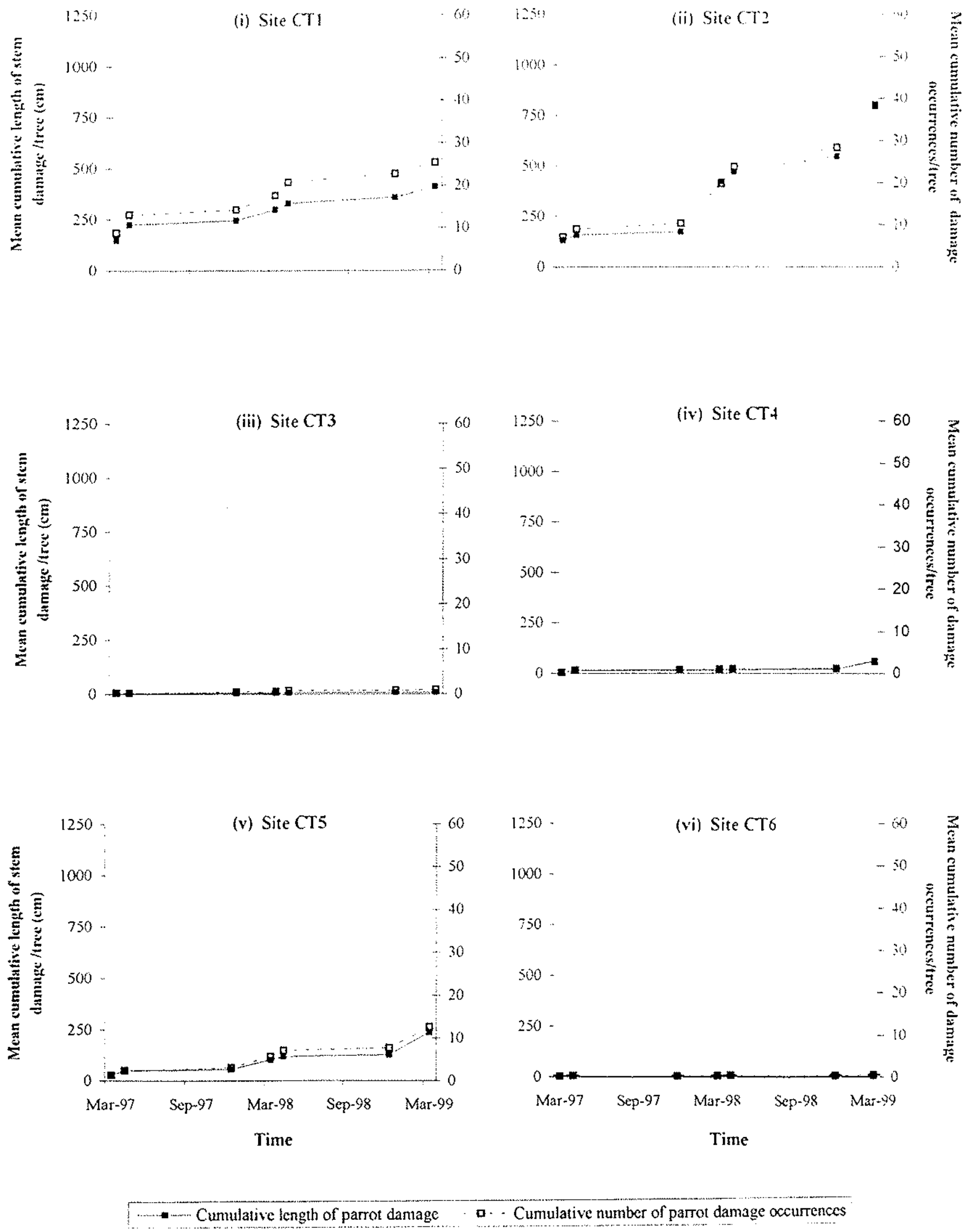
Appendix 7 (cont). Mean number of damage occurrences and mean length of stem damage at River Red Gum sites. NW Control area sites CT15 to 20.



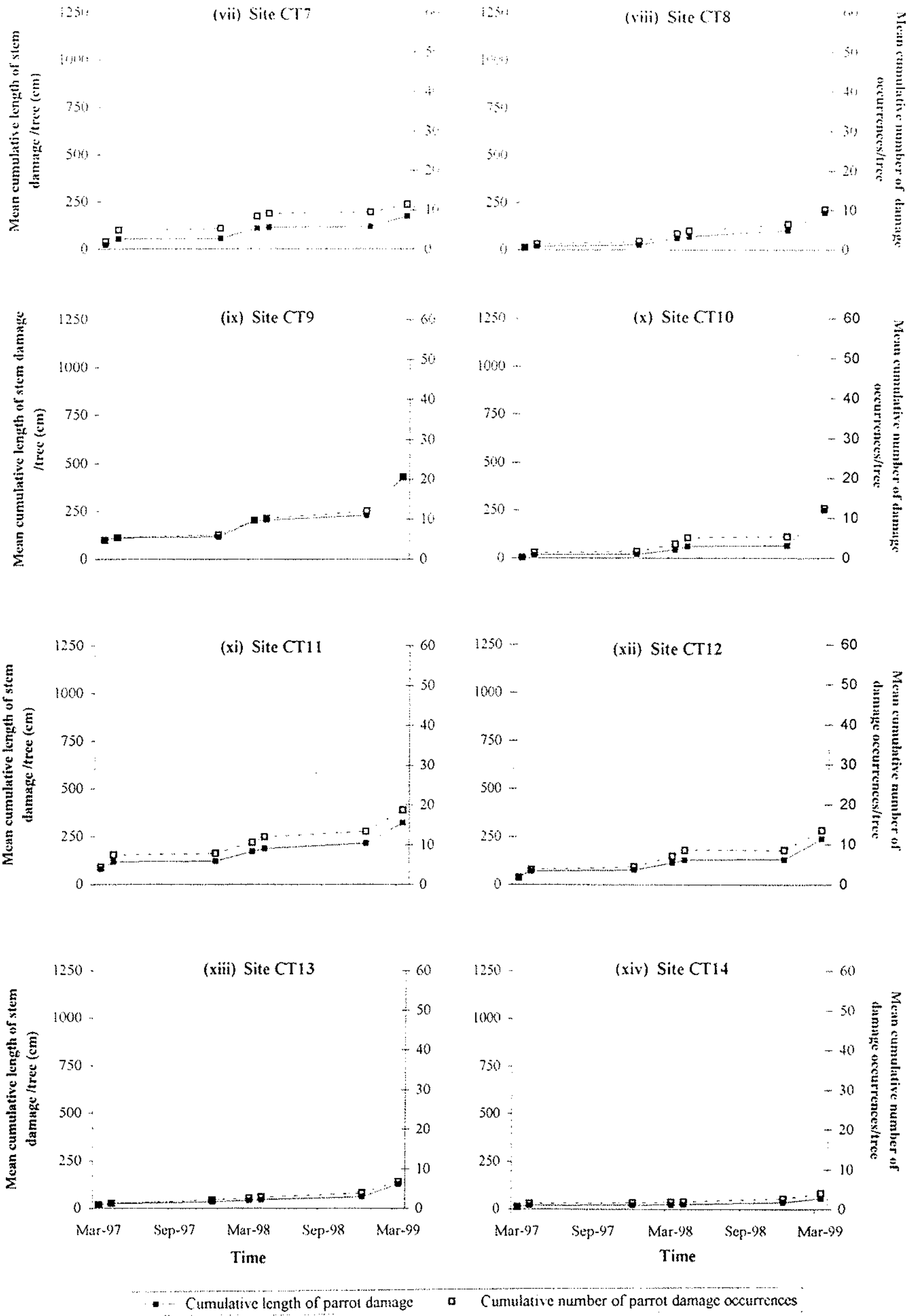
Appendix 8 Percentage of River Red Gum trees with new parrot damage since last survey for each site and treatment area.



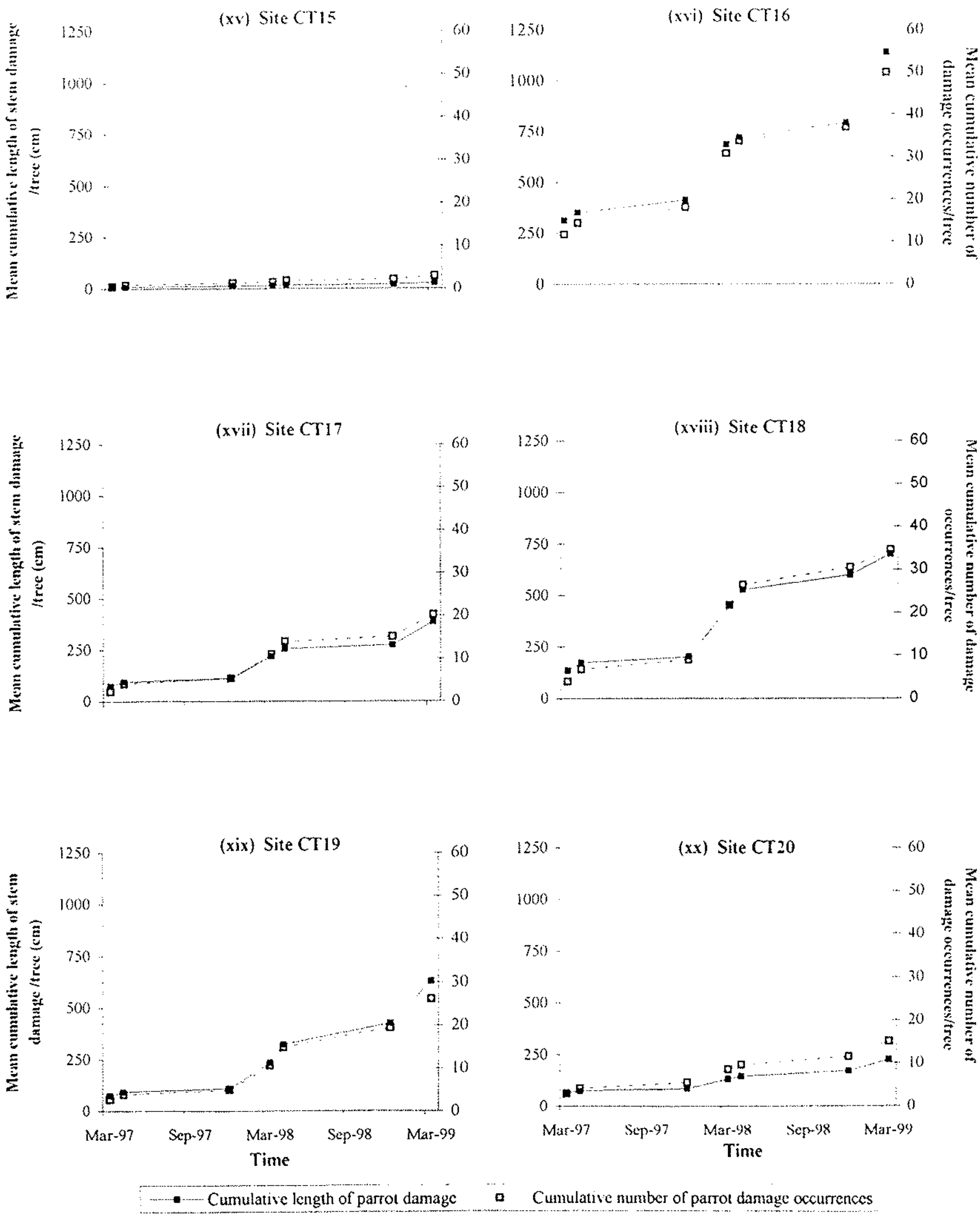
Appendix 9 Mean cumulative number of stem damage occurrences and lengths of damage at River Red Gum sites. SE Control area sites CT1 to 6.



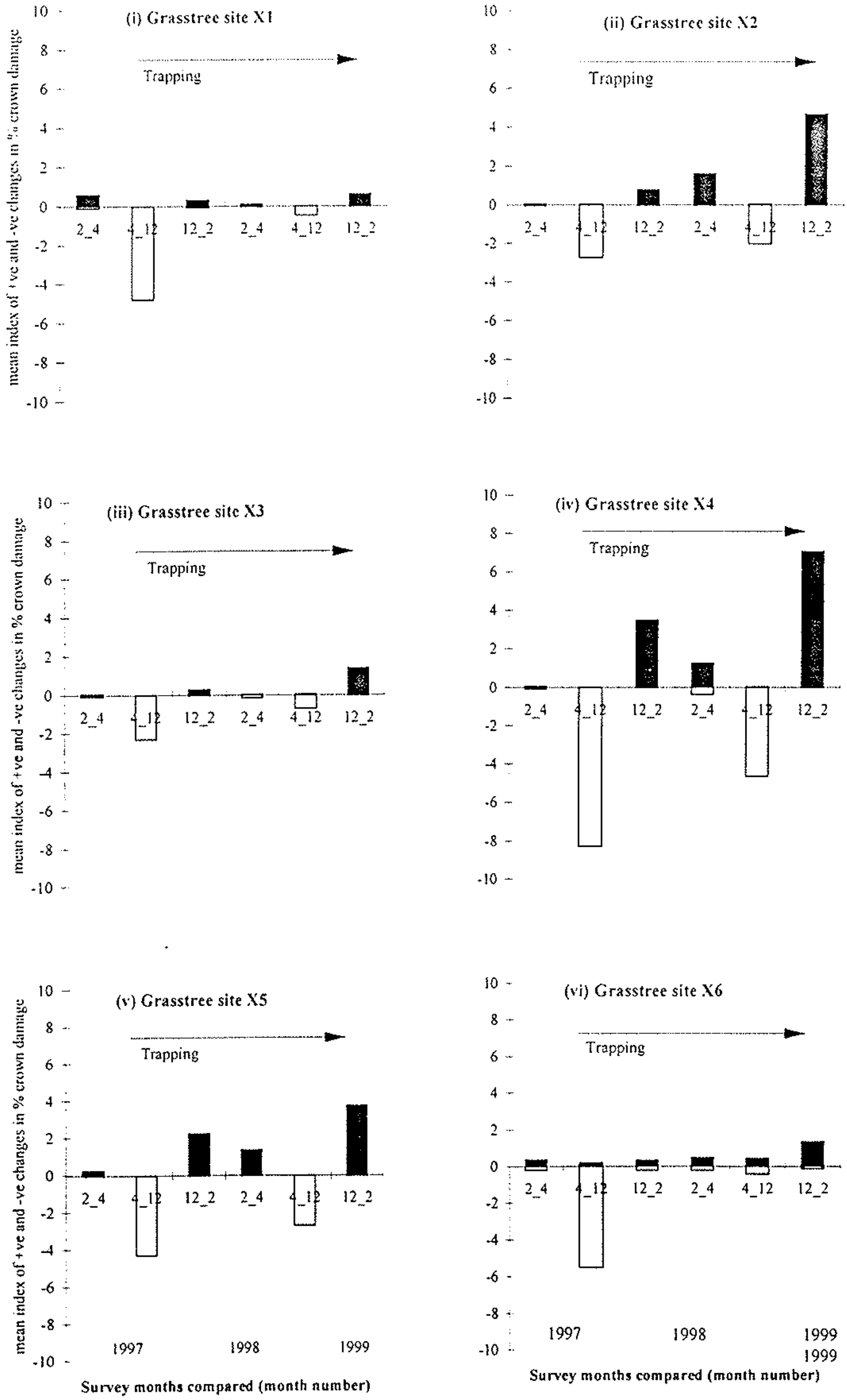
Appendix 9 (cont). Mean cumulative number of stem damage occurrences and lengths of damage at River Red Gum sites. Trapping area sites CT7 to 14.



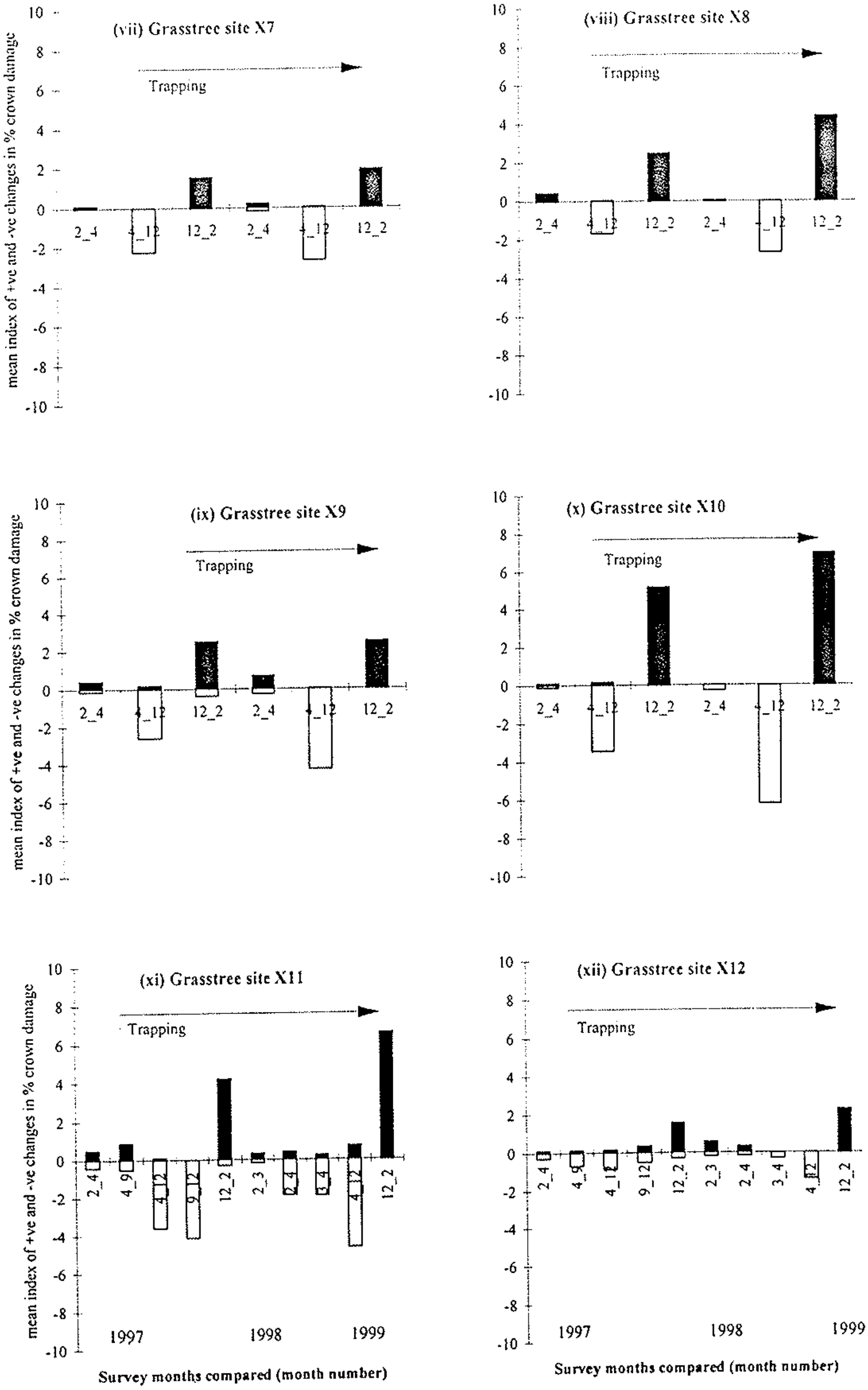
Appendix 9 (cont). Mean cumulative number of stem damage occurrences and lengths of damage at River Red Gum sites. NW Control area sites CT15 to 20.



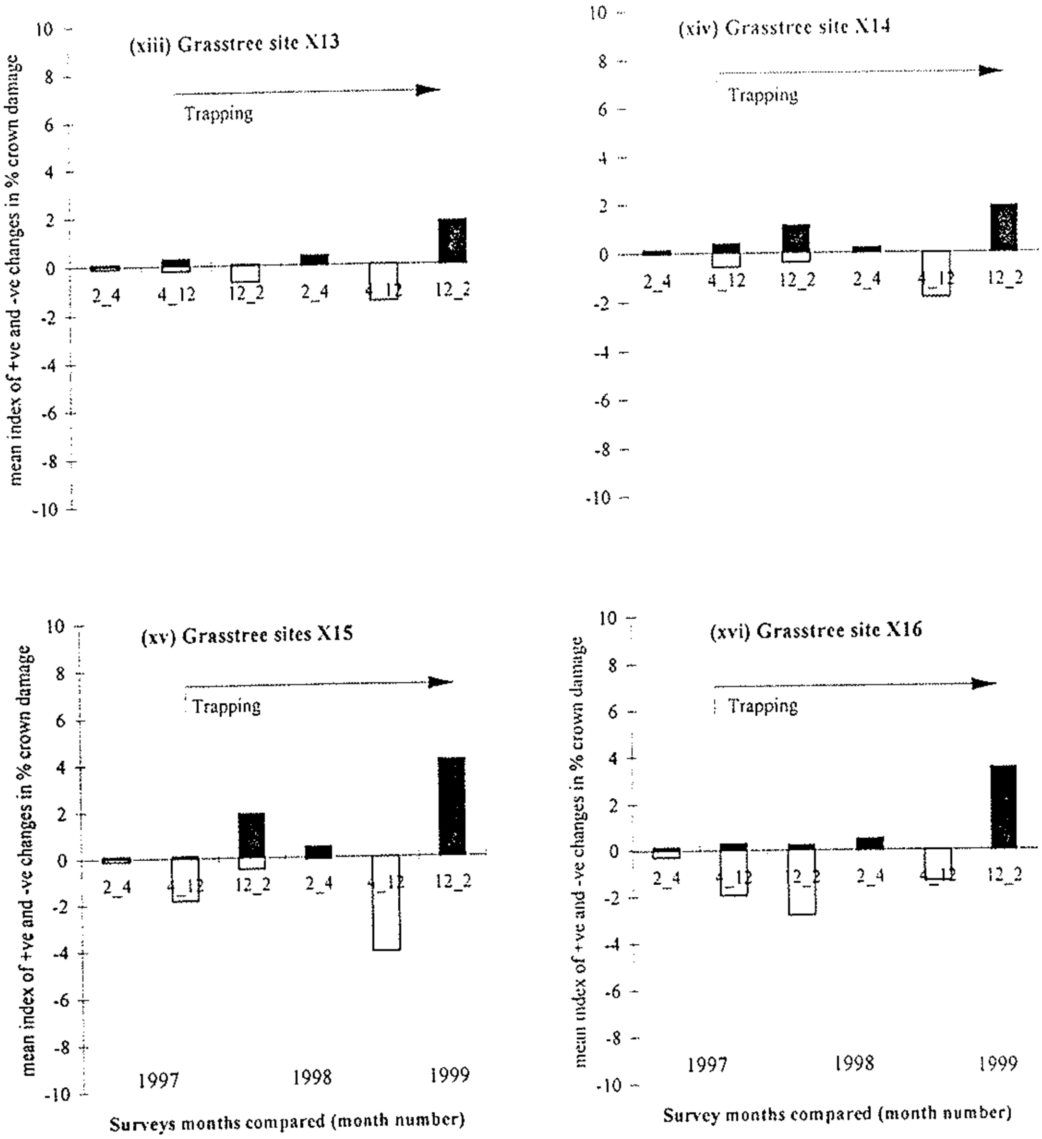
Appendix 10 Mean difference in the index of damage for individual crowns between consecutive surveys at each site in the SE Control area. Solid bars above the line represent increases in damage for crowns (+ve changes) and white bars below the line represent decreases in crown damage (-ve changes). Where crowns have no change in the index of damage, the difference is zero.



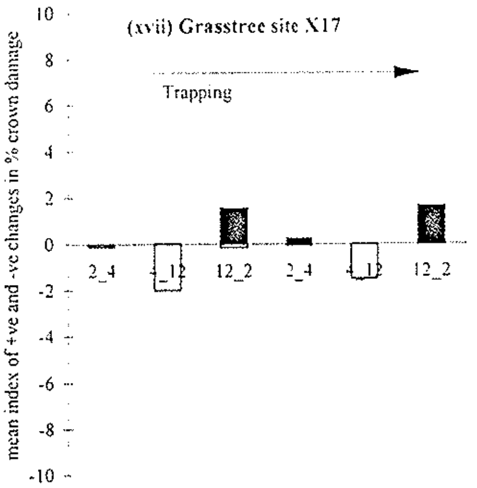
Appendix 10 (cont). Mean difference in the index of damage for individual crowns between consecutive surveys at each site in the Trapping area. Solid bars above the line represent increases in damage for crowns (+ve changes) and white bars below the line represent decreases in crown damage (-ve changes). Where crowns have no change in the index of damage, the difference is zero.

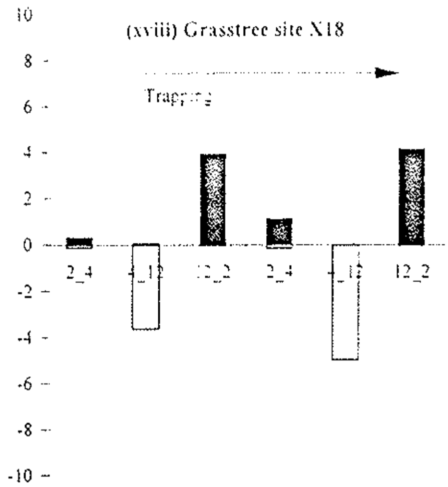


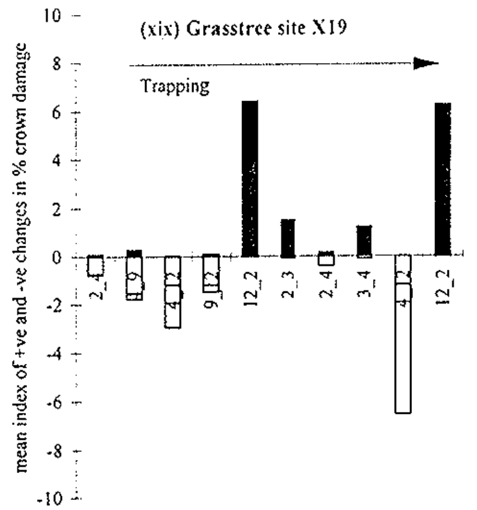
Appendix 10 (cont). **Mean difference in the index of damage for individual crowns between consecutive surveys at each site in the Trapping area. Solid bars above the line represent increases in damage for crowns (+ve changes) and white bars below the line represent decreases in crown damage (-ve changes). Where crowns have no change in the index of damage, the difference is zero.**

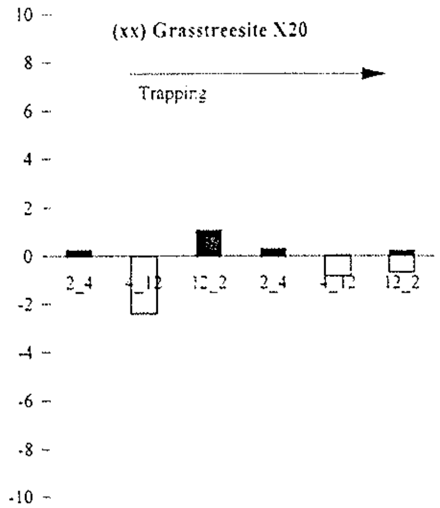


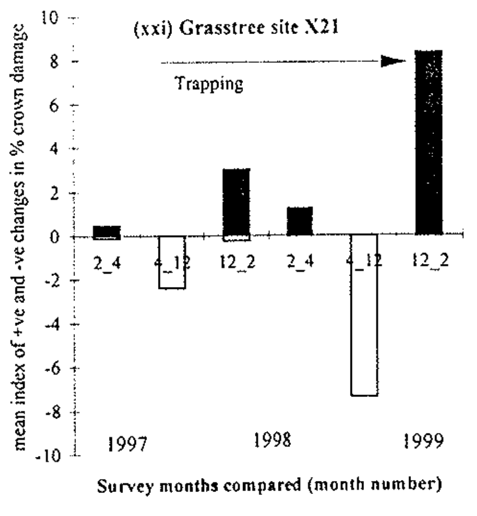
Appendix 10 (cont). Mean difference in the index of damage for individual crowns between consecutive surveys at each site in the NW Control area. Solid bars above the line represent increases in damage for crowns (+ve changes) and white bars below the line represent decreases in crown damage (-ve changes). Where crowns have no change in the index of damage, the difference is zero.

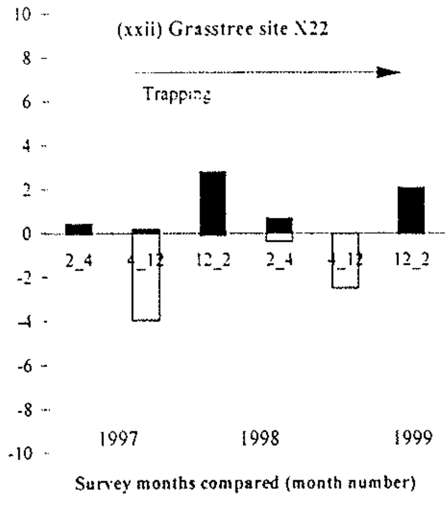




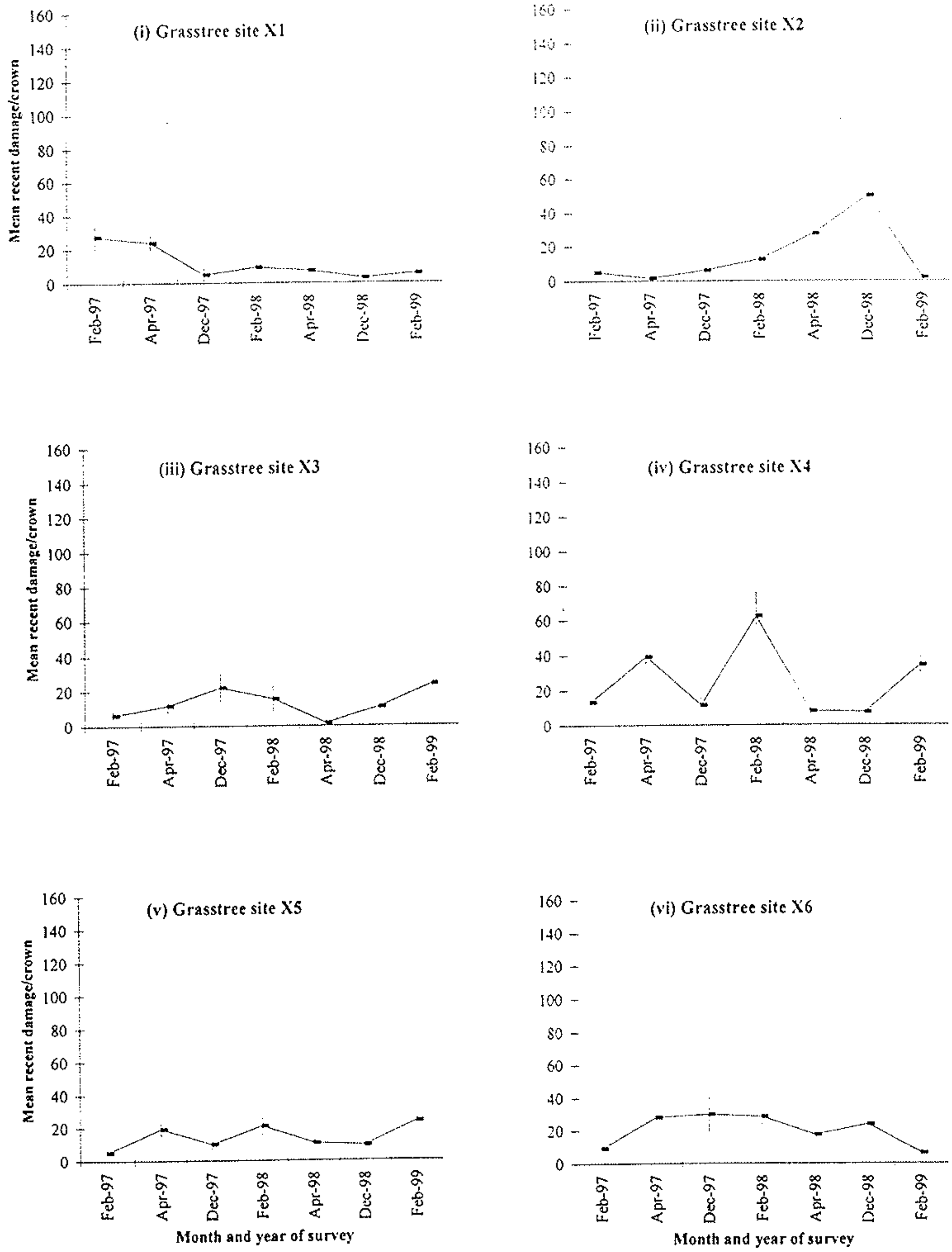




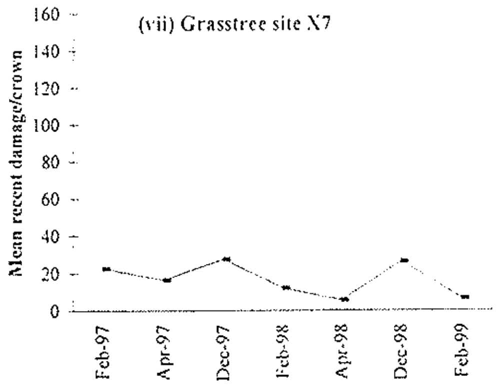


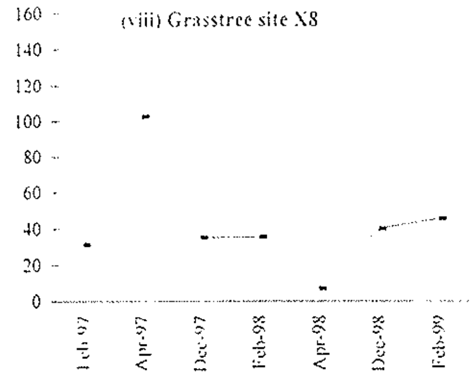


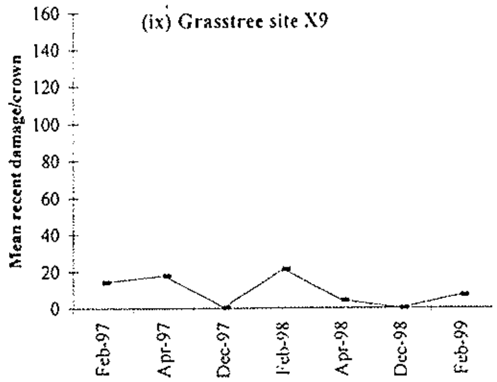
Appendix 11 Mean number of recently damaged fronds per crown at each sites in the SE Control area.

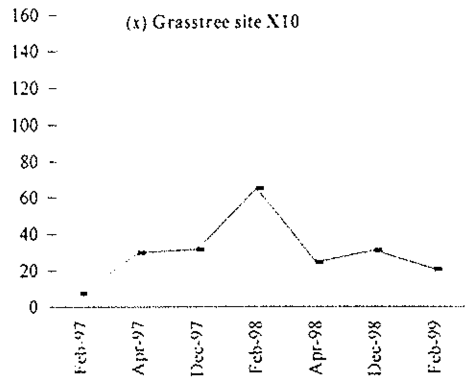


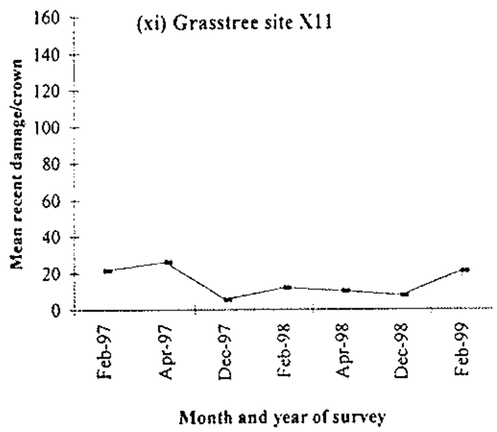
Appendix 11 (cont). Mean number of recently damaged fronds per crown at each sites in the Trapping area.

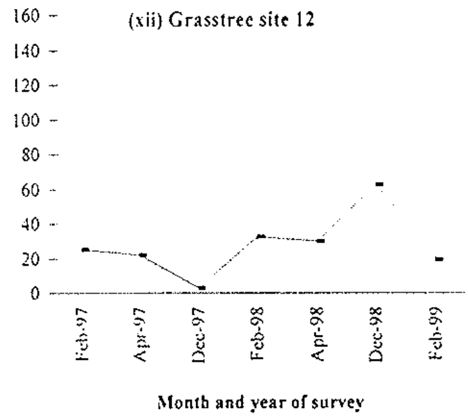




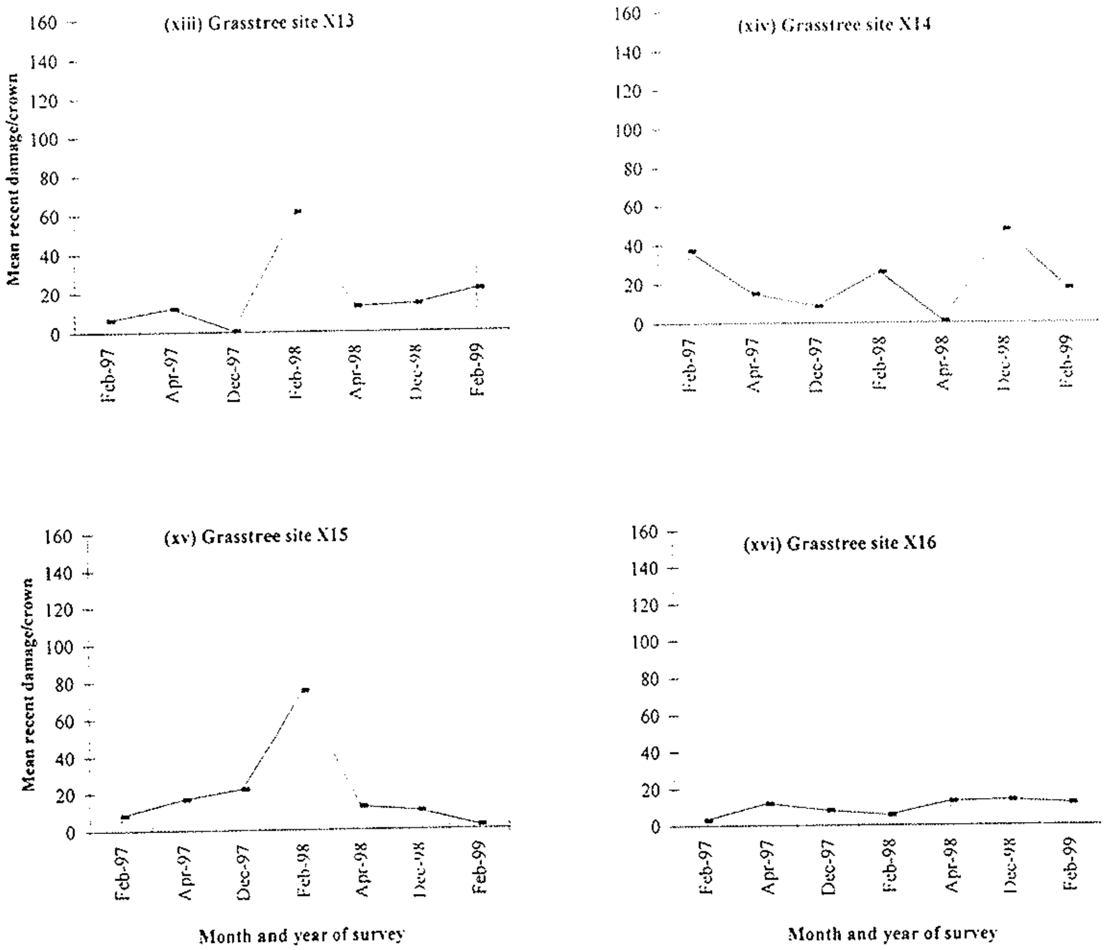




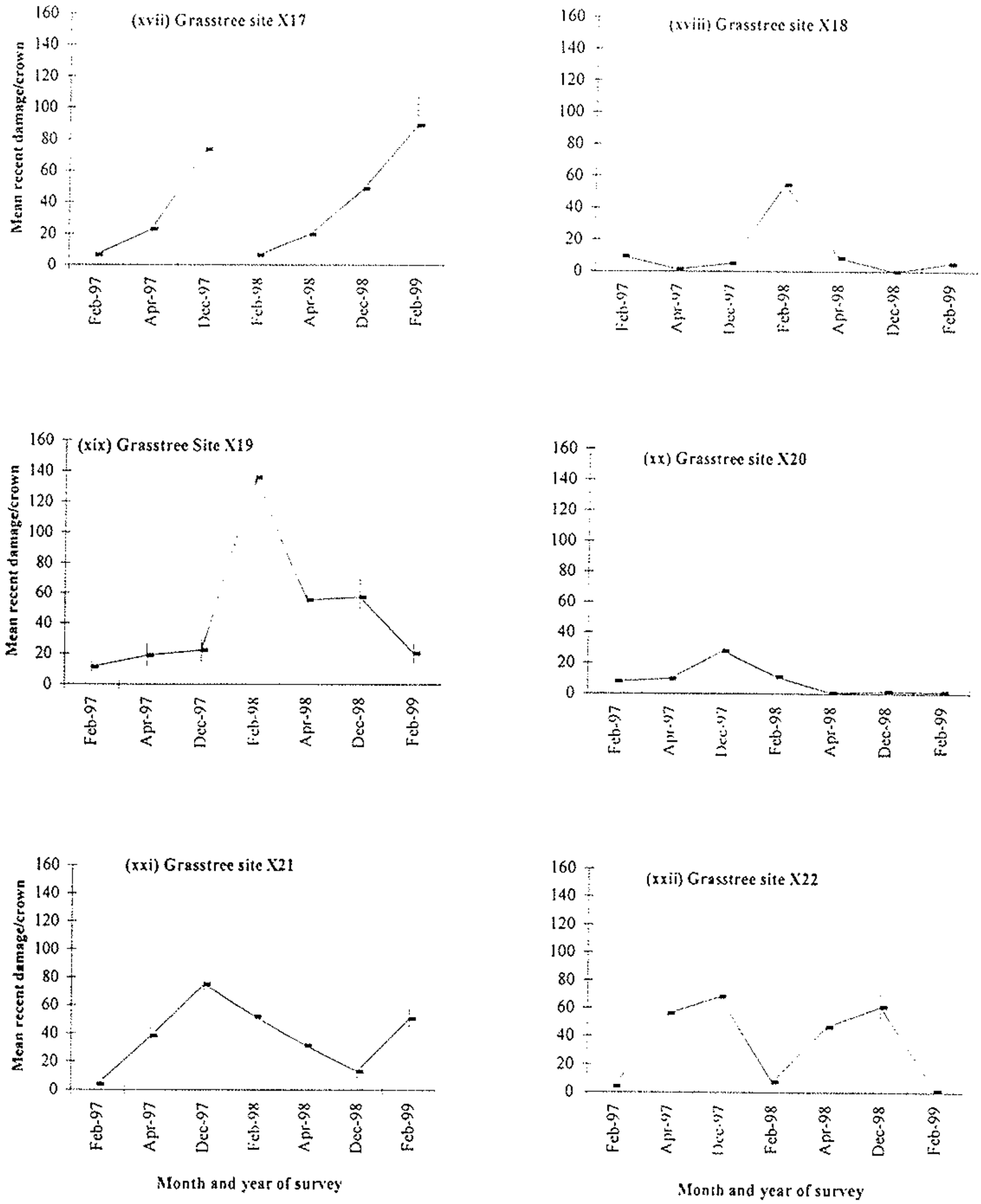




Appendix 11 (cont). Mean number of recently damaged fronds per crown at each sites in the Trapping area.



Appendix 11 (cont). Mean number of recently damaged fronds per crown at each sites in the NW Control area.



Appendix 12 Comparing proportional changes between pre- and post-trapping surveys at individual sites in the SE Control, Trapping and NW Control areas. Proportional changes were given as the Log ratio of mean index of crown damage. If trapping had an effect, by reducing damage levels, then Trapping sites (7 - 16) would be expected to have values < 0.