PAUL G. ARMSTRONG
AND ASSOCIATES
CONSULTANT BOTANIST

*Native Flora Specialist and Ecologist*

14 DOWNER WAY, BULL CREEK,
WESTERN AUSTRALIA, 6149
PHONE - FAX (08) 9310 4473
0408 104473.

# CUT FLOWER HARVESTING TRIAL ON *BORONIA PURDIEANA*

# FINAL REPORT

For

WILDLIFE BRANCH

CONSERVATION AND LAND MANAGEMENT

AUGUST 1999

# PAUL G. ARMSTRONG AND ASSOCIATES
## CONSULTANT BOTANIST
*Native Flora Specialist and Ecologist*
**14 DOWNER WAY, BULL CREEK, WESTERN AUSTRALIA, 6149**
**PHONE/FAX (08) 9310 4473**


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Liesl Rohl
Flora Industry Botanist
Wildlife Branch
Department of Conservation and Land Management
Locked Bag 104
Bentley Delivery Centre WA 6983

Dear Liesl,

Please find enclosed the report titled "CUT FLOWER HARVESTING TRIAL ON *BORONIA PURDIEANA*: Final report" for Wildlife Branch of Department of CALM.

Should you need any material in the report explained or have any queries please contact me for clarification.

Yours sincerely

Paul G. Armstrong
Botanist

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# CUT FLOWER HARVESTING TRIAL OF *BORONIA PURDIEANA*

# FINAL REPORT

## 1 INTRODUCTION

The endemic Western Australian flora species *Boronia purdieana* has been commercially harvested, for the cut flower industry, from wild populations for several years. Populations from which it has been collected are small in size and restricted in distribution. Fears have been raised that the harvesting can not be supported long term because of the limited regeneration capacity of the species.

This investigation was initiated in an attempt to determine the regeneration capacities of the species under commercial harvesting conditions. Two natural populations were used for the trials, both located to the north-east of Wanneroo town site. Five treatments were tested, to determine the likely impacts of different harvesting techniques.

The investigation was initially set-up in August 1998 when the plants would normally be commercially harvested. Then, in October 1998 initial signs of regeneration were recorded. The third and final site inspection was conducted 3 August 1999 to record long-term impacts of harvesting and regeneration.

This report presents the findings of all three site visits. This includes the setting up of the trial, the first and second monitoring periods for signs of regeneration and an analysis of the findings.

## 2 METHODOLOGY AND LIMITATIONS OF SURVEY

Two locations were proposed for the harvesting trial. These were:

- Site 1. – Intersection of R.A.A.F. Boundary Road and High Hill Road, the southern portion ; and
- Site 2. – Located between Quicke Road and Payne Road, north of Lot 130 CALM pine plantation, to the west of the fire break.

Site 1. was selected as it was on land not accessible to commercial pickers, being R.A.A.F. property. Site 2. has been proposed for vesting as a Nature Reserve and would not be available to commercial pickers.

The last fire to occur in the areas, as rerecorded by CALM maps was 1994 for Site 1. and 1995 for Site 2. These fire ages were distinctly reflected in the size (height) of the *Boronia purdieana.* With Site 1. most plants were greater than 30 cm tall, in the range of 40 to 50 cm. Whereas Site 2. most plants were in the order of 25 to 35 cm and single stemmed.

Five treatments were proposed for the trial, to replicate different picking techniques. Each to be replicated 50 times. These were:

- Treatment 1 – harvest stems 1 cm above ground, no leaves left on plant;
- Treatment 2 - harvest stems approximately 10 cm above ground, below any leaves;
- Treatment 3 - harvest stems approximately 10-15 cm above ground, ensuring approximately 4 to 6 leaves remained;
- Treatment 4 – harvest 20% of plant, ie 1 in 4 or 5 stems; and
- Treatment 5 – harvest 50% of plant.

In all Treatments only commercially harvestable stems were selected from healthy plants. The minimum length for a stem was 30 cm, with a preference of 40 to 50 cm lengths. Also, as Site 2. had been proposed for a Nature Reserve, only 25% of *Boronia purdieana* plants observed were harvested.

Each plant harvested was tagged securely (with wire) but not to restrict growth. This was to allow for later location and identification. Data collected for each plant in August 1998 before harvesting was:

- height to first leaf;
- height to first stem;
- height of plant;
- number of harvestable stems;
- length of stems;
- height of cut for Treatments 2 and 3;
- condition of plant; and
- location details.

On advice from Liesal Rohl (pers comm.) only Treatment 1 was sampled to the initial sample size of 50. This was done with the intention of replicating the abundance of the larger plants in the collection area. See Table 1. for actual numbers of the replications of the other Treatments.

GPS location details recorded on 7th and 10th of August were obtained on a Magellan Trailblazer XL (CALM No 405/227). Additional any adjacent significant objects were noted. However, when charting these locations on an x-y plot, it was found the coordinates were not reliable. Consequently on the 11th August, in addition to the GPS locations, a compass bearing was taken to previously recorded plant and flagging tape was used.

On the 26th October 1998, plants were initially searched for using the GPS coordinates recorded in August 1998. Due to the resolution of the GPS used (25m referred to in the handbook) and the size of the plants, a few centimetres, the method was futile. Based on memory and repeatedly walking over the area, as many plants as possible were relocated. This method was applied to Treatments 1, 4 and 5. Relocation of tagged plants was 46%, 38% and 41% respectively

For Treatments 2 and 3, rather than use the GPS coordinates, the compass bearings and flagging tape were used to relocate the tagged plants. This method worked well, relocating 97% and 90% of the marked plants respectively.

On the 3 August, 1999 the Treatments 1, 4 and 5 were again searched for by looking for the tagged plants. Four persons undertook this for approximately three hours. Relocation of the tagged plants was 60%, 61% and 70% respectively. For Treatments 2 and 3 the same method used in 1998 was again used, resulting in the relocation of 97% and 80% respectively. Difficulties encountered in relocating the plants was the increased post-fire regrowth, the increased number of fallen shrubs and the increased leaf litter all contributing to restrict visibility.

Conditions of the relocated plants were recorded in October 1998 and August 1999 for evidence of regrowth. Four conditions were recognised for this:

- Dead – the stem did not bend for Treatments 1, 2 and 3 or the plant was obviously dead for Treatments 4 and 5;
- No new growth – the stem did bend for Treatments 1, 2 and 3 but no new growth evident. Treatments 4 and 5 only exhibited old growth;
- Plant unhealthy – obvious signs dying off; and
- Regenerating – obvious signs of new growth below the cut. Length and amount of new growth was recorded.

# 3 RESULTS OF SURVEY

## 3.1 FIELD OBSERVATIONS

At Site 1. approximately 150 plants were observed, of those 36 were single stem (Treatment 1), 13 were four or five stem (or more) suitable for Treatment 4, 27 were two or three stems and suitable for Treatment 5. Of the remainder, ten plants had recently (1998) been harvested (presumably illegally) and the rest were too small (less than 30 cm) or located in inaccessible/inappropriate locations.

At Site 2. all plants were single stem and only suitable for Treatments 1, 2 or 3.

Table 1. lists the details of the numbers of plants relocated and their condition, dead, unhealthy, no new growth or regenerating for the two monitoring periods. Also see Appendix I for field results.

**Table 1.**

**Numbers of *Boronia purdieana* plants initially harvesting, in August 1998 and the numbers of plants and percentage survival rates of those relocated in October 1998 and August 99. New growth and regeneration (regen) refer to that below the harvesting cut**

| Treatment | Location | Initial sample size | October 1998 | | | | August 1999 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Number relocated | Dead | No new growth | Regen | Number relocated | Dead | Unhealthy | No new growth | Regen |
| T1. | Site 1. | 36 | 17 | 18% | 71% | 24% | 20 | 100% | 0% | 0% | 0% |
| | Site 2. | 14 | 4 | 25% | 75% | 0% | 7 | 86% | 0% | 0% | 14% |
| | Combined | 50 | 21 | 19% | 71% | 19% | 30 | 97% | 0% | 0% | 3% |
| T2. | Site 2. | 40 | 39 | 3% | 10% | 87% | 39 | 51% | 0% | 0% | 49% |
| T3. | Site 2. | 40 | 36 | 0% | 14% | 86% | 32 | 9% | 0% | 0% | 91% |
| T4. | Site 1. | 13 | 5 | 0% | 100% | 0% | 8 | 0% | 25% | 50% | 25% |
| T5 | Site 1. | 27 | 11 | 0% | 64% | 36% | 19 | 21% | 16% | 37% | 26% |

The vegetation of both Sites, using Muir's coding (Muir 1977 and see Appendix II), could be described as: An upper stratum of Low Forest 5 to 8 m tall dominated by *Banksia attenuata* and occasional *Banksia menziesii* and *Eucalyptus todtiana*. The second stratum was Open Scrub 2 to 3 m tall dominated by *Macrozamia riedlei*, over Low Scrub B 1 to 1.5 m tall dominated by *Acacia pulchella*. The understorey was Low Heath D to 0.5 m tall with no species dominating. In the upper stratum at Site 1. *Eucalyptus todtiana* was more common and *Banksia menziesii* at Site 2.

## 3.2 REGENERATION AND HEALTH OF PLANTS

Treatment 1 was undertaken at both sites with similar results being recorded, that most of the relocated plants were dead (97%). Of the four plants that were regenerating in 1998 three were relocated in 1999, all were dead. Only one regenerating plant was located in 1999. This was at Site 2. and was in good health although not flowering.

Treatment 2 initially had a low death rate and a high recovery rate (87%). This initial regeneration occurred along the entire length of the existing stem. Numbers of new growth stems varied between two to ten and a length of 5 mm to 60 mm, all regenerating plants were in good health. However, by August 1999 51% of the plants were dead (97.5% of trial relocated). Those surviving had stems on stems two to ten stems and a length of 50 mm to 150 mm long, these included nine plants in flower.

Treatment 3 initially and long term, had a low death and a high recovery rate. Regeneration occurred along the entire length of the remaining main stem and along the smaller branches retained. In October 1998 the numbers of new growth stems varied between five to 20 and occasionally 30, and a length of 20 mm to 150 mm. All regenerating plants were in good health. This high survival and growth rates continued for the 1999 survey, with four to 20 regenerating stems 50 mm to 200 mm in length. Of those surviving 96.5% were in flower, although too small for harvesting.

Treatment 4 initially showed no signs of regeneration below the cut stem or on the main stem of the plant. All relocated plants were in good health. Subsequently in 1999 it was found that only 25% (two plants) were regenerating from the base and 50% still showed no signs of

regeneration. However, the remaining two plants were both very unhealthy, and were unlikely to survive past the nest summer.

Treatment 5 initially experienced a moderately high rate of no regeneration. Of those that were regenerating, below the cut, the new growth was restricted to the main stem, with one or two stems 10 mm to 20 mm long. All relocated plants, except one were in good health. This plant was obviously almost dead. In 1999 the regenerating population had reduced in numbers with two plant in flower. Dead and unhealthy plant numbers had increased, largely due to the deaths of the no regeneration plants.

## 3.3 OTHER SIGNIFICANT FLORA

In both years *Conostephium minus* was observed growing at Site 2. It has is listed by Atkins (1998) as a Priority 4 taxa. Approximately 20 to 30 plants were observed during the study.

# 4 CONCLUSIONS

From both the preliminary and final survey findings it would appear that the species *Boronia purdieana* is under some threat from commercial activities as it does not regenerate well from most harvesting techniques. The following summary lists the findings.

Treatment 1, where the plant was harvested within 1 cm of the ground, 97% of the plants were killed. This technique of harvesting should be actively discouraged.

Treatment 2, where the plants were harvested at approximately 10 cm above ground and no leaves retained, experienced only a moderate level of regeneration, with more deaths than survivors. This technique of harvesting should be actively discouraged.

Treatment 3 was similar to Treatment 2 but with retained leaves, the regeneration was much stronger (91% survival) with a greater number and longer new stems. Most of the surviving plants were in flower in 1999. This technique was the only one with acceptable levels of regeneration following harvesting.

Treatment 4, multi stemmed plants with 20-25% of stems removed, showed minimal of regeneration with only one plant in flower. However most of the remainder still showed no signs of regeneration or were unhealthy, although none had died. This technique of harvesting should be actively discouraged.

Treatment 5, multi stemmed plants 50% of stems removed, showed minimal signs of regeneration with only two plants in flower. However, most of the remainder still showed no signs of regeneration or were unhealthy to dead. This technique of harvesting should be actively discouraged.

From these findings it would appear that Treatment 3 produced the only strong regeneration. The other Treatments resulted in low to minimal levels of regeneration and greatly increased the mortality of the harvested plants.

The down side of using Treatment 3 was the impact of reduced seed production of a harvested population. Although seed production was not treated specifically in the study, this impact on the population was considered potential negative. Following a Treatment 3 harvesting a plant will produce virtually no for at least two years, due to the lack canopy. Full seed production would likely take several more years to achieve, to allow for the plant canopy to recover to a moderate size. Depending on the longevity of the species, the inter-fire periodicity and the actual time to recover, this seed loss may account for a significant proportion of the population/individual seed production. Also unknown is the longevity of the seed in the soil. If the soil-stored seed were short-lived (two years say) and a fire occurred two years after a harvesting, the population could be severely impacted.

All other harvesting methods result in increased mortality of the harvested plants. Hence these have not been recommended.

The use of a Magellan Trailblazer XL GPS to relocate small plants in a moderately well vegetated area was demonstrated to be very ineffective and totally unworkable. Errors recorded between the two sets of readings (August and October 1998) varied between 65m and 156m. Part of the reason for these high errors was the GPS was only working in 2 dimensional navigation.

## 5 REFERENCES

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Green, J. W. (1985). *Census of the Vascular Plants of Western Australia*. Dept Agriculture: Perth, West. Aust.

Muir, B. G. (1977). Biological Survey of the Western Australian Wheatbelt. Part 2: Vegetation and Habitat of Bendering Reserve. *Rec. West. Aust. Mus. Suppl. No.3*. West. Aust. Museum: Perth, West. Aust.

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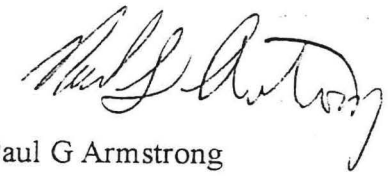

Paul G Armstrong
Consultant Botanist
4 August, 1999

# APPENDIX I

## FIELD DATA OF HARVESTING TRIAL ON *BORONIA PURDIEANA*

The GPS location recorded for the plants has not been included, as they serve no practical use.

# APPENDIX I

## FIELD DATA OF HARVESTING TRIAL ON *BORONIA PURDIEANA*

**Data recorded in the field for the survey. Plant GPS locations were omitted as they serve no useful purpose. In the regeneration column the first number refers to the number of new growth stems and the remainder the length.**

Abbreviations – NF not found; NNG no new growth.

| No | H to 1 leaf | H to 1 branch | H of plant | No stems | L of stems | Location and back bearings | October-98 | August-99 |
|---|---|---|---|---|---|---|---|---|
| 1/01 | 230 | 150 | 510 | 1 | | | NNG | DEAD |
| 1/02 | 150 | 30 | 360 | 1 | | | NNG | DEAD |
| 1/03 | 50 | 50 | 390 | 1 | | | NF | NF |
| 1/04 | 160 | 80 | 350 | 1 | | | NNG | NF |
| 1/05 | 210 | 200 | 450 | 1 | | | NF | NF |
| 1/06 | 70 | 150 | 400 | 1 | | | NNG | DEAD |
| 1/07 | 100 | 120 | 350 | 1 | | | NNG | DEAD |
| 1/08 | 40 | 20 | 350 | 1 | | | NNG | NF |
| 1/09 | 220 | 180 | 400 | 1 | | | NF | NF |
| 1/10 | 80 | 20 | 300 | 1 | | | NF | DEAD |
| 1/11 | 130 | 120 | 310 | 1 | | | 1 x 10mm | DEAD |
| 1/12 | 160 | 100 | 500 | 1 | | | NNG | DEAD |
| 1/13 | 150 | 0 | 360 | 2 | | adj 1/14 | NNG | DEAD |

| No | H to 1 leaf | H to 1 branch | H of plant | No stems | L of stems | Location and back bearings | October-98 | August-99 |
|---|---|---|---|---|---|---|---|---|
| 1/14 | 200 | 100 | 400 | 1 | | adj 1/13 | NNG | NF |
| 1/15 | 140 | 80 | 430 | 1 | | in Et | DEAD | DEAD |
| 1/16 | 80 | 120 | 360 | 1 | | in Bank | NNG | DEAD |
| 1/17 | 120 | 180 | 380 | 1 | | in Bank | NNG | DEAD |
| 1/18 | 20 | 100 | 530 | 1 | | | NNG | NF |
| 1/19 | 100 | 70 | 360 | 1 | | adj 5/13 | NF | NF |
| 1/20 | 260 | 230 | 400 | 1 | | adj 1/21 | DEAD | DEAD |
| 1/21 | 100 | 100 | 360 | 1 | | adj 1/20 | 2 x 5mm | DEAD |
| 1/22 | 100 | 0 | 340 | 1 | | adj 1/23 | 6 x 20mm | NF |
| 1/23 | 250 | 230 | 450 | 1 | | adj 1/22 | 5 x 20mm | DEAD |
| 1/24 | 100 | 20 | 300 | 1 | | track 1.5m | NF | NF |
| 1/25 | 160 | 30 | 300 | 1 | | | NF | DEAD |
| 1/26 | 150 | 100 | 360 | 1 | | | NNG | DEAD |
| 1/27 | 160 | 250 | 460 | 1 | | | NF | NF |
| 1/28 | 120 | 80 | 400 | 1 | | | NF | DEAD |
| 1/29 | 220 | 200 | 400 | 1 | | adj dead Bank | NF | NF |
| 1/30 | 400 | 380 | 600 | 1 | | adj 5/19 | NF | DEAD |
| 1/31 | 330 | 330 | 500 | 1 | | | NF | DEAD |
| 1/32 | 160 | 160 | 430 | 1 | | | NF | DEAD |
| 1/33 | 220 | 250 | 450 | 1 | | | DEAD | DEAD |
| 1/34 | 50 | 40 | 360 | 1 | | adj 5/23 | NF | DEAD |
| 1/35 | 50 | 10 | 320 | 1 | | 2m to 1/34 | NF | DEAD |
| 1/36 | 100 | 100 | 400 | 1 | | adj 5/25 under B att | NF | NF |
| 1/37 | 70 | 60 | 450 | 1 | | | NF | NF |

| No | H to 1 leaf | H to 1 branch | H of plant | No stems | L of stems | Location and back bearings | October-98 | August-99 |
|---|---|---|---|---|---|---|---|---|
| 1/38 | 10 | 60 | 340 | 1 | | | NF | NF |
| 1/39 | 90 | 120 | 390 | 1 | | | NF | NF |
| 1/40 | 60 | 50 | 370 | 1 | | | NF | NF |
| 1/41 | 40 | 40 | 220 | 1 | | | NF | DEAD |
| 1/42 | 30 | 20 | 300 | 1 | | | NF | DEAD |
| 1/43 | 30 | 20 | 160 | 1 | | close to track | NNG | NF |
| 1/44 | 40 | 30 | 210 | 1 | | under B att | NNG | DEAD |
| 1/45 | 30 | 15 | 200 | 1 | | under B att | NNG | DEAD |
| 1/46 | 30 | 30 | 180 | 1 | | | DEAD | DEAD |
| 1/47 | 80 | 50 | 300 | 1 | | adj B men | NF | 8 X 150 |
| 1/48 | 50 | 30 | 300 | 1 | | adj B att | NF | NF |
| 1/49 | 40 | 10 | 300 | 1 | | adj Macro | NF | NF |
| 1/50 | 40 | 30 | 400 | 1 | | | NF | DEAD |
| 2/01 | 70 | 50 | 240 | 1 | 70 | | 3 x 10-30mm | DEAD |
| 2/02 | 20 | 10 | 360 | 1 | 90 | 230 | 3 x 10-30mm | DEAD |
| 2/03 | 40 | 20 | 240 | 1 | 100 | 185 under Batt | 3 x 10-30mm | DEAD |
| 2/04 | 80 | 30 | 380 | 1 | 100 | close | DEAD | DEAD |
| 2/05 | 80 | 40 | 260 | 1 | 80 | 155 adj 2/6 | 6 x 20mm | DEAD |
| 2/06 | 50 | 150 | 250 | 1 | 100 | adj 2/5 | 6 x 20mm | 10 X 50 |
| 2/07 | 50 | 30 | 300 | 1 | 100 | 240 adj batt | 3 x 5mm | DEAD |
| 2/08 | 120 | 90 | 300 | 1 | 100 | 162 adj batt | 1 x 5mm | DEAD |
| 2/09 | 50 | 20 | 250 | 1 | 100 | 185 adj Macroz | NNG | DEAD |
| 2/10 | 80 | 40 | 250 | 1 | 100 | 0.2m away | 1 x 2mm | DEAD |
| 2/11 | 120 | 240 | 380 | 1 | 100 | 124 | 4 x 10mm | 6 X 100 |

| No | H to 1 leaf | H to 1 branch | H of plant | No stems | L of stems | Location and back bearings | October-98 | August-99 |
|---|---|---|---|---|---|---|---|---|
| 2/12 | 140 | 130 | 390 | 1 | 100 | 114 adj Apull | 10 x 30-50mm | 20 X 200 F |
| 2/13 | 90 | 110 | 300 | 1 | 100 | 198 adj batt | 10 x 10mm | 10 X 150 F |
| 2/14 | 100 | 30 | 300 | 1 | 100 | 190 to 2/12 | 6 x 20mm | NF |
| 2/15 | 70 | 50 | 300 | 1 | 100 | 209 | 8 x 30-100mm | 10 X 150 F |
| 2/16 | 50 | 40 | 250 | 1 | 100 | 140 | 5 x 5mm | 16 X 100 |
| 2/17 | 60 | 80 | 250 | 1 | 100 | 218 adj bmen | 5 x 20mm | 6 X 100 |
| 2/18 | 120 | 30 | 300 | 1 | 100 | 153 | 1 x 1mm | DEAD |
| 2/19 | 60 | 30 | 300 | 1 | 100 | other side of same bush adj Jacksonia florib | 10 x 20-40mm | 10 X 150 F |
| 2/20 | 40 | 30 | 250 | 1 | 100 | 185 adj b.att | 10 x 40-60mm | 10 X 100 |
| 2/21 | 70 | 110 | 300 | 1 | 100 | 225 adj b.menz | 6 x 40-60mm | 2 X 50 |
| 2/22 | 50 | 30 | 250 | 1 | 100 | adj batt | NF | 10 X 50 |
| 2/23 | 70 | 30 | 300 | 1 | 100 | 206 | NNG | DEAD |
| 2/24 | 180 | 120 | 570 | 1 | 100 | 70 adj batt | 6 x 20-40mm | DEAD |
| 2/25 | 150 | 120 | 400 | 1 | 100 | 129 | NNG | DEAD |
| 2/26 | 70 | 150 | 280 | 1 | 100 | 1m away | 6 x 20-40mm | 2 X 200 |
| 2/27 | 100 | 10 | 380 | 1 | 100 | 100 to blue flag on blind track | 6 x 5-20mm | 3 X 50 |
| 2/28 | 100 | 20 | 250 | 1 | 100 | adj 3/27 | 10 x 20-40mm | 6 X 150 F |
| 2/29 | 120 | 190 | 350 | 1 | 100 | 345 adj b.menz | 2 x 5-10 | DEAD |
| 2/30 | 60 | 30 | 250 | 1 | 100 | 40 adj b.menz | NNG | DEAD |
| 2/31 | 70 | 200 | 360 | 1 | 100 | 330 in acacia | 4 x 5-10mm | 2 X 50 F |
| 2/32 | 140 | 30 | 300 | 1 | 100 | adj 3/31 | 1 x 2mm | DEAD |
| 2/33 | 40 | 180 | 300 | 1 | 100 | 295 under b.att | 4 x 10-20mm | DEAD |
| 2/34 | 40 | 200 | 320 | 1 | 100 | 330 adj b.att | 4 x 10-20mm | DEAD |
| 2/35 | 40 | 120 | 300 | 1 | 100 | 59 adj b.att | 10 x 40-80mm | 1 X 200 F |

| No | H to 1 leaf | H to 1 branch | H of plant | No stems | L of stems | Location and back bearings | October-98 | August-99 |
|---|---|---|---|---|---|---|---|---|
| 2/36 | 40 | 90 | 380 | 1 | 100 | 30 adj b.att/macroz | 15 x 40-80mm | 12 X 150 F |
| 2/37 | 100 | 60 | 300 | 1 | 100 | adj 2/36 | 10 x 10-30mm | 12 X 150 F |
| 2/38 | 100 | 160 | 300 | 1 | 100 | 356 under b.att | 3 x 5-20mm | 5 X 100 F |
| 2/39 | 50 | 30 | 300 | 1 | 100 | 0 under mel.scab | 3 x 5mm | DEAD |
| 2/40 | 30 | 20 | 250 | 1 | 100 | 0 near acacia | 5 x 5mm | DEAD |
| 3/01 | 70 | 170 | 380 | 1 | 100 | 220 to 2/26 adj b.att | 20 x 20-50mm | NF |
| 3/02 | 60 | 50 | 300 | 1 | 100 | 150 | 10 x 50-100mm | NF |
| 3/03 | 120 | 60 | 330 | 1 | 100 | 193 adj dead adenanthos | NNG | 15 X 200 F |
| 3/04 | 130 | 70 | 450 | 1 | 100 | 169 | NF | 20 X 200 F |
| 3/05 | 100 | 200 | 420 | 1 | 100 | adj 3/4 | NF | NF |
| 3/06 | 60 | 90 | 340 | 1 | 100 | 185 under b.att | 10 x 80mm | NF |
| 3/07 | 80 | 50 | 300 | 1 | 100 | adj 3/7 | 10 x 50mm | NF |
| 3/08 | 60 | 20 | 300 | 1 | 100 | 90 | 15 x 50mm | NF |
| 3/09 | 100 | 60 | 300 | 1 | 100 | 167 adj b.att | 6 x 50-80mm | 20 X 200 F |
| 3/10 | 100 | 60 | 450 | 1 | 100 | 119 | NNG | DEAD |
| 3/11 | 30 | 150 | 300 | 1 | 100 | adj 3/10 | 6 x 20mm | 4 X 50 F |
| 3/12 | 70 | 150 | 300 | 1 | 100 | 115 | 7 x 50mm | 6 X 100 F |
| 3/13 | 20 | 30 | 450 | 1 | 100 | 273 | 5 x 50mm | 20 X 200 F |
| 3/14 | 30 | 20 | 300 | 1 | 100 | 85 | 20 x 50-100mm | 4 X 50 F |
| 3/15 | 40 | 30 | 300 | 1 | 100 | 252 | NF | NF |
| 3/16 | 40 | 30 | 300 | 1 | 100 | 202 adj b.att | 15 x 30-80mm | 15 X 200 F |
| 3/17 | 150 | 0 | 300 | 1 | 100 | 298 | 20 x 30-80mm | 16 X 200 F |
| 3/18 | 50 | 30 | 250 | 1 | 100 | 194 adj b.att | 6 x 20-50mm | 10 X 150 F |
| 3/19 | 70 | 280 | 500 | 1 | 100 | 310 under b.att | 15 x 50-100mm | 15 X 150 F |

| No | H to 1 leaf | H to 1 branch | H of plant | No stems | L of stems | Location and back bearings | October-98 | August-99 |
|---|---|---|---|---|---|---|---|---|
| 3/20 | 50 | 30 | 300 | 1 | 100 | 2m away 3/19 | NNG | 10 X 100 F |
| 3/21 | 170 | 100 | 400 | 1 | 100 | 295 adj b.att | 15 x 30-100mm | 15 X 200 F |
| 3/22 | 10 | 10 | 300 | 1 | 100 | 218 under b.att | NNG | 10 X 100 F |
| 3/23 | 10 | 10 | 420 | 1 | 100 | 205 edge of wood heap on track | 30 x 100-150mm | 10 X 200 F |
| 3/24 | 20 | 10 | 250 | 1 | 100 | 110 adj b.att | 5 x 20-50mm | 10 X 150 F |
| 3/25 | 70 | 70 | 300 | 1 | 100 | 162 adj adenanthos | 5 x 20-50mm | NF |
| 3/26 | 10 | 20 | 300 | 1 | 100 | 126 adj b.att | 8 x 50-100mm | 8 X 100 |
| 3/27 | 60 | 40 | 260 | 1 | 100 | 347 under b.menz | 2 x 10-20mm | DEAD |
| 3/28 | 40 | 40 | 300 | 1 | 100 | 320 1m from 2/28 | 4 x 20-40mm | 10 X 150 F |
| 3/29 | 100 | 160 | 400 | 1 | 100 | 50 adj b.menz | 10 x 40-80mm | 10 X 200 F |
| 3/30 | 60 | 50 | 250 | 1 | 100 | 30 adj b.att | 10 x 20-40mm | 10 X 100 F |
| 3/31 | 30 | 80 | 300 | 1 | 100 | 355 adj b.att | NNG | DEAD |
| 3/32 | 70 | 80 | 270 | 1 | 100 | 339 adj b.menz | 6 x 10-20mm | 6 X 120 F |
| 3/33 | 100 | 40 | 300 | 1 | 100 | 301 adj Jacksonia | 10 x 20-60mm | 6 X 120 F |
| 3/34 | 100 | 80 | 250 | 1 | 100 | 0 adj b.menz | 15 x 20-60mm | 10 X 200 F |
| 3/35 | 100 | 100 | 360 | 1 | 100 | 0 adj stirlingia | 10 x 20-80mm | 10 X 200 F |
| 3/37 | 40 | 180 | 300 | 1 | 100 | 3 adj b.att | 15 x 40-100mm | 12 X 150 F |
| 3/37 | 20 | 80 | 400 | 1 | 100 | 340 under macroz | 15 x 40-80mm | 15 X 100 F |
| 3/38 | 20 | 0 | 300 | 1 | 100 | 301 under b.menz | NF | 5 X 100 F |
| 3/39 | 10 | 0 | 250 | 1 | 100 | 310 near b.att | 20 x 20-40mm | 15 X 150 F |
| 3/40 | 40 | 10 | 300 | 1 | 100 | 21 near b.menz | 15 x 20-80mm | 15 X 150 F |
| 4/01 | 20 | 50 | 320 | 6 | 300 | | NF | NF |
| 4/02 | 100 | 10 | 480 | 5 | 300 | near dead bank | NNG | NF |
| 4/03 | 120 | 60 | 540 | 6 | 400 | | NF | NF |

| No | H to 1 leaf | H to 1 branch | H of plant | No stems | L of stems | Location and back bearings | October-98 | August-99 |
|---|---|---|---|---|---|---|---|---|
| 4/04 | 100 | 10 | 390 | 5 | 500 | | NF | NF |
| 4/05 | 80 | 10 | 320 | 4 | 320 | | NF | NF |
| 4/06 | 80 | 20 | 500 | 7 | 450 | | NNG | 5 X 200 F |
| 4/07 | 180 | 40 | 380 | 5 | 350 | | NF | NNG |
| 4/08 | 100 | 20 | 540 | 5 | 500 | | NF | NNG |
| 4/09 | 50 | 0 | 360 | 5 | 400 | adj 4/10 | NNG | NNG |
| 4/10 | 50 | 0 | 450 | 5 | 400 | adj 4/9 | NNG | SICK |
| 4/11 | 70 | 0 | 300 | 5 | 400 | under Et | NF | SICK |
| 4/12 | 50 | 10 | 400 | 4 | | adj log | NF | 4 X 150 |
| 4/13 | 50 | 10 | 360 | 10 | 360 | | NF | NNG |
| 5/01 | 40 | 40 | 500 | 2 | 370 | | NNG | NF |
| 5/02 | 110 | 90 | 480 | 3 | 400 | near log | 4 x 10mm | NNG |
| 5/03 | 230 | 50 | 570 | 4 | 440 | near E.t | NNG | NNG |
| 5/04 | 120 | 10 | 370 | 2 | 400 | | 1 x 10mm | NNG |
| 5/05 | 200 | 0 | 300 | 3 | 400 | | NF | 4 X 100 F |
| 5/06 | 90 | 10 | 400 | 3 | 400 | | NF | NNG |
| 5/07 | 10 | 0 | 370 | 2 | 330 | adj 5/8 | NF | NF |
| 5/08 | 20 | 10 | 380 | 2 | 320 | adj 5/7 | NF | SICK |
| 5/09 | 20 | 30 | 340 | 2 | 350 | adj 5/9 | NF | NNG |
| 5/10 | 30 | 0 | 350 | 2 | 350 | adj 5/10 | 1 x 20mm | 1 X 50 |
| 5/11 | 110 | 40 | 420 | 2 | 340 | | NNG | NF |
| 5/12 | 300 | 20 | 580 | 2 | 500 | adj 5/13 Health = 4 | NNG | NF |
| 5/13 | 200 | 40 | 580 | 3 | 300 | adj 1/19 + 5/12 | NNG | NF |
| 5/13 | 100 | 80 | 400 | 2 | 300 | | NF | NNG |

| No | H to 1 leaf | H to 1 branch | H of plant | No stems | L of stems | Location and back bearings | October-98 | August-99 |
|---|---|---|---|---|---|---|---|---|
| 5/14 | 160 | 50 | 430 | 2 | 340 | | NF | NNG |
| 5/15 | 220 | 130 | 420 | 2 | 320 | | NF | DEAD |
| 5/16 | 190 | 0 | 430 | 2 | 430 | | NF | DEAD |
| 5/18 | 100 | 50 | 480 | 3 | 600 | adj 5/19 | NF | NF |
| 5/19 | 220 | 50 | 400 | 2 | 450 | adj 5/18 + 1/30 | NF | 4 X 100 F |
| 5/20 | 100 | 0 | 330 | 2 | 400 | adj 5/21 | 2 x 5mm | SICK |
| 5/21 | 100 | 40 | 350 | 2 | 300 | adj 5/20 | NNG | SICK |
| 5/22 | 140 | 80 | 360 | 3 | 300 | | NF | NF |
| 5/23 | 110 | 70 | 360 | 3 | 340 | adj 1/34 under log | NNG | 2 X 150 |
| 5/24 | 140 | 30 | 360 | 2 | 300 | | NF | DEAD |
| 5/25 | 100 | 10 | 400 | 2 | 400 | 1m to 4/11 | NNG | DEAD |
| 5/26 | 100 | 20 | 630 | 2 | 600 | adj 1/36 adj B att | NF | 1 X 200 |
| 5/27 | 290 | 50 | 470 | 2 | 420 | | NF | NF |

# APPENDIX II

## VEGETATION CLASSIFICATION USED IN THE WHEATBELT SURVEY

(Extracted from Muir 1977)

# APPENDIX II - VEGETATION CLASSIFICATION USED IN WHEATBELT SURVEY

(Extracted from Muir 1977*)

| LIFE FORM/HEIGHT CLASS | CANOPY COVER | | | |
|---|---|---|---|---|
| | DENSE **d** 70-100% | MID-DENSE **c** 30-70% | SPARSE **i** 10-30% | VERY SPARSE **r** 2-10% |
| T Trees >30m | Dense Tall Forest | Tall Forest | Tall Woodland | Open Tall Woodland |
| M Trees 15-30m | Dense Forest | Forest | Woodland | Open Woodland |
| LA Trees 5-15m | Dense Low Forest A | Low Forest A | Low Woodland A | Open Low Woodland A |
| LB Trees <5m | Dense Low Forest B | Low Forest B | Low Woodland B | Open Low Woodland B |
| KT Mallee tree form | Dense Tree Mallee | Tree Mallee | Open Tree Mallee | Very Open Tree Mallee |
| KS Mallee shrub form | Dense Shrub Mallee | Shrub Mallee | Open Shrub Mallee | Very Open Shrub Mallee |
| S Shrubs >2m | Dense Thicket | Thicket | Scrub | Open Scrub |
| SA Shrubs 1.5-2.0m | Dense Heath A | Heath A | Low Scrub A | Open Low Scrub A |
| SE Shrubs 1 0-1.5m | Dense Heath B | Heath B | Low Scrub B | Open Low Scrub B |
| SC Shrubs 0.5-1.0m | Dense Low Heath C | Low Heath C | Dwarf Scrub C | Open Dwarf Scrub C |
| SD Shrubs 0.0-0.5m | Dense Low Heath D | Low Heath D | Dwarf Scrub D | Open Dwarf Scrub D |
| P Mat plants | Dense Mat Plants | Mat Plants | Open Mat Plants | Very Open Mat Plants |
| H Hummock Grass | Dense Hummock | Mid-Dense Hummock Grass | Hummock Grass | Open Hummock Grass |
| GT Bunch grass >0.5m | Dense Tall Grass | Tall Grass | Open Tall Grass | Very Open Tall Grass |
| GL Bunch grass<0.5m | Dense Low Grass | Low Grass | Open Low Grass | Very Open Low Grass |
| J Herbaceous spp. | Dense Herbs | Herbs | Open Herbs | Very Open Herbs |
| VT Sedges >0.5m | Dense Tall Sedges | Tall Sedges | Open Tall Sedges | Very Open Tall Sedges |
| VL Sedges <0.5m | Dense Low Sedges | Low Sedges | Open Low Sedges | Very Open Low Sedges |
| X Ferns | Dense Ferns | Ferns | Open Ferns | Very Open Ferns |
| Mosses, liverwort | Dense Mosses | Mosses | Open Mosses | Very Open Mosses |

Note: Muir, B.G. (1977). Biological Survey of the Western Australian Wheatbelt. Pt 2: Vegetation and Habitat of Bendering Reserve. Records of the Western Australian Museum. Suppl. No.3.