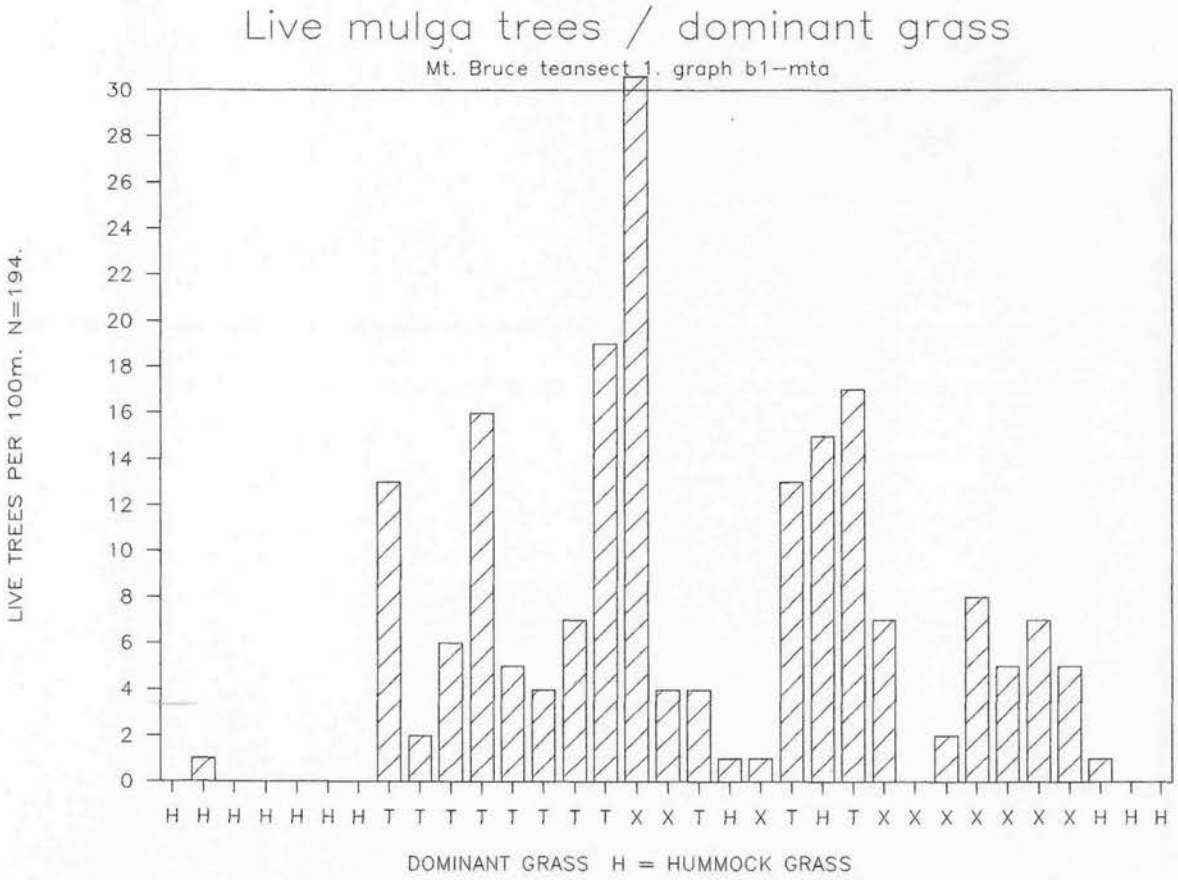
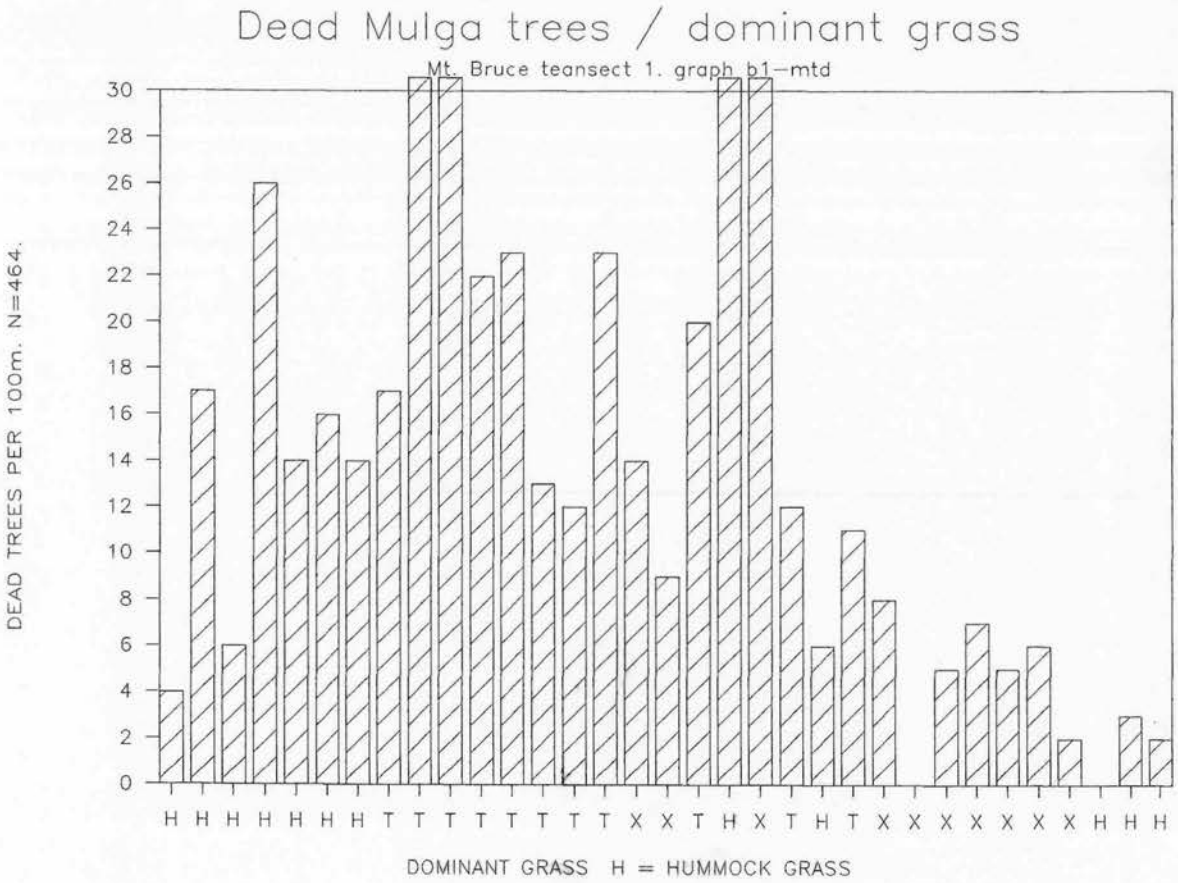
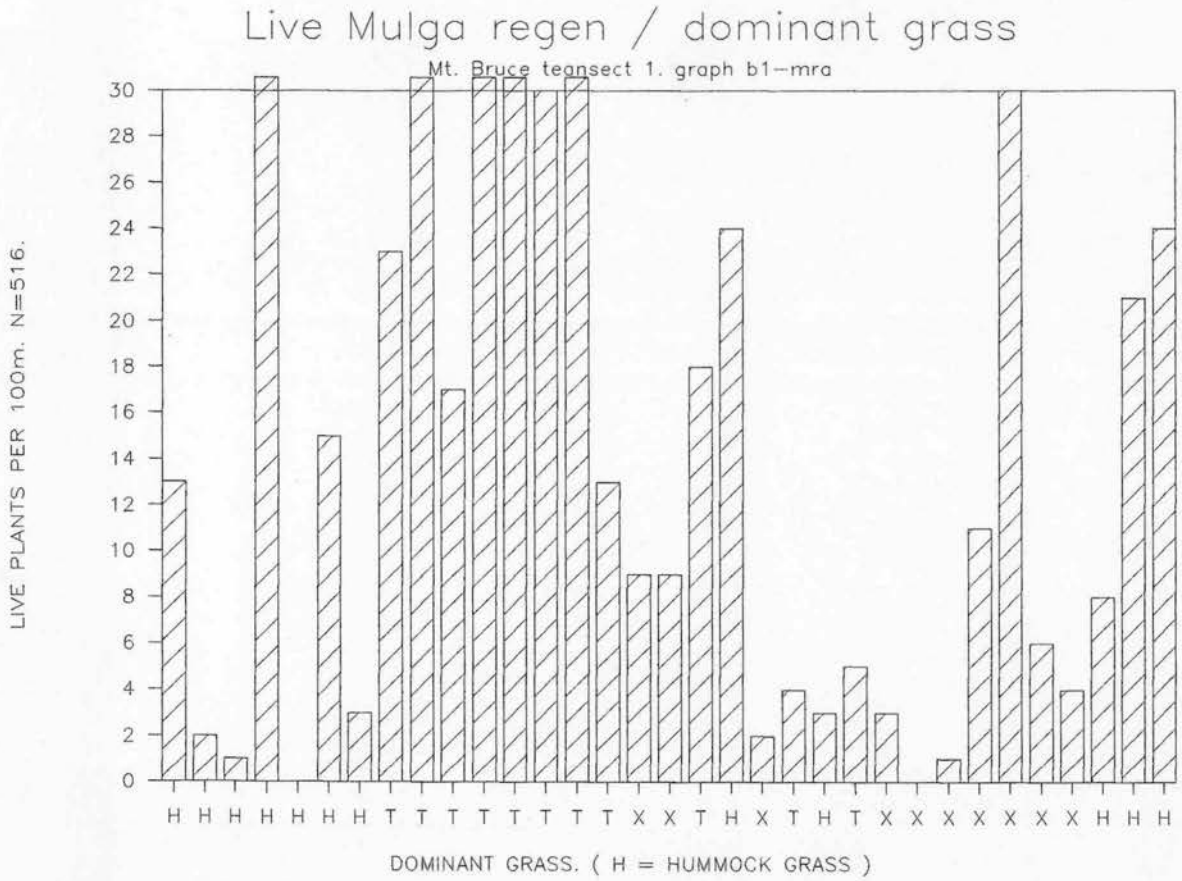
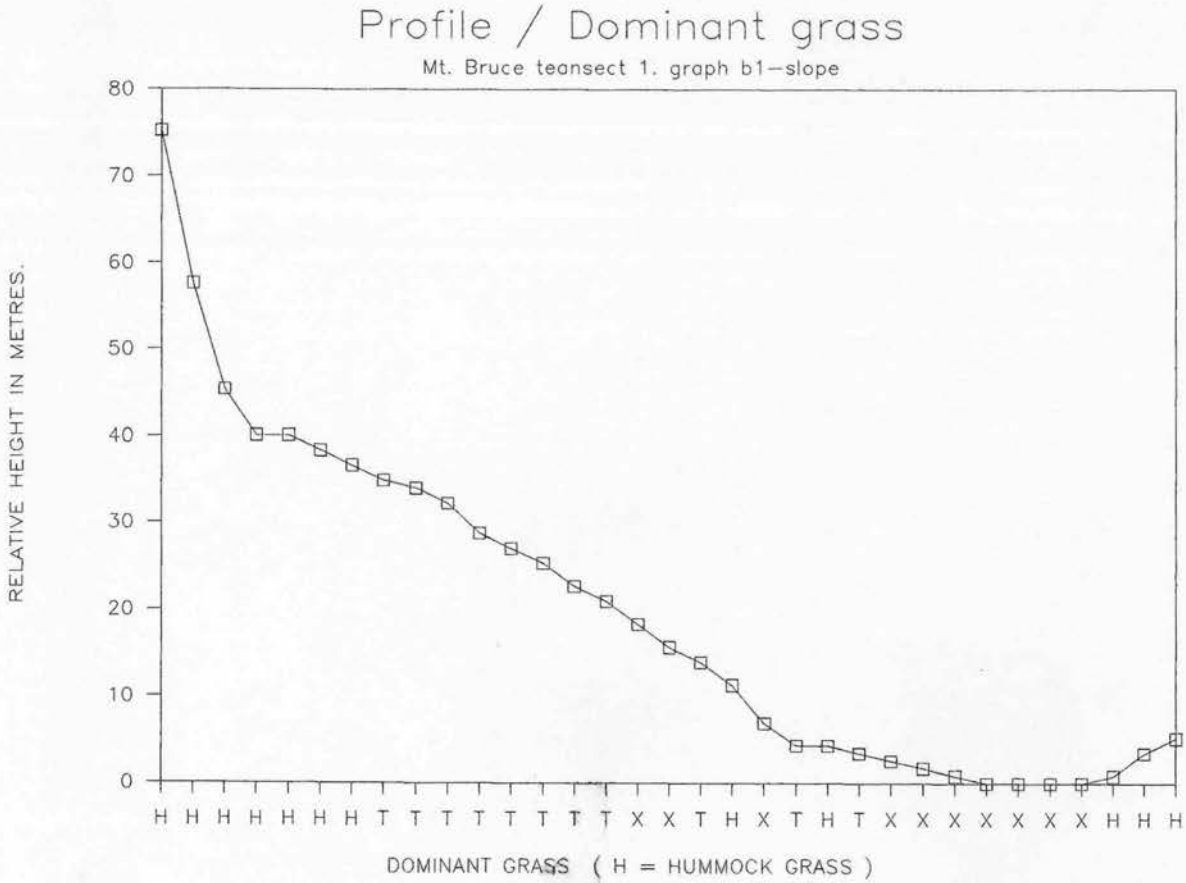
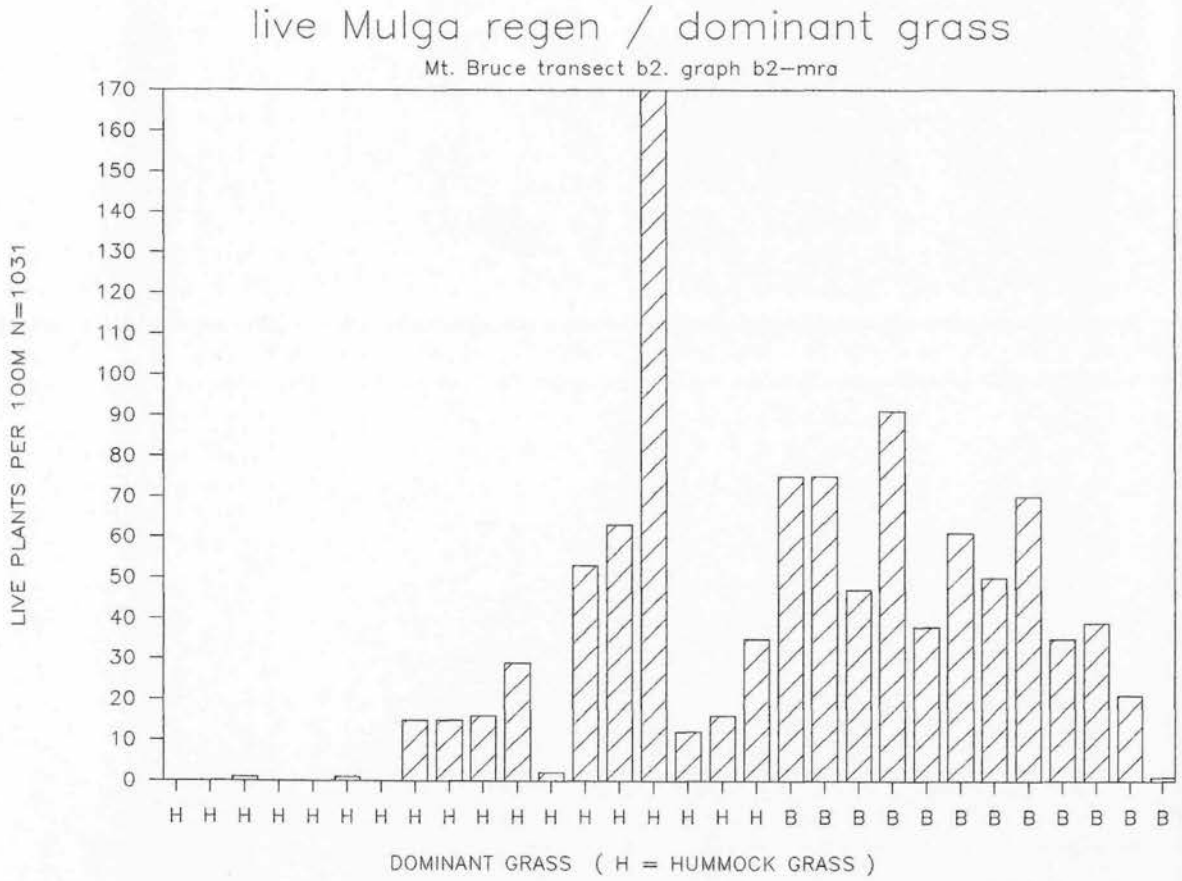
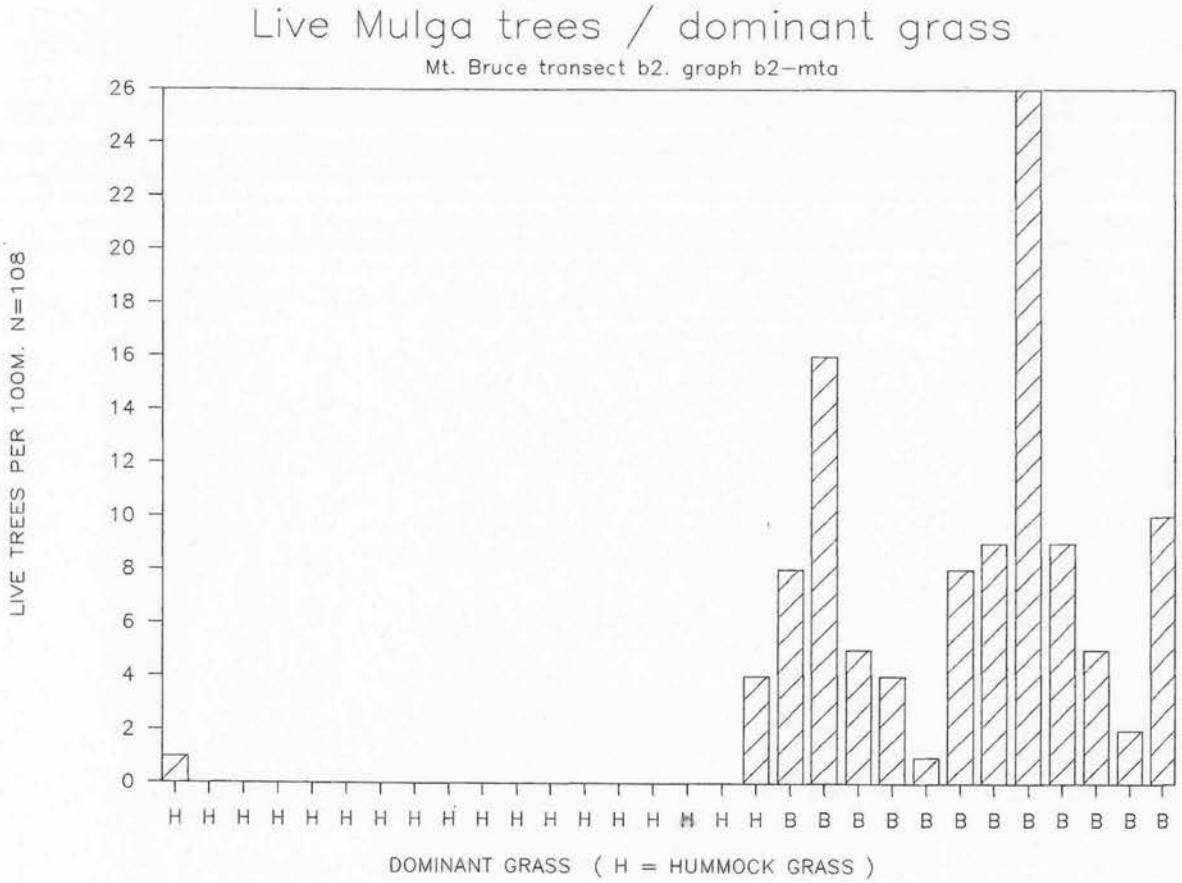

Live mulga trees / dominant grass
Mt. Bruce teansect 1. graph b1-mta
LIVE TREES PER 100m. N=194.
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
H H H H H H H T T T T T T T T X X T H X T H T X X X X X X X H H H
DOMINANT GRASS H = HUMMOCK GRASS

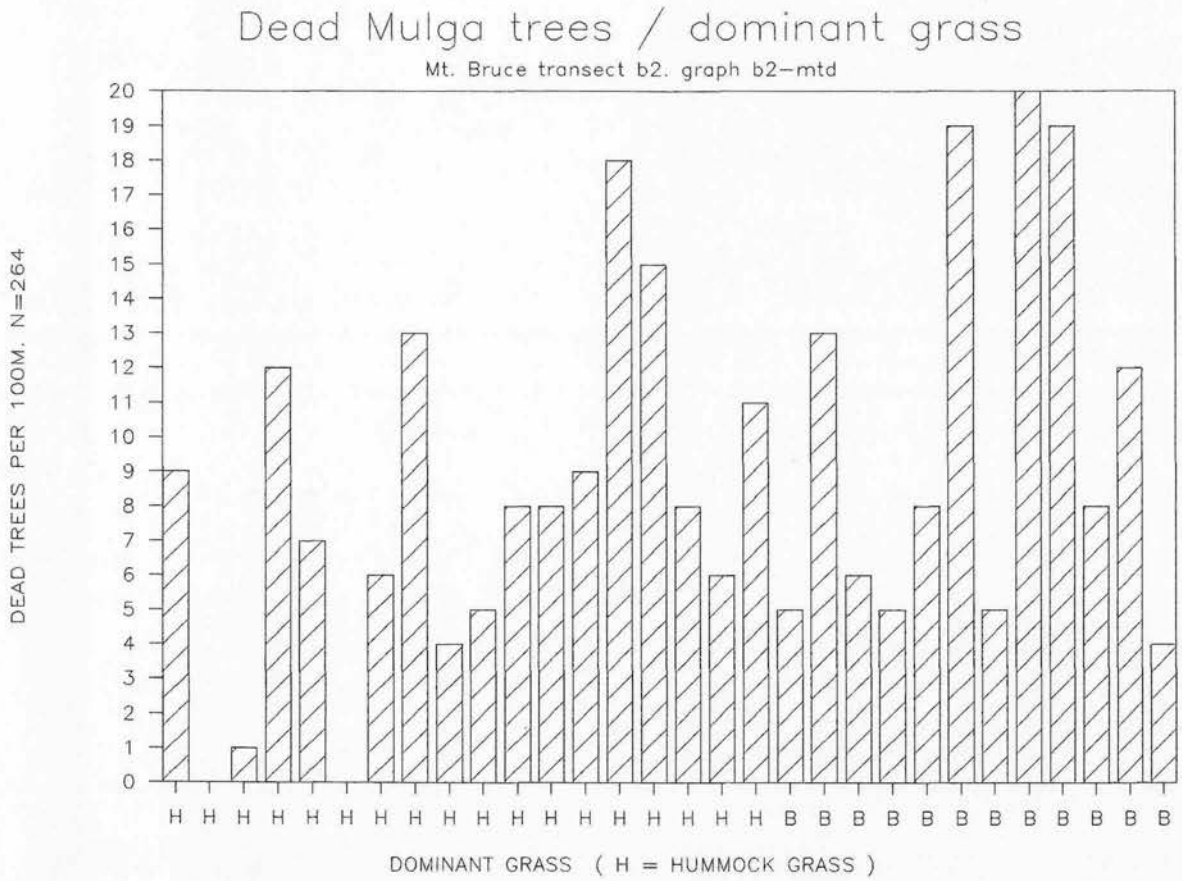

Dead Mulga trees / dominant grass
Mt. Bruce teansect 1. graph b1-mtd
DEAD TREES PER 100m. N=464.
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
H H H H H H H T T T T T T T T X X T H X T H T X X X X X X X H H H
DOMINANT GRASS H = HUMMOCK GRASS

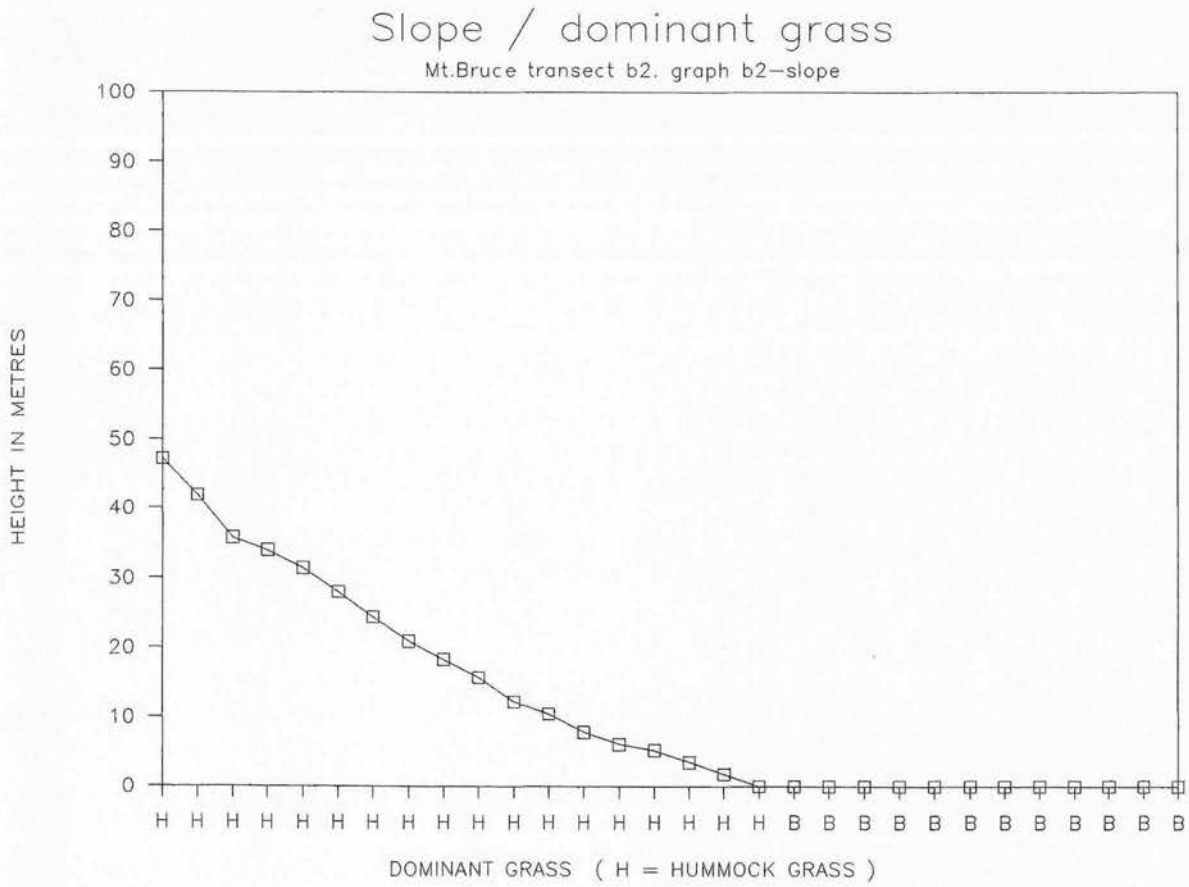

Live Mulga regen / dominant grass
Mt. Bruce teansect 1. graph b1-mra
LIVE PLANTS PER 100m. N=516.
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
H H H H H H H T T T T T T T T X X T H X T H T X X X X X X X H H H
DOMINANT GRASS. (H = HUMMOCK GRASS)

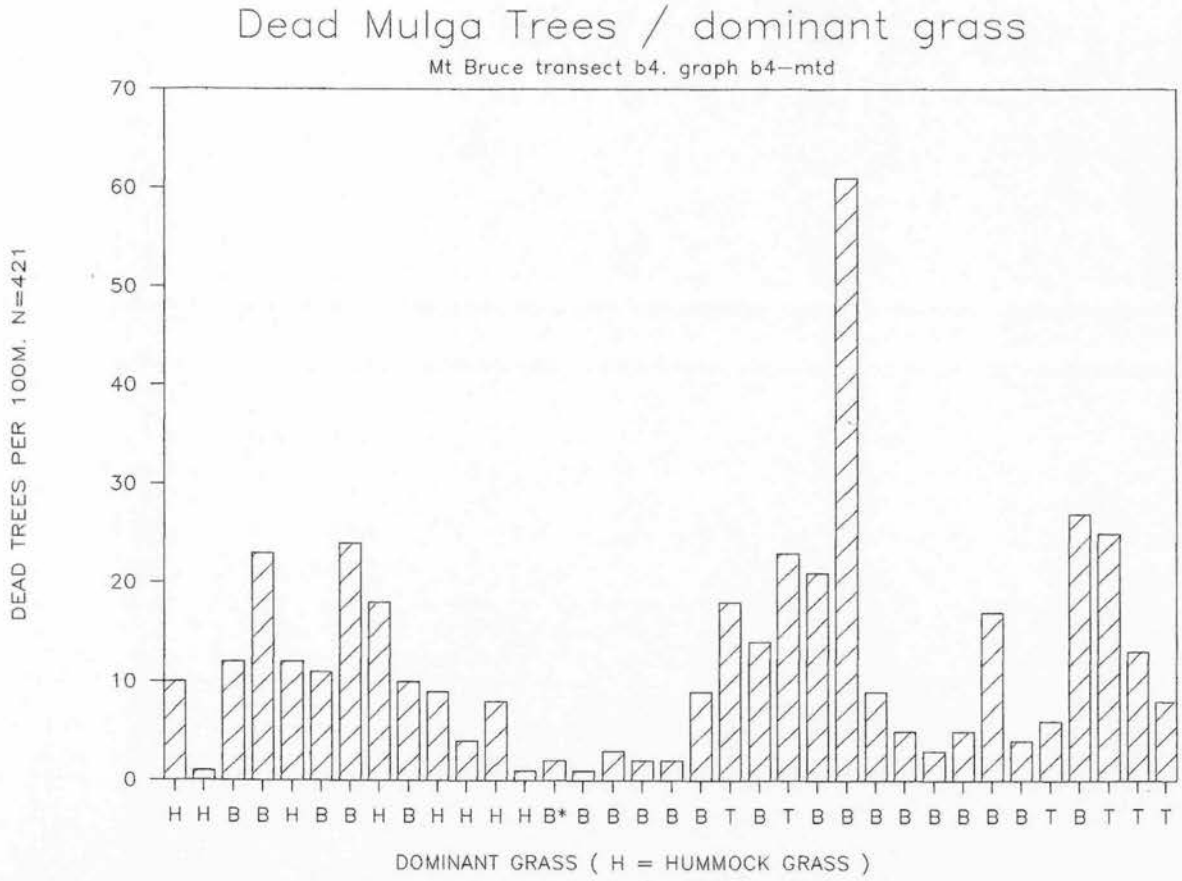

Profile / Dominant grass
Mt. Bruce teansect 1. graph b1-slope
RELATIVE HEIGHT IN METRES.
0
10
20
30
40
50
60
70
80
H H H H H H H T T T T T T T T X X T H X T H T X X X X X X X H H H
DOMINANT GRASS (H = HUMMOCK GRASS)

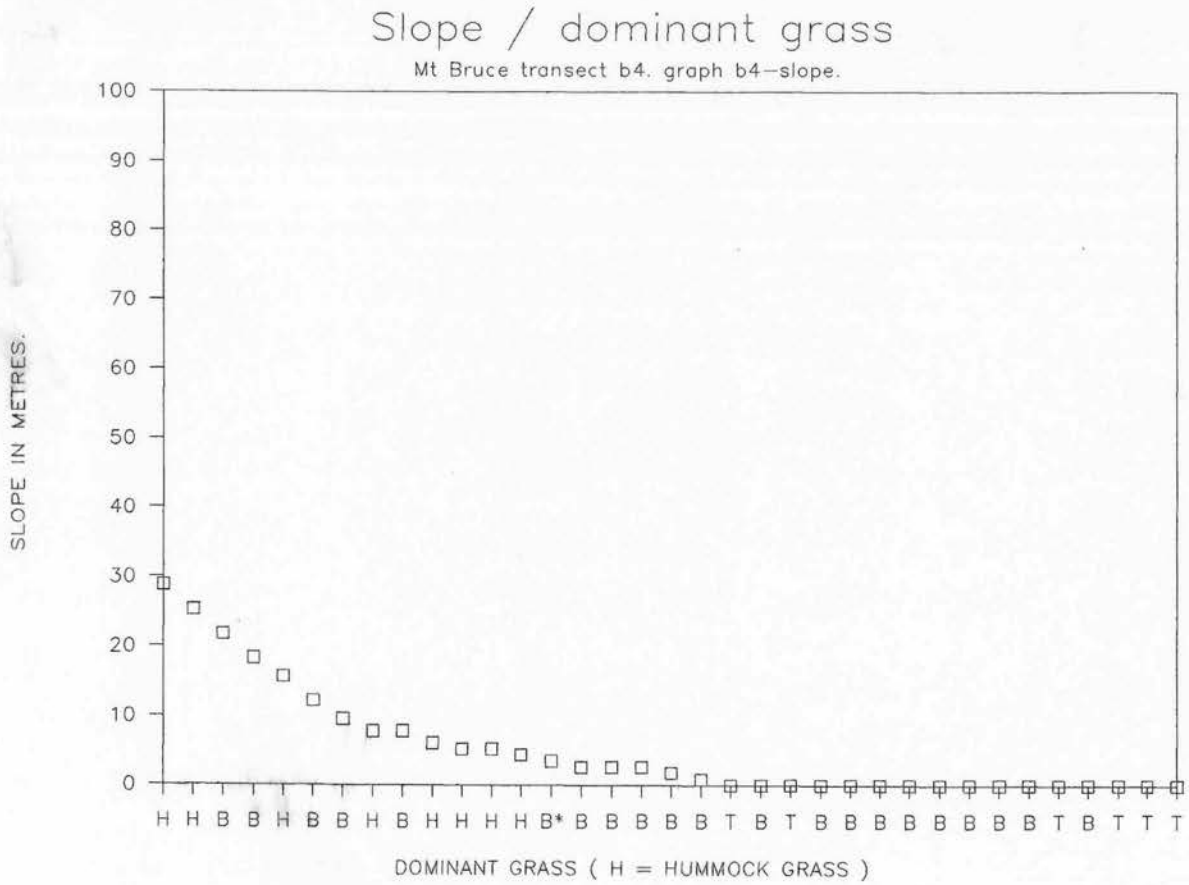

live Mulga regen / dominant grass
Mt. Bruce transect b2. graph b2-mra
LIVE PLANTS PER 100M N=1031
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
H H H H H H H H H H H H H H H H H H H B B B B B B B B B B B B
DOMINANT GRASS (H = HUMMOCK GRASS)

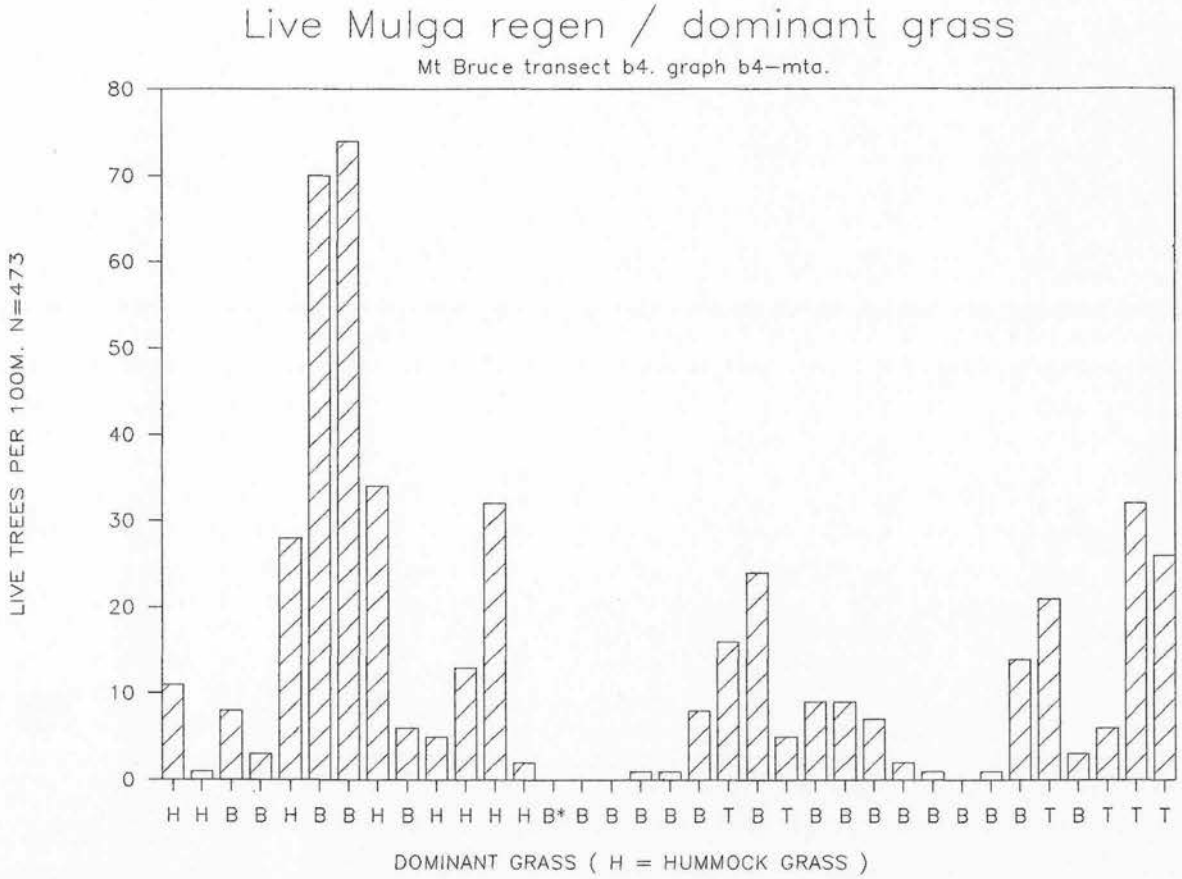

Live Mulga trees / dominant grass
Mt. Bruce transect b2. graph b2-mta
LIVE TREES PER 100M. N=108
0
2
4
6
8
10
12
14
16
18
20
22
24
26
H H H H H H H H H H H H H H H H H H H B B B B B B B B B B B B
DOMINANT GRASS (H = HUMMOCK GRASS)

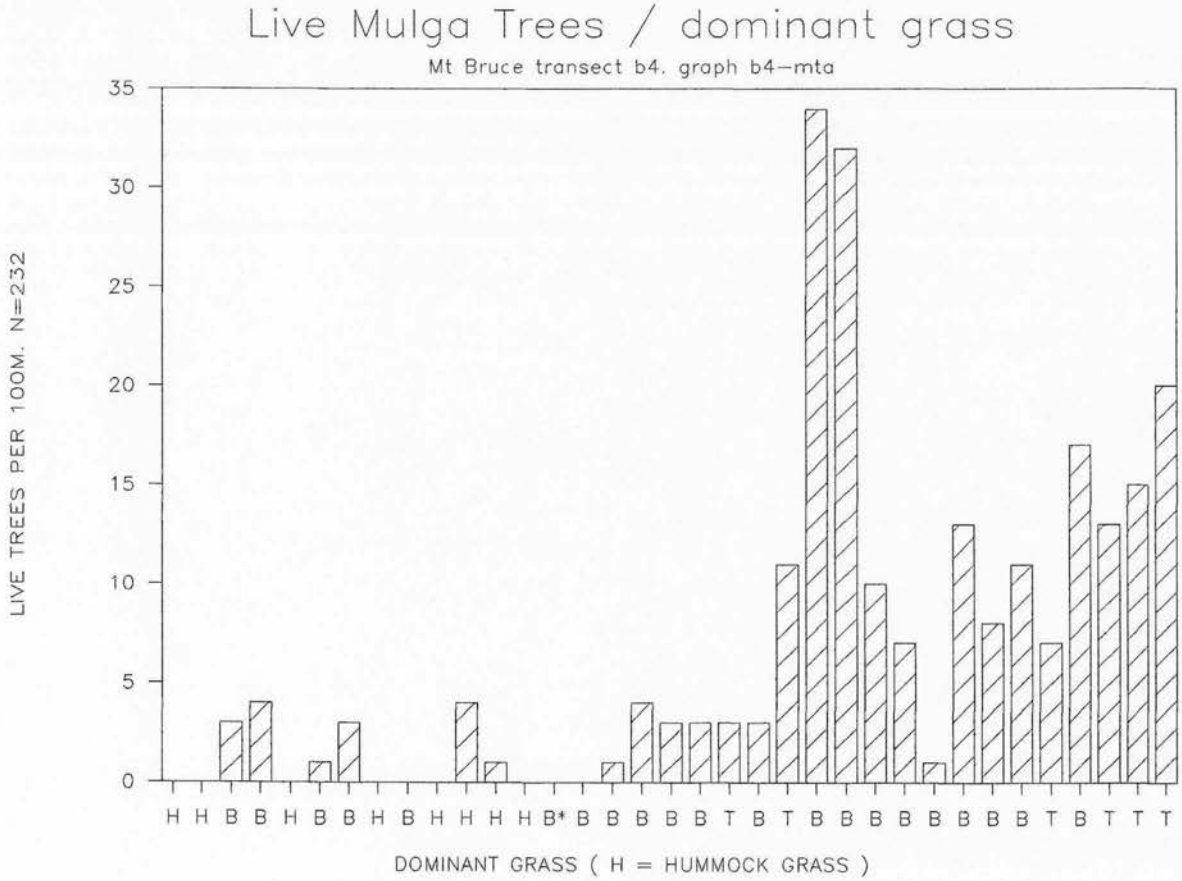

Dead Mulga trees / dominant grass
Mt. Bruce transect b2. graph b2-mtd
DEAD TREES PER 100M. N=264
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
H H H H H H H H H H H H H H H H H H H B B B B B B B B B B B B
DOMINANT GRASS (H = HUMMOCK GRASS)

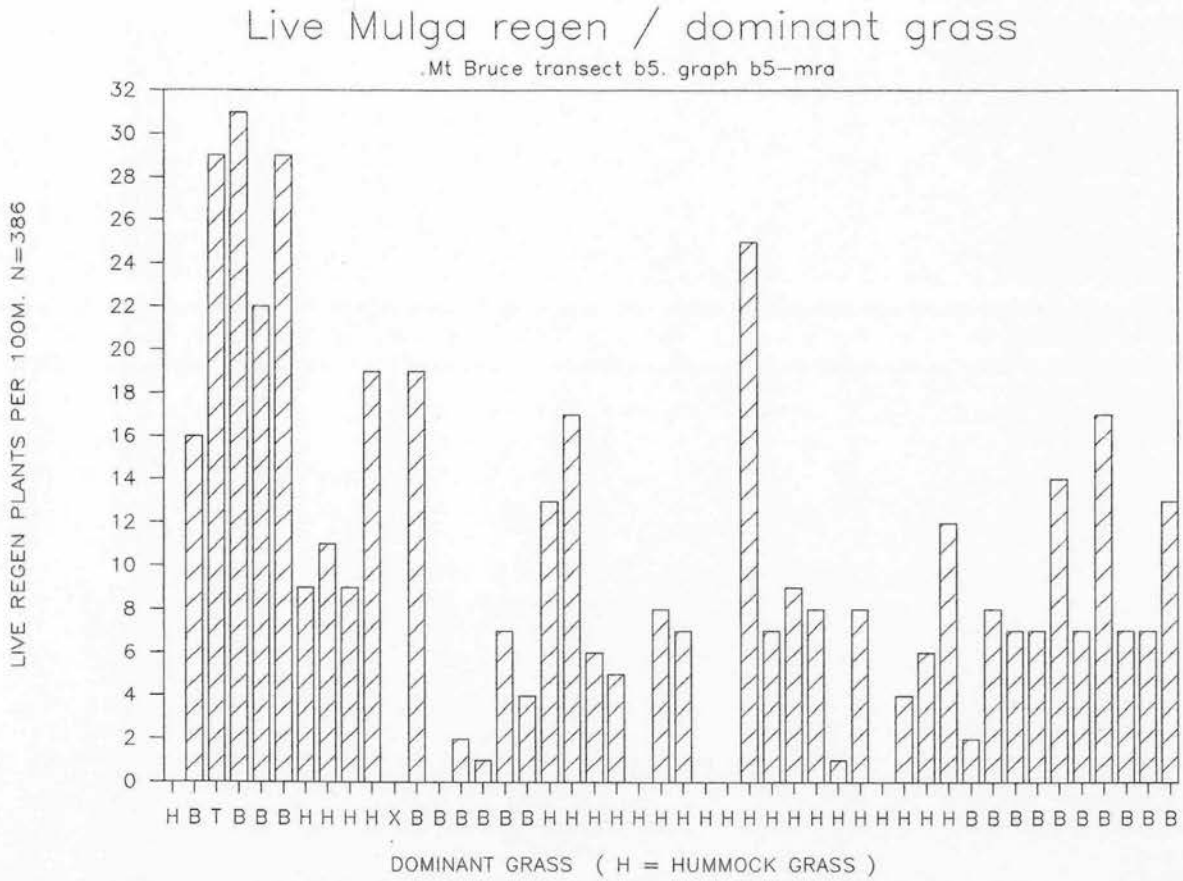

Slope / dominant grass
Mt.Bruce transect b2. graph b2-slope
HEIGHT IN METRES
0 10 20 30 40 50 60 70 80 90 100
H H H H H H H H H H H H H H H H H H H B B B B B B B B B B B B
DOMINANT GRASS (H = HUMMOCK GRASS)

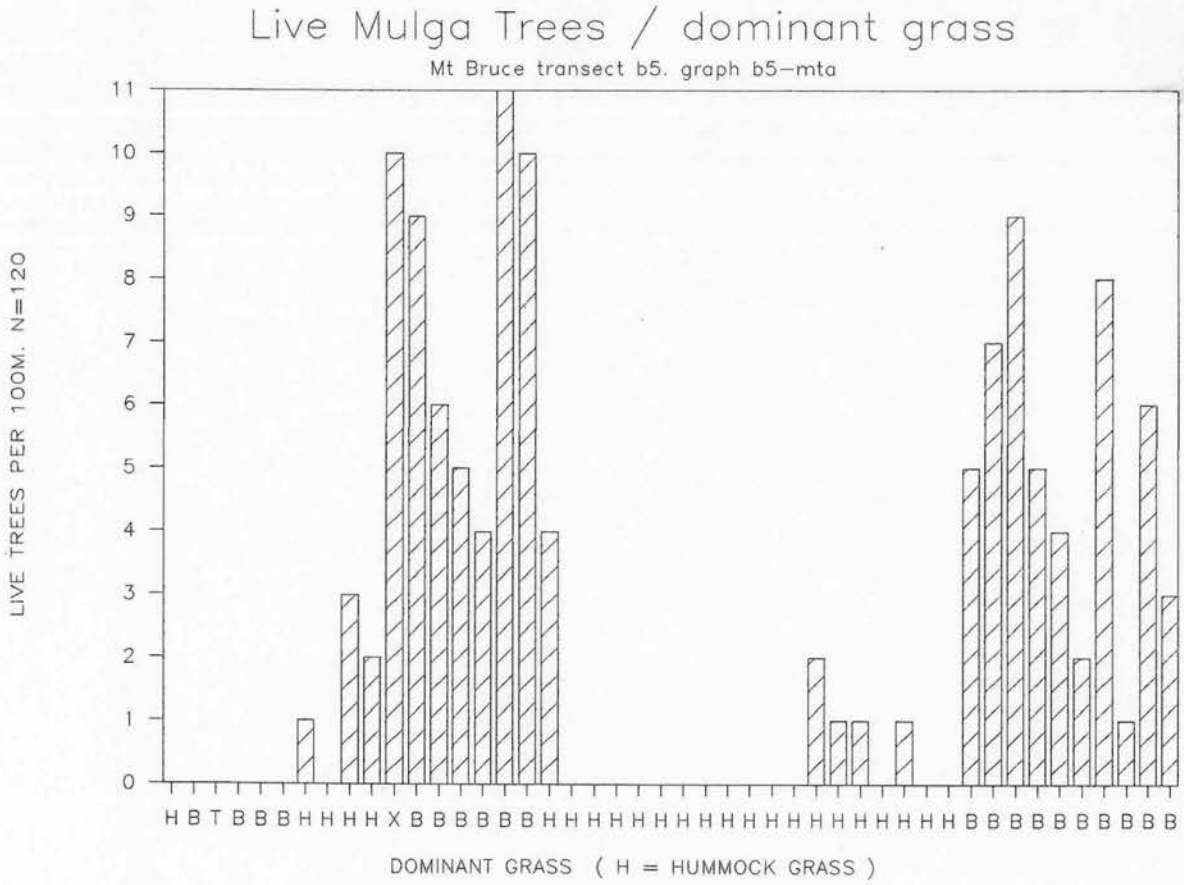

Dead Mulga Trees / dominant grass
Mt Bruce transect b4. graph b4-mtd
DEAD TREES PER 100M. N=421
0
10
20
30
40
50
60
70
H H B B H B B H B H H H H B* B B B B B T B T B B B B B B B B T B T T T
DOMINANT GRASS (H = HUMMOCK GRASS)

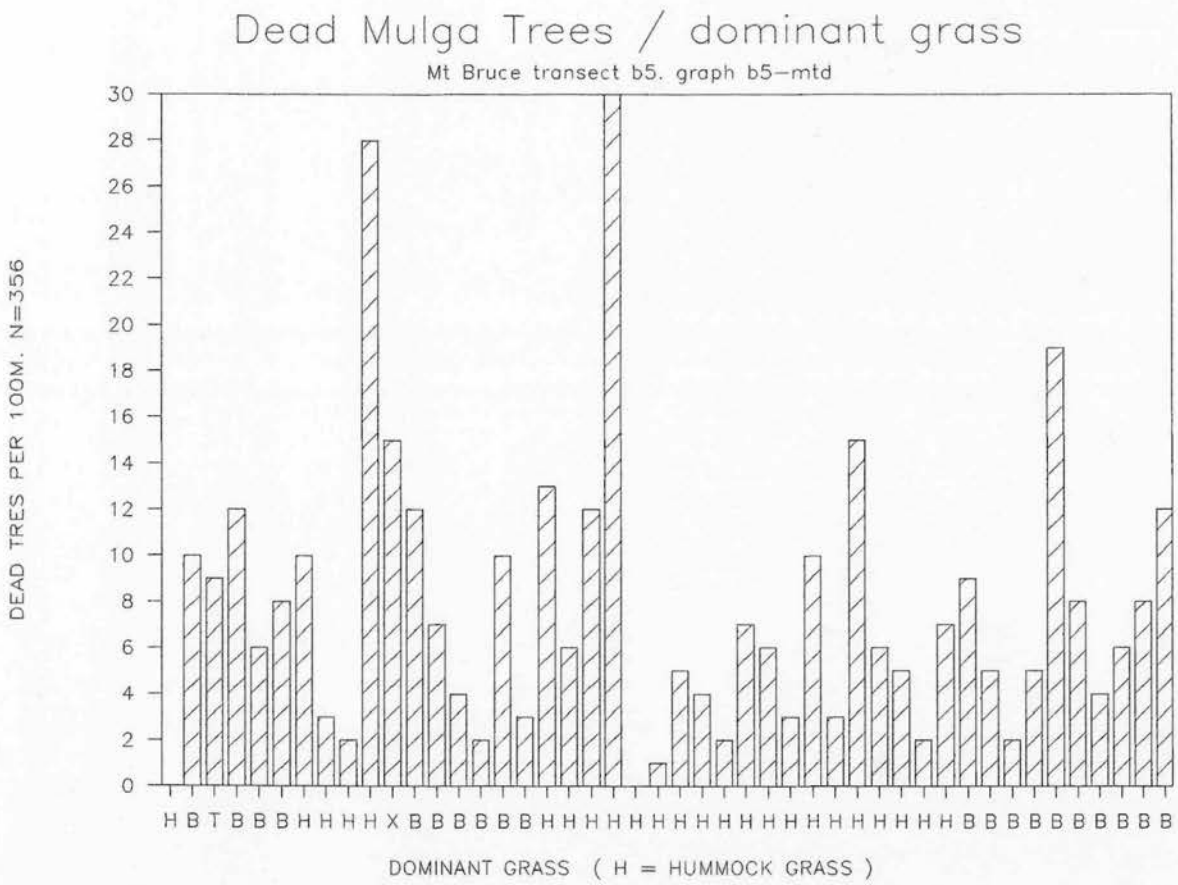

Slope / dominant grass
Mt Bruce transect b4. graph b4-slope.
SLOPE IN METRES.
0
10
20
30
40
50
60
70
80
90
100
H H B B H B B H B H H H H B* B B B B B T B T B B B B B B B B T B T T T
DOMINANT GRASS (H = HUMMOCK GRASS)

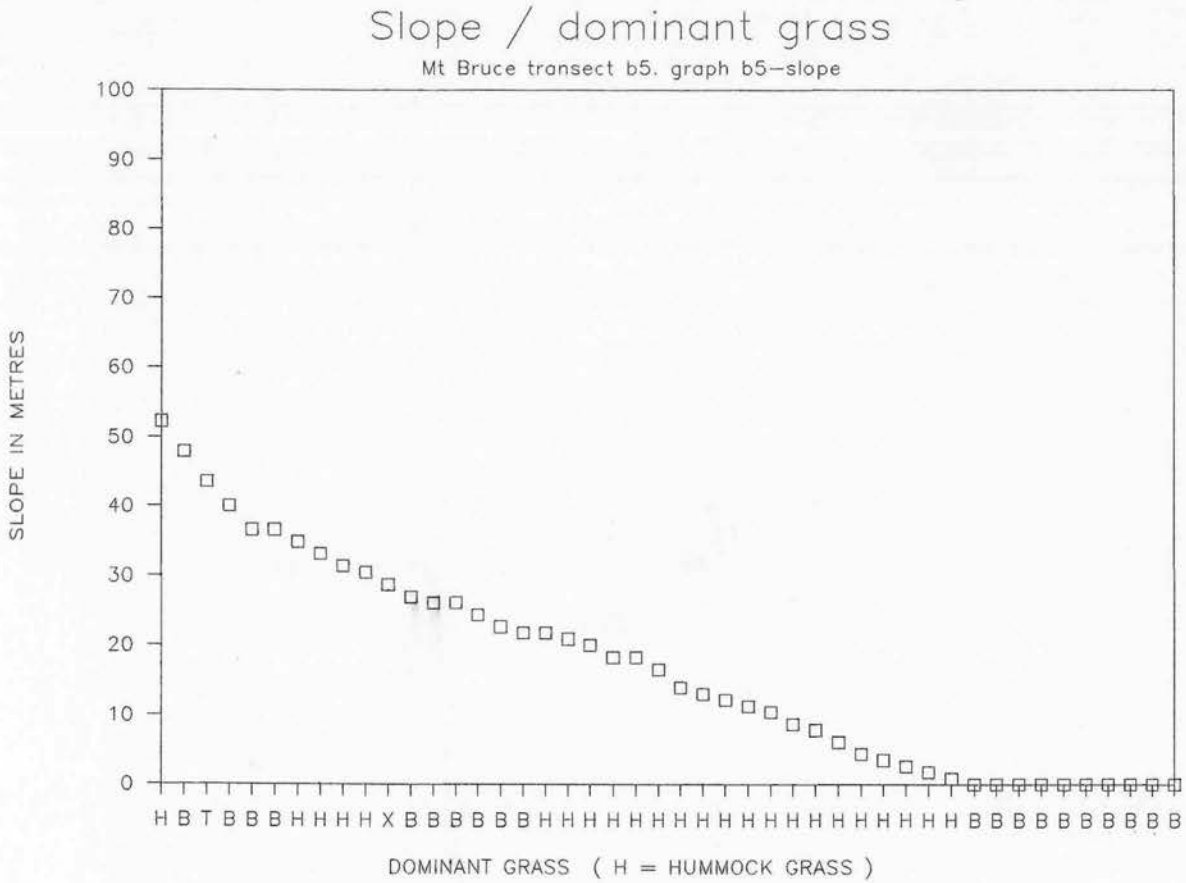

Live Mulga regen / dominant grass
Mt Bruce transect b4. graph b4–mta.
LIVE TREES PER 100M. N=473
0
10
20
30
40
50
60
70
80
H H B B H B B H B H H H H B* B B B B B T B T B B B B B B B B B T B T T T
DOMINANT GRASS (H = HUMMOCK GRASS)

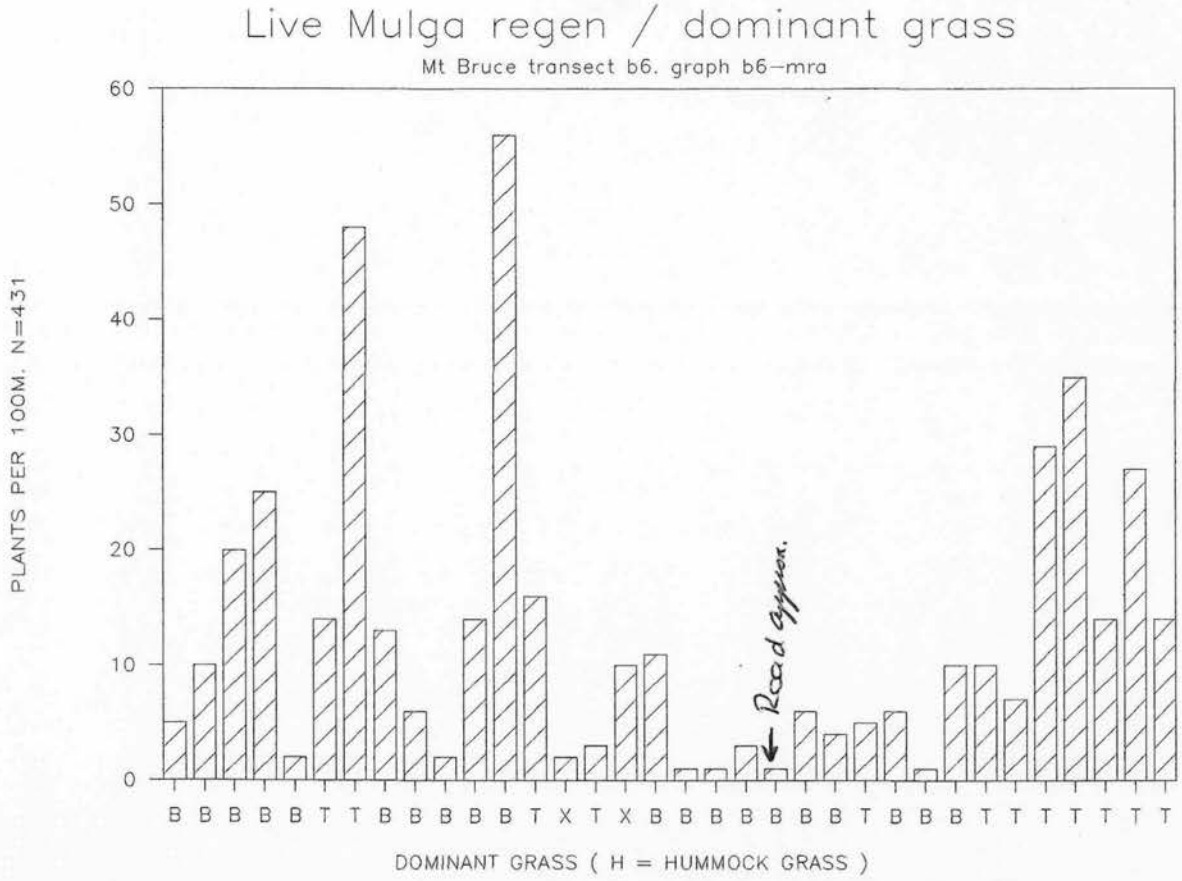

Live Mulga Trees / dominant grass
Mt Bruce transect b4. graph b4–mta
LIVE TREES PER 100M. N=232
0
5
10
15
20
25
30
35
H H B B H B B H B H H H H B* B B B B B T B T B B B B B B B B B T B T T T
DOMINANT GRASS (H = HUMMOCK GRASS)


Live Mulga regen / dominant grass
.Mt Bruce transect b5. graph b5–mra
LIVE REGEN PLANTS PER 100M. N=386
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32
H B T B B B H H H H X B B B B B B H H H H H H H H H H H H H H H H H H H H B B B B B B B B B B
DOMINANT GRASS (H = HUMMOCK GRASS)

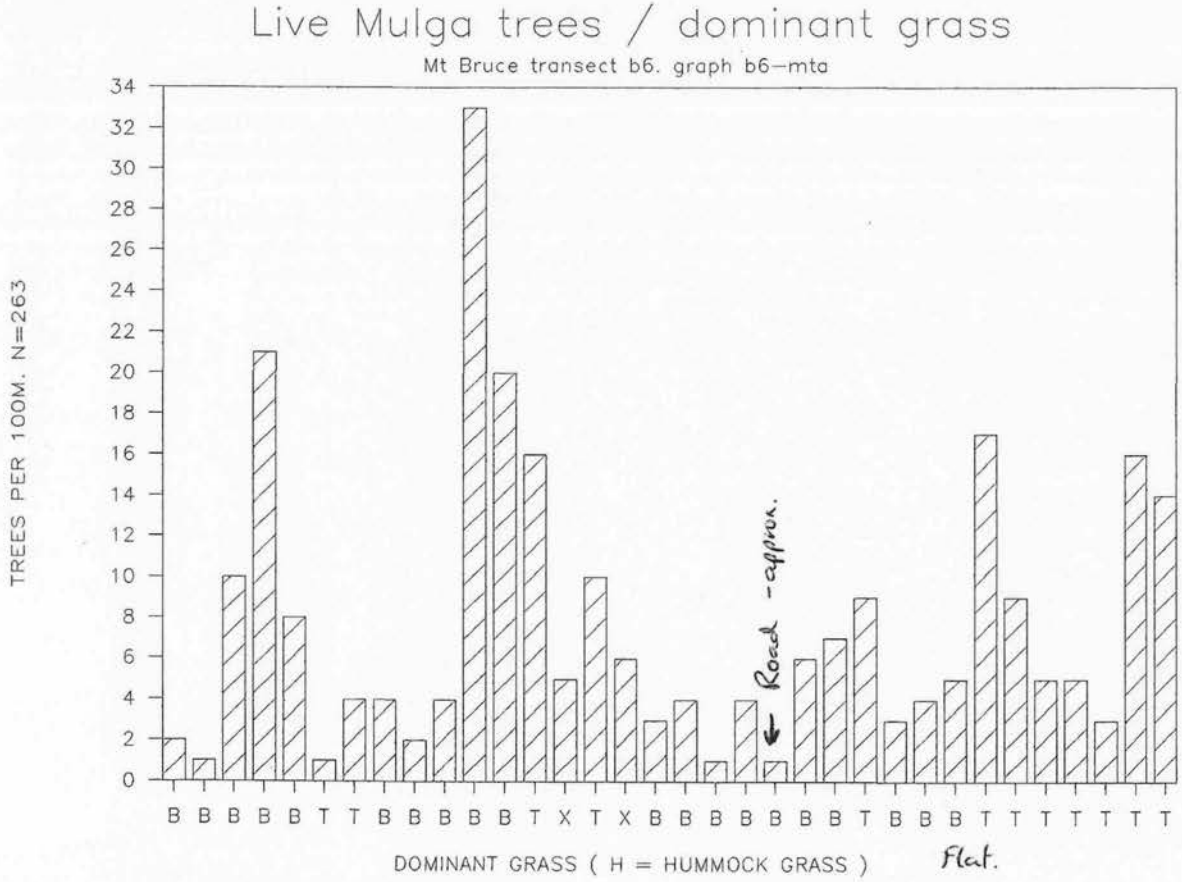

Live Mulga Trees / dominant grass
Mt Bruce transect b5. graph b5–mta
LIVE TREES PER 100M. N=120
0 1 2 3 4 5 6 7 8 9 10 11
H B T B B B H H H H X B B B B B B H H H H H H H H H H H H H H H H H H H H B B B B B B B B B B
DOMINANT GRASS (H = HUMMOCK GRASS)


Dead Mulga Trees / dominant grass
Mt Bruce transect b5. graph b5-mtd
DEAD TRES PER 100M. N=356
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
H B T B B B H H H H X B B B B B B H H H H H H H H H H H H H H H H H H H H H B B B B B B B B B B
DOMINANT GRASS (H = HUMMOCK GRASS)

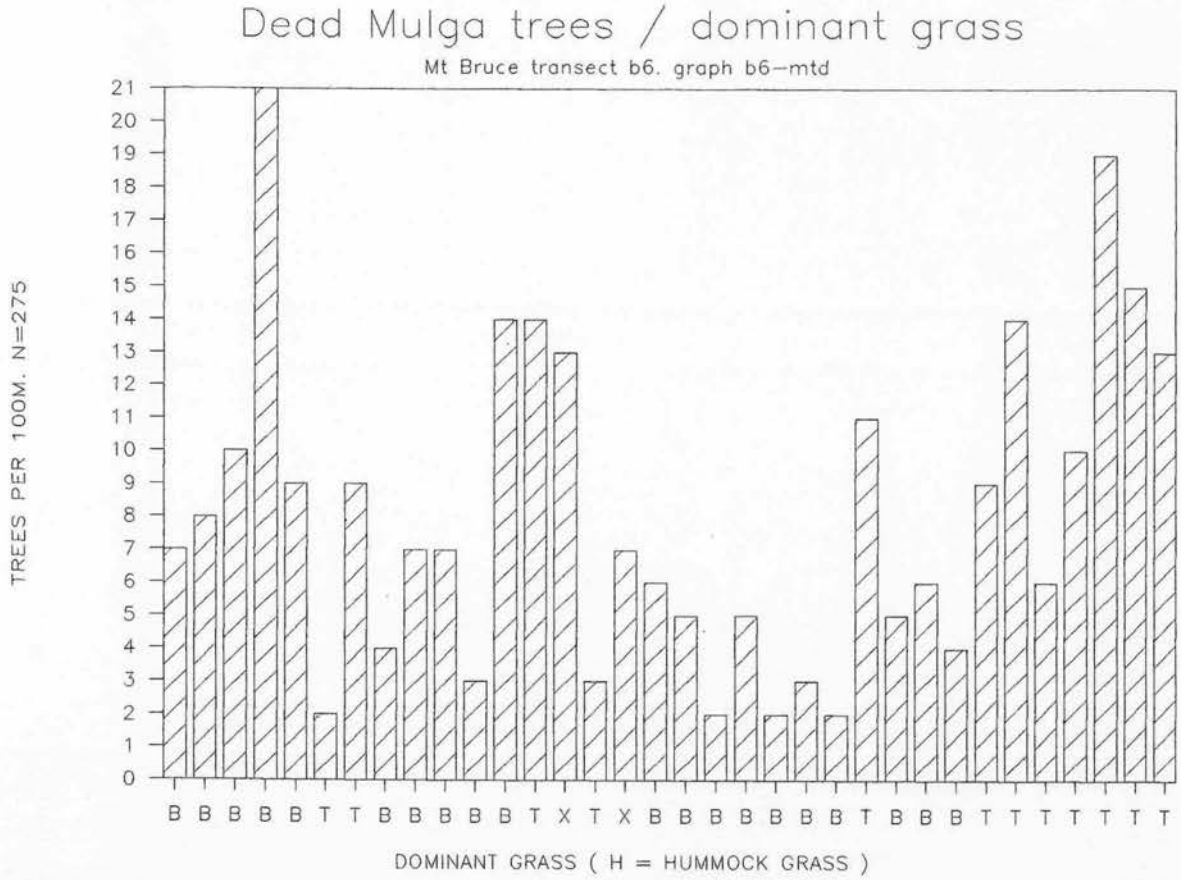

Slope / dominant grass
Mt Bruce transect b5. graph b5-slope
SLOPE IN METRES
0
10
20
30
40
50
60
70
80
90
100
H B T B B B H H H H X B B B B B B H H H H H H H H H H H H H H H H H H H H H B B B B B B B B B B
DOMINANT GRASS (H = HUMMOCK GRASS)


Live Mulga regen / dominant grass
Mt Bruce transect b6. graph b6–mra
PLANTS PER 100M. N=431
0
10
20
30
40
50
60
B B B B B T T B B B B B T X T X B B B B B B B T B B B T T T T T T T
DOMINANT GRASS (H = HUMMOCK GRASS)
Road approx.

B6
MRA.


Live Mulga trees / dominant grass
Mt Bruce transect b6. graph b6–mta
TREES PER 100M. N=263
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
B B B B B T T B B B B B T X T X B B B B B B B T B B B T T T T T T T
DOMINANT GRASS (H = HUMMOCK GRASS)
Road -approx.
Flat.

B6.
MTA.


Dead Mulga trees / dominant grass
Mt Bruce transect b6. graph b6-mtd
TREES PER 100M. N=275
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
B B B B B T T B B B B B T X T X B B B B B B B T B B B T T T T T T T
DOMINANT GRASS (H = HUMMOCK GRASS)

Burnt vs unburnt

No. of species per quadrat

Tony,

Attached are results of Student *t* tests performed on all vegetation units and on all quadrats to see if there is any difference in the number of species per quadrat between burnt and unburnt quadrats.

The results indicate that there is a significant difference in the number of species between burnt and unburnt quadrats (16.8 vs 15.5 species respectively).

For each of the vegetation units there is no significant difference in the number of species between burnt and unburnt quadrats except for vegetation unit 3 where the difference is significant ($P < 0.1$, 15.5 vs 11.8 species respectively).

ALL VEGETATION UNITS
Burnt vs unburnt
species per quadrat

VAR NAME	SIZE	MEAN	SAMPLE STD DEV	SAMPLE VARIANCE	COEF. OF VARIATION
BURNT	253	16.80237	6.29314	39.60367	.37454
UNBURN	218	15.57339	6.2259	38.76186	.39978

2-SAMPLE T-TEST

GROUP:	BURNT	UNBURN
SIZE:	253	218
MEAN:	16.80237	15.57339
SD:	6.293144	6.225902

F-RATIO (VAR): 1.021717
DF: 252 , 217
2-TAIL PROB: .8728

T-VALUE: 2.123741
DF: 469
2-TAIL PROB: .0342

Significant P<05

OMEGA SQUARED: .007398
ETA SQUARED: .009525

--PAIRWISE COMPARISONS--

	1 BURNT	2 UNBURN
BURNT	0	2.1237*
UNBURN	2.1237*	0

** p<.01 * p<.05

VEG UNIT 1
Burnt vs Unburnt

VAR NAME	SIZE	MEAN	SAMPLE STD DEV	SAMPLE VARIANCE	COEF. OF VARIATION
V1-Bn	74	18.01351	6.5092	42.36969	.36135
V1-UBn	37	16.7027	5.38447	28.9925	.32237

2-SAMPLE T-TEST

GROUP:	V1-Bn	V1-UBn
SIZE:	74	37
MEAN:	18.01351	16.7027
SD:	6.5092	5.384468

F-RATIO (VAR): 1.461402
DF: 73 , 36
2-TAIL PROB: .2124

T-VALUE: 1.05677
DF: 109
2-TAIL PROB: .293 NS

OMEGA SQUARED: .001051
ETA SQUARED: .010142

VEG UNIT 2
Burnt vs Unburnt

VAR NAME	SIZE	MEAN	SAMPLE STD DEV	SAMPLE VARIANCE	COEF. OF VARIATION
V2-Bn	67	19.46269	5.75597	33.13117	.29574
V2-UBn	72	21.13889	5.63766	31.78325	.2667

2-SAMPLE T-TEST

GROUP:	V2-Bn	V2-UBn
SIZE:	67	72
MEAN:	19.46269	21.13889
SD:	5.755968	5.637664

F-RATIO (VAR): 1.04241
DF: 66 , 71
2-TAIL PROB: .862

T-VALUE: -1.733927
DF: 137
2-TAIL PROB: .0852 NS

OMEGA SQUARED: .01423
ETA SQUARED: .021474

VEG UNIT 3
Burnt vs Unburnt

VAR NAME	SIZE	MEAN	SAMPLE STD DEV	SAMPLE VARIANCE	COEF. OF VARIATION
V3-Bn	80	15.55	5.99768	35.97216	.3857
V3-UBn	32	11.875	2.84832	8.1129	.23986

2-SAMPLE T-TEST

GROUP:	V3-Bn	V3-UBn
SIZE:	80	32
MEAN:	15.55	11.875
SD:	5.997679	2.848316

F-RATIO (VAR): 4.433944
DF: 79 , 31
2-TAIL PROB: <.0001

T-VALUE: 3.313246
DF: 110
2-TAIL PROB: .0012

Significant
P<0.1

Significant
P<

OMEGA SQUARED: .081799
ETA SQUARED: .090741

VEG UNIT 4
Burnt vs Unburnt

VAR NAME	SIZE	MEAN	SAMPLE STD DEV	SAMPLE VARIANCE	COEF. OF VARIATION
V4-Bn	32	11.5625	2.96145	8.77016	.25613
V4-UBn	77	11.36364	3.20324	10.26077	.28189

2-SAMPLE T-TEST

GROUP:	V4-Bn	V4-UBn
SIZE:	32	77
MEAN:	11.5625	11.36364
SD:	2.961446	3.203243

F-RATIO (VAR): 1.169963
DF: 76 , 31
2-TAIL PROB: .5708

T-VALUE: .30158
DF: 107
2-TAIL PROB: .7636

NS

OMEGA SQUARED: -.00841
ETA SQUARED: .000849

SPECIES DISTRIBUTION WITHIN VEGETATION UNITS

Tony

Attached are lists of the distribution of species within each of the vegetation units in terms on the percentage number of quadrats which they occurred in as against the total number of quadrats within that vegetation unit type.

I hope these list will allow us to identify with some accuracy the different vegetation units in the field. I think we should use those species which occur in greater than 50% of quadrats within a particular vegetation unit to identify that unit in the field.

It is interesting to note that veg unit 3 has very few dominant species present while all the others have quite a few, especially veg unit 2. Perhaps the difference between veg unit 2 and 3 is related to their relative age since they were last burnt or the frequency, number of times that they have been burnt. I suggest that veg unit 3 have been burnt more often that veg unit 2.

Veg. Unit 3 have been burnt more than Veg Unit 2. (look at transect profiles and map where transects are and it appears this way to me).

ALL SITES

Species composition and occurrence of species within quadrats for each of the four vegetation types identified by PATN. Data obtained from dendogram and Two Way Table

VEG UNIT 1

>90%

89% - 75%

74% - 50%

Acacia aneura
Acacia pruinocarpa
Senna glutinosa
Triodia wiseana
Solanum lasiophyllum
Acacia bivenosa
Senna glutinosa subsp pruinosa

49% - 25%

Plectrachne aff. schinzii
Eremophila forrestii
Ptilotus obovatus
Paraneurachne muelleri
Porana sericea
Acacia stowardii
Triodia basedowii
Eucalyptus gamophylla
Acacia atkinsiana
Ptilotus rotundifolius
Acacia aneura (2)
Hakea suberea
Themeda australis
Senna artemisioides subsp. helmsii
Triodia pungens
Triodia sp (225)
Acacia ancistrocarpa
Senna artemisioides subsp oligophylla
Eucalyptus leucophloia
Acacia pachyacra

24% - 10%

Canthium lineare
Eremophila longifolia
Gen sp. nov (73)
Sida virgata
Gen sp nov (153)
Eragrostis sp (166)
Acacia rhodophloia
Acacia maitlandii
Solanum sp (102)
Capparis lasiantha
Acacia inaequilatera
Gompholobium polyzyga
Tribulus platyptera
Keraudrenia sp (96)
Scaevola parviflora
Acacia marramamba
Eremophila latrobei
Rhagodia sp. (93)
Ptilotus exaltatus
Gen sp nov (152)
Eriachne aff helmsii
Acacia aneura (3)
Acacia adsurgens
Gossypium robinsonii
Indigofera monophylla
Senna sp nov (106)
Jasminum didymum
Acacia monticola
Acacia dictyophleba
Exocarpos aphyllus
Tephrosia arenicola
Eremophila sp (222)

<9%

Canthium latifolium
Salsola kali
Marianum sp. (97)
Maireana aff. villosa
Sclerolaena sp. (52)
Enneapogon clelandii
Enchylaena sp (108)
Aristida sp (161)

Gen nov sp (162)
Grevillea stenobotrya
Acacia aneura (208)
Malvaceae sp nov (231)
Santalum spicatum
Gen nov sp (50)
Eulalia fulva
Sida sp (56)
Crotalaria sp (107)
Eriachne flaccida
Acacia aneura (226)
Pittosporum sp (48)
Eucalyptus setosa
Indigofera sp (82)
Rhyncharrhena linearis
Acacia cowleana
Triodia aff longiceps
Eremophila cuneifolia
Clerodendrum tomentosum

Gen nov sp (154) (Panicum)
Acacia tetragonophylla
Rhagodia sp (228)
Eucalyptus patellaris
Senna aff. artemisioides (68)
Mukia maderaspatana
Senna notabilis
Corchorus walcottii
Eucalyptus coolabah
Solanum ferocissimum
Acacia pyrifolia
Codonocarpus cotinifolius
Acacia tenuissima
Senna pleurocarpa
Cymbopogon sp (156)
Rhynchosia minima
Petalostylis labicheoides
Stylobasium spathulatum
Dodonaea viscosa subsp angustissima

Absent from Veg Unit

Malvastrum americanum
Sclerolaena sp (117)
Solanum horridum
Eucalyptus aspera
Acacia aneura (4)

Setaria viridis
Eremophila sp (76) (12 Mile)
Corchorus sp (213) (tebby rings)
Gen nov sp (220) (Chenopod)
Santalum lanceolatum

2 3
1/2 E pat <9
<9 E asp <9
<9 E cool <9
<9 E gean <9
<9 E set. 1/2

2 3
0 E leuco 0

VEG UNIT 2

>90%

Acacia aneura

89% - 75%

2/4 Sida virgata
9+ Plectrachne aff. schinzii

74% - 50%

Acacia aneura (2)
1/2 Ptilotus obovatus
2/5 Themeda australis
1/2 Porana sericea
<9 Gen sp nov (152)
2/4 Gen sp nov (153)
2/4 Gen sp. nov (73)
2/4 Eremophila forrestii
2/4 Solanum lasiophyllum
7/9 Acacia pruinocarpa
1/2 Sclerolaena sp. (52)
1/2 Aristida sp (161)
2/5 Maireana aff. villosa

49% - 25%

Canthium lineare
Paraneurachne muelleri
<9 Rhagodia sp. (93)
<9 Ptilotus exaltatus
1/2 Anthobolus leptomerioides
Hakea suberea
1/2 Senna artemisioides subsp. helmsii
<9 Salsola kali
Gen nov sp (154) (Panicum)
1/2 Triodia pungens

24% - 10%

Eremophila latrobei
Eremophila longifolia
Marianum sp. (97)
Eriachne aff helmsii
Grevillea stenobotrya
Rhagodia sp (228)
Santalum spicatum
Mukia maderaspatana
Eriachne flaccida
Solanum ferocissimum
2/4 Triodia basedowii
Senna glutinosa
3/7 Acacia pachyacra
2/4 Cymbopogon sp (156)
Canthium latifolium
Enneapogon clelandii
Enchylaena sp (108)
Gen nov sp (162)
Acacia aneura (208)
Eucalyptus patellaris
Gen nov sp (50)
Malvastrum americanum
Eremophila sp (76) (12 Mile)
Acacia bivenosa
Senna artemisioides subsp oligophylla
Capparis lasiantha
Indigofera sp (82)

<9%

Malvaceae sp nov (231)
Eulalia fulva
Setaria viridis
Sida sp (56)
Crotalaria sp (107)
Sclerolaena sp (117)
Eragrostis sp (166)
Eucalyptus aspera
Acacia rhodophloia
Acacia adsurgens
Acacia aneura (226)
Gossypium robinsonii
Acacia ancistrocarpa
Acacia tetragonophylla
Senna aff. artemisioides (68)
Senna notabilis
Corchorus walcottii
Eucalyptus coolabah
Solanum horridum
Corchorus sp (213) (tebby rings)
Acacia aneura (3)
Acacia stowardii
Triodia sp (225)
Acacia maitlandii
Acacia pyrifolia
Solanum sp (102)

Eucalyptus gamophylla
Triodia wiseana
Senna sp nov (106)
Jasminum didymum
Acacia monticola
Tribulus platyptera
Acacia aneura (4)
Acacia dictyophleba
Eucalyptus setosa
Exocarpos aphyllus
Senna pleurocarpa
Acacia cowleana
Rhynchosia minima
Triodia aff longiceps
Clerodendrum tomentosum

Indigofera monophylla
Senna glutinosa subsp pruinosa
Acacia inaequilatera
Gompholobium polyzyga
Acacia atkinsiana
Ptilotus rotundifolius
Codonocarpus cotinifolius
Keraudrenia sp (96)
Acacia tenuissima
Scaevola parviflora
Rhyncharrhena linearis
Tephrosia arenicola
Petalostylis labicheoides
Stylobasium spathulatum
Dodonaea viscosa subsp angustissima

Absent from Veg Unit

Gen nov sp (216)
Pittosporum sp (48)
Eremophila cuneifolia
Eremophila sp (222)

Gen nov sp (220) (Chenopod)
Eucalyptus leucophloia
Acacia marramamba
Santalum lanceolatum

VEG UNIT 3

>90%

Acacia aneura

7/9 Plectrachne aff. schinzii

89% - 75%

5/7 Acacia pruinocarpa

74% - 50%

Acacia aneura (2)

1/2 Acacia pachyacra

49% - 25%

Canthium lineare
Hakea suberea
3/7 Themeda australis
5/7 Gen sp. nov (73)
5/7 Maireana aff. villosa
1/2 Triodia basedowii
<9 Acacia dictyophleba
1/2 Cymbopogon sp (156)

5/7 Eremophila forrestii
5/7 Solanum lasiophyllum
Paraneurachne muelleri
7/9 Sida virgata
3/7 Gen sp nov (153)
Gen nov sp (154) (Panicum)
<9 Keraudrenia sp (96)

24% - 10%

5/7 Ptilotus obovatus
5/7 Porana sericea
Eremophila longifolia
5/7 Aristida sp (161)
2/4 Triodia pungens
Eragrostis sp (166)
Acacia aneura (3)
Acacia bivenosa
Eucalyptus setosa
Acacia tenuissima
Scaevola parviflora
Senna pleurocarpa

Canthium latifolium
2/4 Senna artemisioides subsp. helmsii
5/7 Sclerolaena sp. (52)
Anthobolus leptomerioides
2/4 Solanum horridum
Gen nov sp (220) (Chenopod)
Acacia stowardii
Acacia ancistrocarpa
Codonocarpus cotinifolius
Exocarpos aphyllus
Indigofera sp (82)

<9%

Eremophila latrobei
2/4 Salsola kali
Enneapogon clelandii
Enchylaena sp (108)
Eriachne aff helmsii
Grevillea stenobotrya
Acacia aneura (208)
Malvaceae sp nov (231)
Santalum spicatum
Gen nov sp (50)
Malvastrum americanum
Setaria viridis
Sida sp (56)
Crotalaria sp (107)
Sclerolaena sp (117)
Eriachne flaccida
Acacia rhodophloia
Acacia adsurgens

2/4 Rhagodia sp. (93)
Ptilotus exaltatus
Marianum sp. (97)
5/7 Gen sp nov (152).
Gen nov sp (162)
Acacia tetragonophylla
Rhagodia sp (228)
Eucalyptus patellaris
Senna aff. artemisioides (68)
Mukia maderaspatana
Eulalia fulva
Senna notabilis
Corchorus walcottii
Eucalyptus coolabah
Eremophila sp (76) (12 Mile)
Solanum ferocissimum
Corchorus sp (213) (tebby rings)
Santalum lanceolatum

Acacia aneura (226)
Gossypium robinsonii
Solanum sp (102)
Eucalyptus gamophylla
Senna glutinosa
Triodia wiseana
Senna sp nov (106)
Jasminum didymum
Acacia monticola
Tribulus platyptera
Acacia aneura (4)
Acacia cowleana
Rhynchosia minima
Eremophila cuneifolia
Eremophila sp (222)
Acacia maitlandii
Acacia pyrifolia
Senna artemisioides subsp oligophylla
Indigofera monophylla
Senna glutinosa subsp pruinosa
Capparis lasiantha
Acacia inaequilatera
Gompholobium polyzyga
Acacia atkinsiana
Ptilotus rotundifolius
Rhyncharrhena linearis
Tephrosia arenicola
Stylobasium spathulatum
Acacia marramamba
Clerodendrum tomentosum

Absent from Veg Unit

Gen nov sp (216)
Pittosporum sp (48)
Petalostylis labicheoides
Triodia aff longiceps
Eucalyptus aspera
Eucalyptus leucophloia
Dodonaea viscosa subsp angustissima

VEG UNIT 4

>90%

Acacia aneura
Eremophila sp (76) (12 Mile)

89% - 75%

Gen sp nov (152)
Gen sp nov (153)
Aristida sp (161)

74% - 50%

Sida virgata
Eriachne flaccida
Maireana aff. villosa

49% - 25%

Canthium lineare
Hakea suberea
Themeda australis
Eucalyptus coolabah
Plectrachne aff. schinzii
Solanum lasiophyllum
Eriachne aff helmsii
Eragrostis sp (166)

24% - 10%

Acacia aneura (2)
Salsola kali
Anthobolus leptomerioides
Gen nov sp (216)
Solanum ferocissimum
Ptilotus obovatus
Enneapogon clelandii
Gen nov sp (154) (Panicum)
Sclerolaena sp (117)
Solanum horridum

<9%

Eremophila forrestii
Acacia pruinocarpa
Porana sericea
Eremophila longifolia
Sclerolaena sp. (52)
Ptilotus exaltatus
Enchylaena sp (108)
Grevillea stenobotrya
Triodia pungens
Eucalyptus patellaris
Mukia maderaspatana
Eulalia fulva
Senna notabilis
Corchorus walcottii
Eucalyptus aspera
Triodia sp (225)
Capparis lasiantha
Cymbopogon sp (156)
Eremophila latrobei
Paraneurachne muelleri
Senna artemisioides subsp. helmsii
Rhagodia sp. (93)
Gen sp. nov (73)
Marianum sp. (97)
Gen nov sp (162)
Acacia tetragonophylla
Rhagodia sp (228)
Gen nov sp (50)
Malvastrum americanum
Setaria viridis
Sida sp (56)
Corchorus sp (213) (tebby rings)
Gen nov sp (220) (Chenopod)
Triodia basedowii
Rhyncharrhena linearis
Rhynchosia minima

Absent from Veg Unit

Canthium latifolium
Malvaceae sp nov (231)
Crotalaria sp (107)
Acacia aneura (3)
Acacia stowardii
Acacia aneura (226)
Gossypium robinsonii
Acacia aneura (208)
Santalum spicatum
Senna aff. artemisioides (68)
Acacia rhodophloia
Acacia adsurgens
Acacia maitlandii
Acacia pyrifolia

Acacia bivenosa
Solanum sp (102)
Eucalyptus gamophylla
Senna glutinosa
Triodia wiseana
Acacia inaequilatera
Gompholobium polyzyga
Acacia atkinsiana
Eucalyptus leucophloia
Tribulus platyptera
Acacia dictyophleba
Keraudrenia sp (96)
Eucalyptus setosa
Exocarpos aphyllus
Indigofera sp (82)
Acacia cowleana
Triodia aff longiceps
Stylobasium spathulatum
Acacia marramamba
Clerodendrum tomentosum
Santalum lanceolatum
Acacia ancistrocarpa
Senna artemisioides subsp oligophylla
Indigofera monophylla
Senna glutinosa subsp pruinosa
Senna sp nov (106)
Jasminum didymum
Acacia monticola
Pittosporum sp (48)
Ptilotus rotundifolius
Acacia aneura (4)
Codonocarpus cotinifolius
Acacia pachyacra
Acacia tenuissima
Scaevola parviflora
Senna pleurocarpa
Tephrosia arenicola
Petalostylis labicheoides
Eremophila cuneifolia
Eremophila sp (222)
Dodonaea viscosa subsp angustissima

MT BRUCE

Species composition and occurrence of species within quadrats for each of the four vegetation types identified by PATN. Data obtained from dendogram and Two Way Table

VEG UNIT 1

>90%

89% - 75%

Triodia basedowii
Senna glutinosa

74% - 50%

Solanum lasiophyllum
Paraneurachne muelleri
Acacia bivenosa
Triodia wiseana
Acacia pruinocarpa
Porana sericea
Acacia ancistrocarpa
Senna glutinosa subsp pruinosa

49% - 25%

Acacia aneura
Hakea suberea
Themeda australis
Solanum sp (102)
Indigofera monophylla
Scaevola parviflora
Tephrosia arenicola
Plectrachne aff. schinzii
Ptilotus obovatus
Senna artemisioides subsp. helmsii
Eucalyptus gamophylla
Acacia atkinsiana
Senna artemisioides subsp oligophylla

24% - 10%

Canthium lineare
Eremophila forrestii
Eremophila longifolia
Ptilotus exaltatus
Gen sp nov (152)
Sida sp (56)
Acacia stowardii
Capparis lasiantha
Acacia inaequilatera
Gompholobium polyzyga
Eucalyptus leucophloia
Tribulus platyptera
Acacia pachyacra
Cymbopogon sp (156)
Acacia aneura (2)
Canthium latifolium
Gen sp. nov (73)
Sida virgata
Gen sp nov (153)
Eragrostis sp (166)
Acacia adsurgens
Senna sp nov (106)
Jasminum didymum
Acacia monticola
Ptilotus rotundifolius
Keraudrenia sp (96)
Exocarpos aphyllus

<9%

Eremophila latrobei
Salsola kali
Maireana aff. villosa
Eriachne aff helmsii
Gen nov sp (162)
Santalum spicatum
Mukia maderaspatana
Senna notabilis
Rhagodia sp. (93)
Enneapogon clelandii
Aristida sp (161)
Gen nov sp (154) (Panicum)
Acacia aneura (208)
Gen nov sp (50)
Eulalia fulva
Corchorus walcottii

Crotalaria sp (107)
Solanum ferocissimum
Gossypium robinsonii
Acacia dictyophleba
Eucalyptus setosa
Senna pleurocarpa
Acacia cowleana
Stylobasium spathulatum
Eremophila cuneifolia
Clerodendrum tomentosum
Pittosporum sp (48)
Eriachne flaccida
Acacia rhodophloia
Acacia pyrifolia
Codonocarpus cotinifolius
Acacia tenuissima
Rhyncharrhena linearis
Rhynchosia minima
Petalostylis labicheoides
Acacia marramamba
Acacia maitlandii

Absent from Veg Unit

Sclerolaena sp. (52)
Enchylaena sp (108)
Grevillea stenobotrya
Triodia pungens
Malvaceae sp nov (231)
Malvastrum americanum
Setaria viridis
Gen nov sp (216)
Solanum horridum
Acacia aneura (3)
Eucalyptus aspera
Triodia sp (225)
Acacia aneura (4)
Triodia aff longiceps
Santalum lanceolatum
Marianum sp. (97)
Anthobolus leptomerioides
Acacia tetragonophylla
Rhagodia sp (228)
Eucalyptus patellaris
Senna aff. artemisioides (68)
Eucalyptus coolabah
Sclerolaena sp (117)
Eremophila sp (76) (12 Mile)
Gen nov sp (220) (Chenopod)
Corchorus sp (213) (tebby rings)
Acacia aneura (226)
Indigofera sp (82)
Eremophila sp (222)
Dodonaea viscosa subsp angustissima

VEG UNIT 2 (MB)

— 1 unit higher than 3
— 2 units higher than 3

>90%
Acacia aneura

89% - 75%
Themeda australis
Sida virgata
Plectrachne aff. schinzii

74% - 50%
Eremophila forrestii
Solanum lasiophyllum
Porana sericea
Sclerolaena sp. (52)
Ptilotus exaltatus
Gen sp nov (152)
Gen sp nov (153)
Ptilotus obovatus
Acacia pruinocarpa
Rhagodia sp. (93)
Gen sp. nov (73)
Maireana aff. villosa
Aristida sp (161)

49% - 25%
Canthium lineare
Hakea suberea
Eremophila longifolia
~~Salsola kali~~
Anthobolus leptomerioides
Eriachne aff helmsii
Triodia basedowii
Gen nov sp (50)
Acacia aneura (2)
Paraneurachne muelleri
Senna artemisioides subsp. helmsii
Enneapogon clelandii
Gen nov sp (154) (Panicum)
Gen nov sp (162)
Cymbopogon sp (156)

24% - 10%
Eremophila latrobei
Marianum sp. (97)
Eucalyptus patellaris
Malvastrum americanum
Setaria viridis
Corchorus walcottii
Acacia bivenosa
Senna glutinosa
Triodia wiseana
Acacia pachyacra
Canthium latifolium
Enchylaena sp (108)
Santalum spicatum
Eulalia fulva
Sida sp (56)
Eriachne flaccida
Senna artemisioides subsp oligophylla
Senna glutinosa subsp pruinosa
Acacia dictyophleba
Indigofera sp (82)

<9%
Grevillea stenobotrya
Acacia aneura (208)
Crotalaria sp (107)
Sclerolaena sp (117)
Solanum ferocissimum
Eragrostis sp (166)
Acacia aneura (3)
Acacia stowardii
Gossypium robinsonii
Acacia ancistrocarpa
Eucalyptus gamophylla
Capparis lasiantha
Jasminum didymum
Acacia tetragonophylla
Senna notabilis
Eucalyptus coolabah
Eremophila sp (76) (12 Mile)
Solanum horridum
Corchorus sp (213) (tebby rings)
Acacia rhodophloia
Acacia maitlandii
Acacia pyrifolia
Solanum sp (102)
Indigofera monophylla
Senna sp nov (106)
Gompholobium polyzyga

Acacia monticola
Ptilotus rotundifolius
Acacia aneura (4)
Keraudrenia sp (96)
Acacia tenuissima
Scaevola parviflora
Rhyncharrhena linearis
Tephrosia arenicola
Petalostylis labicheoides
Stylobasium spathulatum
Clerodendrum tomentosum
Acacia atkinsiana
Tribulus platyptera
Codonocarpus cotinifolius
Eucalyptus setosa
Exocarpos aphyllus
Senna pleurocarpa
Acacia cowleana
Rhynchosia minima
Triodia aff longiceps
Dodonaea viscosa subsp angustissima

Absent from Veg Unit

Triodia pungens
Malvaceae sp nov (231)
Eucalyptus aspera
Acacia adsurgens
Acacia aneura (226)
Pittosporum sp (48)
Eremophila cuneifolia
Eremophila sp (222)
Rhagodia sp (228)
Gen nov sp (216)
Gen nov sp (220) (Chenopod)
Triodia sp (225)
Acacia inaequilatera
Eucalyptus leucophloia
Acacia marramamba
Santalum lanceolatum

VEG UNIT 3 (MB)

>90%
Acacia aneura

89% - 75%
Acacia pruinocarpa
Plectrachne aff. schinzii

74% - 50%
Acacia aneura (2)
Acacia pachyacra

49% - 25%
Canthium lineare
Hakea suberea
Solanum lasiophyllum
Paraneurachne muelleri
Sida virgata
Gen sp nov (153)
Acacia bivenosa
Acacia dictyophleba
Keraudrenia sp (96)
Cymbopogon sp (156)
Eremophila forrestii
Ptilotus obovatus
Themeda australis
Gen sp. nov (73)
Maireana aff. villosa
Gen nov sp (154) (Panicum)
Triodia basedowii
Codonocarpus cotinifolius
Indigofera sp (82)

24% - 10%
Canthium latifolium
Porana sericea
Aristida sp (161)
Solanum ferocissimum
Eragrostis sp (166)
Acacia aneura (3)
Acacia stowardii
Acacia atkinsiana
Eucalyptus setosa
Exocarpos aphyllus
Senna pleurocarpa
Senna artemisioides subsp. helmsii
Eremophila longifolia
Eriachne aff helmsii
Solanum horridum
Corchorus sp (213) (tebby rings)
Gen nov sp (220) (Chenopod)
Acacia ancistrocarpa
Senna artemisioides subsp oligophylla
Acacia tenuissima
Scaevola parviflora

<9%
Eremophila latrobei
Sclerolaena sp. (52)
Enneapogon clelandii
Gen sp nov (152)
Gen nov sp (162)
Acacia tetragonophylla
Eucalyptus patellaris
Gen nov sp (50)
Malvastrum americanum
Setaria viridis
Sida sp (56)
Crotalaria sp (107)
Eriachne flaccida
Acacia rhodophloia
Acacia maitlandii
Acacia pyrifolia
Eucalyptus gamophylla
Rhagodia sp. (93)
Salsola kali
Marianum sp. (97)
Eriachne aff helmsii
Grevillea stenobotrya
Acacia aneura (208)
Senna aff. artemisioides (68)
Mukia maderaspatana
Eulalia fulva
Senna notabilis
Corchorus walcottii
Eucalyptus coolabah
Eremophila sp (76) (12 Mile)
Acacia adsurgens
Gossypium robinsonii
Solanum sp (102)
Indigofera monophylla

Senna glutinosa
Triodia wiseana
Senna sp nov (106)
Jasminum didymum
Acacia monticola
Tribulus platyptera
Acacia cowleana
Rhynchosia minima
Eremophila cuneifolia
Eremophila sp (222)
Santalum lanceolatum
Enchylaena sp (108)
Senna glutinosa subsp pruinosa
Capparis lasiantha
Acacia inaequilatera
Gompholobium polyzyga
Ptilotus rotundifolius
Rhyncharrhena linearis
Tephrosia arenicola
Stylobasium spathulatum
Acacia marramamba
Clerodendrum tomentosum
Acacia aneura (4)

Absent from Veg Unit

Triodia pungens
Malvaceae sp nov (231)
Gen nov sp (216)
Eucalyptus aspera
Acacia aneura (226)
Eucalyptus leucophloia
Triodia aff longiceps
Rhagodia sp (228)
Santalum spicatum
Sclerolaena sp (117)
Triodia sp (225)
Pittosporum sp (48)
Petalostylis labicheoides
Dodonaea viscosa subsp angustissima

VEG UNIT 4 (MB)

>90%
Acacia aneura

89% - 75%
Gen sp nov (152)
Gen sp nov (153)
Eremophila sp (76) (12 Mile)

74% - 50%
Sida virgata
Eriachne aff helmsii
Aristida sp (161)
Eriachne flaccida

49% - 25%
Solanum lasiophyllum
Maireana aff. villosa
Eucalyptus coolabah
Themeda australis
Gen nov sp (154) (Panicum)
Eragrostis sp (166)

24% - 10%
Canthium lineare
Acacia aneura (2)
Ptilotus obovatus
Salsola kali
Enneapogon clelandii
Gen nov sp (216)
Solanum horridum
Plectrachne aff. schinzii
Hakea suberea
Paraneurachne muelleri
Gen sp. nov (73)
Setaria viridis
Solanum ferocissimum
Gen nov sp (220) (Chenopod)

<9%
Eremophila forrestii
Acacia pruinocarpa
Porana sericea
Rhagodia sp. (93)
Ptilotus exaltatus
Enchylaena sp (108)
Gen nov sp (162)
Eucalyptus patellaris
Mukia maderaspatana
Eulalia fulva
Corchorus walcottii
Triodia sp (225)
Triodia basedowii
Rhyncharrhena linearis
Rhynchosia minima
Eremophila latrobei
Senna artemisioides subsp. helmsii
Eremophila longifolia
Sclerolaena sp. (52)
Marianum sp. (97)
Anthobolus leptomerioides
Grevillea stenobotrya
Gen nov sp (50)
Malvastrum americanum
Senna notabilis
Sclerolaena sp (117)
Corchorus sp (213) (tebby rings)
Capparis lasiantha
Cymbopogon sp (156)

Absent from Veg Unit
Canthium latifolium
Acacia aneura (208)
Rhagodia sp (228)
Santalum spicatum
Sida sp (56)
Eucalyptus aspera
Acacia rhodophloia
Acacia adsurgens
Acacia tetragonophylla
Triodia pungens
Malvaceae sp nov (231)
Senna aff. artemisioides (68)
Crotalaria sp (107)
Acacia aneura (3)
Acacia stowardii
Acacia aneura (226)

Acacia maitlandii
Acacia pyrifolia
Acacia ancistrocarpa
Solanum sp (102)
Indigofera monophylla
Triodia wiseana
Senna sp nov (106)
Jasminum didymum
Acacia monticola
Pittosporum sp (48)
Ptilotus rotundifolius
Acacia aneura (4)
Acacia dictyophleba
Acacia pachyacra
Acacia tenuissima
Scaevola parviflora
Senna pleurocarpa
Tephrosia arenicola
Triodia aff longiceps
Eremophila cuneifolia
Eremophila sp (222)
Santalum lanceolatum
Gossypium robinsonii
Acacia bivenosa
Senna artemisioides subsp oligophylla
Eucalyptus gamophylla
Senna glutinosa
Senna glutinosa subsp pruinosa
Acacia inaequilatera
Gompholobium polyzyga
Acacia atkinsiana
Eucalyptus leucophloia
Tribulus platyptera
Codonocarpus cotinifolius
Keraudrenia sp (96)
Eucalyptus setosa
Exocarpos aphyllus
Indigofera sp (82)
Acacia cowleana
Petalostylis labicheoides
Stylobasium spathulatum
Acacia marramamba
Clerodendrum tomentosum
Dodonaea viscosa subsp angustissima

PACKSADDLE

Species composition and occurrence of species within quadrats for each of the four vegetation types identified by PATN. Data obtained from dendogram and Two Way Table

VEG UNIT 1

>90%

89% - 75%
Acacia aneura

74% - 50%
Solanum lasiophyllum
Acacia stowardii
Acacia pruinocarpa
Triodia sp (225)

49% - 25%
Acacia aneura (2)
Hakea suberea
Triodia pungens
Acacia adsurgens
Acacia ancistrocarpa
Senna glutinosa
Triodia wiseana
Ptilotus rotundifolius
Acacia pachyacra
Eremophila forrestii
Ptilotus obovatus
Senna artemisioides subsp. helmsii
Acacia bivenosa
Senna artemisioides subsp oligophylla
Senna glutinosa subsp pruinosa
Eucalyptus leucophloia
Acacia dictyophleba

24% - 10%
Canthium lineare
Themeda australis
Porana sericea
Gen sp. nov (73)
Anthobolus leptomerioides
Acacia aneura (208)
Eragrostis sp (166)
Acacia rhodophloia
Acacia maitlandii
Eucalyptus gamophylla
Capparis lasiantha
Jasminum didymum
Keraudrenia sp (96)
Eremophila sp (222)
Plectrachne aff. schinzii
Paraneurachne muelleri
Eremophila longifolia
Sida virgata
Eriachne aff helmsii
Eucalyptus patellaris
Acacia aneura (3)
Acacia aneura (226)
Acacia pyrifolia
Indigofera monophylla
Acacia inaequilatera
Tribulus platyptera
Triodia aff longiceps

<9%
Eremophila latrobei
Rhagodia sp. (93)
Salsola kali
Marianum sp. (97)
Maireana aff. villosa
Aristida sp (161)
Acacia tetragonophylla
Malvaceae sp nov (231)
Canthium latifolium
Sclerolaena sp. (52)
Ptilotus exaltatus
Enchylaena sp (108)
Gen sp nov (152)
Gen sp nov (153)
Rhagodia sp (228)
Santalum spicatum

Eulalia fulva
Corchorus walcottii
Solanum ferocissimum
Triodia basedowii
Senna sp nov (106)
Acacia monticola
Eucalyptus setosa
Exocarpos aphyllus
Rhyncharrhena linearis
Tephrosia arenicola
Rhynchosia minima
Acacia marramamba
Senna aff. artemisioides (68)
Eucalyptus coolabah
Gossypium robinsonii
Solanum sp (102)
Gompholobium polyzyga
Acacia atkinsiana
Acacia tenuissima
Indigofera sp (82)
Acacia cowleana
Petalostylis labicheoides
Stylobasium spathulatum
Dodonaea viscosa subsp angustissima

Absent from Veg Unit

Enneapogon clelandii
Gen nov sp (162)
Gen nov sp (50)
Malvastrum americanum
Senna notabilis
Crotalaria sp (107)
Sclerolaena sp (117)
Eriachne flaccida
Solanum horridum
Eucalyptus aspera
Acacia aneura (4)
Scaevola parviflora
Cymbopogon sp (156)
Eremophila cuneifolia
Santalum lanceolatum
Gen nov sp (154) (Panicum)
Grevillea stenobotrya
Mukia maderaspatana
Setaria viridis
Sida sp (56)
Gen nov sp (216)
Eremophila sp (76) (12 Mile)
Corchorus sp (213) (tebby rings)
Gen nov sp (220) (Chenopod)
Pittosporum sp (48)
Codonocarpus cotinifolius
Senna pleurocarpa
Rhynchosia minima
Clerodendrum tomentosum

VEG UNIT 2 (P)

>90%
Acacia aneura

89% - 75%
Acacia aneura (2)
Sida virgata
Plectrachne aff. schinzii
Gen sp nov (152)

74% - 50%
Canthium lineare
Ptilotus obovatus
Sclerolaena sp. (52)
Maireana aff. villosa
Triodia pungens
Eremophila forrestii
Solanum lasiophyllum
Gen sp. nov (73)
Aristida sp (161)
Rhagodia sp (228)

49% - 25%
Themeda australis
Salsola kali
Gen sp nov (153)
Acacia pruinocarpa
Ptilotus exaltatus
Anthobolus leptomerioides

24% - 10%
Hakea suberea
Canthium latifolium
Porana sericea
Rhagodia sp. (93)
Marianum sp. (97)
Eriachne aff helmsii
Grevillea stenobotrya
Acacia aneura (208)
Eucalyptus patellaris
Solanum ferocissimum
Acacia aneura (3)
Solanum sp (102)
Acacia pachyacra
Exocarpos aphyllus
Eremophila latrobei
Paraneurachne muelleri
Eremophila longifolia
Enneapogon clelandii
Enchylaena sp (108)
Gen nov sp (154) (Panicum)
Acacia tetragonophylla
Malvaceae sp nov (231)
Santalum spicatum
Eremophila sp (76) (12 Mile)
Senna artemisioides subsp oligophylla
Capparis lasiantha
Eucalyptus setosa

<9%
Gen nov sp (162)
Malvastrum americanum
Senna notabilis
Crotalaria sp (107)
Sclerolaena sp (117)
Solanum horridum
Eucalyptus aspera
Acacia stowardii
Triodia sp (225)
Acacia pyrifolia
Acacia ancistrocarpa
Senna glutinosa
Senna sp nov (106)
Jasminum didymum
Senna pleurocarpa
Triodia aff longiceps
Senna artemisioides subsp. helmsii
Senna aff. artemisioides (68)
Corchorus walcottii
Eucalyptus coolabah
Eriachne flaccida
Eragrostis sp (166)
Corchorus sp (213) (tebby rings)
Acacia adsurgens
Acacia aneura (226)
Acacia bivenosa
Eucalyptus gamophylla
Senna glutinosa subsp pruinosa
Acacia inaequilatera
Acacia dictyophleba
Rhyncharrhena linearis
Petalostylis labicheoides

Absent from Veg Unit

Gen nov sp (50)
Eulalia fulva
Sida sp (56)
Acacia rhodophloia
Acacia maitlandii
Triodia basedowii
Triodia wiseana
Acacia monticola
Pittosporum sp (48)
Ptilotus rotundifolius
Acacia aneura (4)
Keraudrenia sp (96)
Scaevola parviflora
Cymbopogon sp (156)
Tephrosia arenicola
Stylobasium spathulatum
Acacia marramamba
Clerodendrum tomentosum
Santalum lanceolatum
Mukia maderaspatana
Setaria viridis
Gen nov sp (216)
Gen nov sp (220) (Chenopod)
Gossypium robinsonii
Indigofera monophylla
Gompholobium polyzyga
Acacia atkinsiana
Eucalyptus leucophloia
Tribulus platyptera
Codonocarpus cotinifolius
Acacia tenuissima
Indigofera sp (82)
Acacia cowleana
Rhynchosia minima
Eremophila cuneifolia
Eremophila sp (222)
Dodonaea viscosa subsp angustissima

VEG UNIT 3 (P)

>90%

Acacia aneura
Plectrachne aff. schinzii

89% - 75%

74% - 50%

Canthium lineare
Eremophila forrestii
Triodia pungens
Acacia aneura (2)
Acacia pruinocarpa

49% - 25%

Hakea suberea
Maireana aff. villosa
Acacia aneura (3)
Acacia pachyacra
Sida virgata
Anthobolus leptomerioides
Triodia sp (225)

24% - 10%

Solanum lasiophyllum
Paraneurachne muelleri
Gen sp. nov (73)
Aristida sp (161)
Grevillea stenobotrya
Acacia tetragonophylla
Malvaceae sp nov (231)
Eremophila latrobei
Sclerolaena sp. (52)
Gen sp nov (152)
Gen sp nov (153)
Gen nov sp (154) (Panicum)
Acacia aneura (208)
Acacia dictyophleba

<9%

Ptilotus obovatus
Canthium latifolium
Salsola kali
Eriachne aff helmsii
Sclerolaena sp (117)
Eragrostis sp (166)
Acacia stowardii
Acacia adsurgens
Triodia basedowii
Capparis lasiantha
Acacia inaequilatera
Indigofera sp (82)
Rhyncharrhena linearis
Themeda australis
Eremophila longifolia
Enchylaena sp (108)
Rhagodia sp (228)
Senna aff. artemisioides (68)
Eremophila sp (76) (12 Mile)
Gen nov sp (220) (Chenopod)
Acacia aneura (226)
Eucalyptus gamophylla
Senna glutinosa subsp pruinosa
Keraudrenia sp (96)
Senna pleurocarpa
Santalum spicatum

Absent from Veg Unit

Porana sericea
Rhagodia sp. (93)
Enneapogon clelandii
Gen nov sp (162)
Mukia maderaspatana
Eulalia fulva
Senna notabilis
Corchorus walcottii
Eucalyptus coolabah
Eriachne flaccida
Senna artemisioides subsp. helmsii
Ptilotus exaltatus
Marianum sp. (97)
Gen nov sp (50)
Malvastrum americanum
Setaria viridis
Sida sp (56)
Crotalaria sp (107)
Gen nov sp (216)
Solanum ferocissimum

Solanum horridum
Eucalyptus aspera
Acacia maitlandii
Acacia pyrifolia
Acacia ancistrocarpa
Solanum sp (102)
Senna glutinosa
Senna sp nov (106)
Gompholobium polyzyga
Acacia atkinsiana
Eucalyptus leucophloia
Tribulus platyptera
Eucalyptus setosa
Acacia tenuissima
Scaevola parviflora
Acacia cowleana
Rhynchosia minima
Triodia aff longiceps
Eremophila cuneifolia
Eremophila sp (222)
Santalum lanceolatum
Corchorus sp (213) (tebby rings)
Acacia rhodophloia
Gossypium robinsonii
Acacia bivenosa
Senna artemisioides subsp oligophylla
Indigofera monophylla
Triodia wiseana
Jasminum didymum
Acacia monticola
Pittosporum sp (48)
Ptilotus rotundifolius
Acacia aneura (4)
Codonocarpus cotinifolius
Exocarpos aphyllus
Cymbopogon sp (156)
Tephrosia arenicola
Petalostylis labicheoides
Stylobasium spathulatum
Acacia marramamba
Clerodendrum tomentosum
Dodonaea viscosa subsp angustissima

VEG UNIT 4 (P)

>90%

Acacia aneura
Aristida sp (161)
Anthobolus leptomerioides
Gen sp nov (152)
Eremophila sp (76) (12 Mile)

89% - 75%

Maireana aff. villosa
Gen sp nov (153)

74% - 50%

Sclerolaena sp. (52)
Rhagodia sp (228)
Salsola kali
Sclerolaena sp (117)

49% - 25%

Canthium lineare
Acacia aneura (2)
Plectrachne aff. schinzii
Themeda australis

24% - 10%

Hakea suberea
Sida virgata
Solanum ferocissimum
Enneapogon clelandii
Eriachne flaccida

<9%

Marianum sp. (97)
Acacia tetragonophylla
Triodia pungens
Eucalyptus aspera
Enchylaena sp (108)
Gen nov sp (154) (Panicum)
Sida sp (56)

Absent from Veg Unit

Eremophila forrestii
Solanum lasiophyllum
Canthium latifolium
Paraneurachne muelleri
Porana sericea
Rhagodia sp. (93)
Ptilotus exaltatus
Gen nov sp (162)
Acacia aneura (208)
Eucalyptus patellaris
Gen nov sp (50)
Mukia maderaspatana
Eulalia fulva
Senna notabilis
Crotalaria sp (107)
Gen nov sp (216)
Eragrostis sp (166)
Acacia aneura (3)
Acacia rhodophloia
Acacia adsurgens
Acacia aneura (226)
Gossypium robinsonii
Acacia bivenosa
Ptilotus obovatus
Eremophila latrobei
Acacia pruinocarpa
Senna artemisioides subsp. helmsii
Eremophila longifolia
Gen sp. nov (73)
Eriachne aff helmsii
Grevillea stenobotrya
Malvaceae sp nov (231)
Santalum spicatum
Senna aff. artemisioides (68)
Malvastrum americanum
Setaria viridis
Corchorus walcottii
Eucalyptus coolabah
Solanum horridum
Corchorus sp (213) (tebby rings)
Gen nov sp (220) (Chenopod)
Acacia stowardii
Triodia sp (225)
Acacia maitlandii
Acacia pyrifolia
Triodia basedowii

Acacia ancistrocarpa
Solanum sp (102)
Indigofera monophylla
Triodia wiseana
Capparis lasiantha
Acacia inaequilatera
Gompholobium polyzyga
Acacia atkinsiana
Eucalyptus leucophloia
Tribulus platyptera
Acacia dictyophleba
Keraudrenia sp (96)
Eucalyptus setosa
Exocarpos aphyllus
Indigofera sp (82)
Rhyncharrhena linearis
Acacia cowleana
Rhynchosia minima
Triodia aff longiceps
Eremophila cuneifolia
Eremophila sp (222)
Santalum lanceolatum
Senna artemisioides subsp oligophylla
Eucalyptus gamophylla
Senna glutinosa
Senna glutinosa subsp pruinosa
Senna sp nov (106)
Jasminum didymum
Acacia monticola
Pittosporum sp (48)
Ptilotus rotundifolius
Acacia aneura (4)
Codonocarpus cotinifolius
Acacia pachyacra
Acacia tenuissima
Scaevola parviflora
Senna pleurocarpa
Cymbopogon sp (156)
Tephrosia arenicola
Petalostylis labicheoides
Stylobasium spathulatum
Acacia marramamba
Clerodendrum tomentosum
Dodonaea viscosa subsp angustissima

Tony

Attached are the result of Student *t* test performed to determine if there is a difference in the distribution of mulga (dead & alive) between the different vegetation units.

A key to the abbreviations follows;

RA - Mulga regeneration alive (includes seedlings){pg 1}
TA - Mulga trees alive {pg 2}
MA - Mulga alive (includes seedlings, regen. & trees) {pg 3}
MD - Mulga dead (includes seedlings, regen. & trees) {pg 4}

The numbers alongside each code name indicate the vegetation unit.

The results indicate there is a significant difference in the distribution of live mulga between the different veg units (pg 3) with the exception of veg unit 2 & 4. Veg unit 2 has significantly more alive mulga that veg unit 3.

Similarly for dead mulga there is a significant difference between veg units (pg 4)

Alive Mulga trees are most abundant in veg unit 2 followed by 4, 3 and 1 respectively. The difference between veg unit 2 & 3 is significant - there are more alive trees in veg type 2.

Veg unit 2 has more alive regen (including seedling) that veg unit 3 however this difference is not significant (pg 2).

These results along with previous test results which indicate that veg unit 2 has more species than veg unit 3 and that veg unit 3 has few dominant species (only 5 as against 16 in veg unit 2) suggest to me that veg unit 3 has been burnt more frequently that veg unit 2 (perhaps?). If they had been burnt to a similar extent them I would expect species numbers and the living status of mulga to be similar especially with regards to th number of live trees present. This hypothesis is further highlighted by the fact that veg unit 2 has more alive trees

Results provided for dead mulga are not very useful because as we already know we were unable to count or locate all dead trees.

MULGA REGENERATION ALIVE
Mulga/500m vs Vegetation Unit

VAR NAME	SIZE	MEAN	SAMPLE STD DEV	SAMPLE VARIANCE	COEF. OF VARIATION
RA1	103	4.93204	18.0094	324.3385	3.65151
RA2	137	11.62044	15.33553	235.1785	1.3197
RA3	113	8.50442 NS	18.50006	342.2522	2.17535
RA4	109	13.65137	18.08743	327.1551	1.32495

--PAIRWISE COMPARISONS--

	1 RA1	2 RA2	3 RA3	4 RA4
RA1	0	-3.1017**	-1.4355	-3.5154**
RA2	-3.1017**	0	1.4562	-.9527
RA3	-1.4355	1.4562	0	-2.0951*
RA4	-3.5154**	-.9527	-2.0951*	0

** p<.01 * p<.05

MULGA TREES ALIVE
Mulga/500m vs Vegetation Unit

VAR NAME	SIZE	MEAN	SAMPLE STD DEV	SAMPLE VARIANCE	COEF. OF VARIATION
TA1	103	2.16505	4.48111	20.08034	2.06975
TA2	137	9.17518	9.68086	93.7191	1.05511
TA3	113	2.35398 p<0.1	4.33202	18.76643	1.8403
TA4	109	7.20184	5.94073	35.29223	.82489

--PAIRWISE COMPARISONS--

	5 TA1	6 TA2	7 TA3	8 TA4
TA1	0	-6.8178**	-.3149	-6.9388**
TA2	-6.8178**	0	6.9373**	1.8664
TA3	-.3149	6.9373**	0	-6.965**
TA4	-6.9388**	1.8664	-6.965**	0

** p<.01 * p<.05

MULGA ALIVE
Mulga/500m vs Vegetation Unit

VAR NAME	SIZE	MEAN	SAMPLE STD DEV	SAMPLE VARIANCE	COEF. OF VARIATION
MA1	103	7.09709	19.57265	383.0887	2.75784
MA2	137	20.79562	17.54035	307.6639	.84346
MA3	113	10.85841	18.33803	336.2833	1.68883
MA4	109	20.85321	20.22367	408.9968	.96981

p<0.1

--PAIRWISE COMPARISONS--

	9 MA1	10 MA2	11 MA3	12 MA4
MA1	0	-5.6966**	-1.458	-5.0279**
MA2	-5.6966**	0	4.3674**	-.0239
MA3	-1.458	4.3674**	0	-3.86**
MA4	-5.0279**	-.0239	-3.86**	0

** p<.01 * p<.05

MULGA DEAD
Mulga/500m vs Vegatation Unit

VAR NAME	SIZE	MEAN	SAMPLE STD DEV	SAMPLE VARIANCE	COEF. OF VARIATION
MD1	103	4.15534	6.2556	39.13251	1.50544
MD2	137	15.72993 p<.01	11.67294	136.2575	.74208
MD3	113	7.64602	7.00372	49.05214	.916
MD4	109	10.74312	11.50475	132.3593	1.07089

--PAIRWISE COMPARISONS--

	13 MD1	14 MD2	15 MD3	16 MD4
MD1	0	-9.1234**	-3.8488**	-5.1375**
MD2	-9.1234**	0	6.4632**	3.3498**
MD3	-3.8488**	6.4632**	0	-2.4324*
MD4	-5.1375**	3.3498**	-2.4324*	0

** p<.01 * p<.05

ANS

SPECIES PER VEGETATION TYPE

Tony,

Attached are results of Student *t* tests performed on all vegetation units to determine if there is a difference in the number of species recorded within each vegetation type. The test was performed on all vegetation types regardless of location and also for each of the two locations.

Overall the results indicate that there is a significant difference in the number of species recorded within each of the different vegetation units. In all case the significance is greater that 0.01. Vegetation unit 2 has the highest number of species followed by 1,3 and 4 respectively.

At Mt Bruce the results were identical to those obtained from the overall test.

At Packsaddle the results showed that there is now significant difference in the number of species present between vegetation units 3 and 4. The differences between these two veg units and the remaining two were significantly different as was the difference between the remaining two units.

ALL QUADRATS
numeric values

VAR NAME	SIZE	MEAN	SAMPLE STD DEV	SAMPLE VARIANCE	COEF. OF VARIATION
VU1 N	111	17.57657	6.16375	37.99181	.35068
VU2 N	139	20.33094	5.73622	32.90419	.28214
VU3 N	112	14.5	5.53612	30.64865	.3818
VU4 N	109	11.42202	3.12189	9.74618	.27332

--PAIRWISE COMPARISONS--

	1 VU1 N	3 VU2 N	5 VU3 N	7 VU4 N
VU1 N	0	-3.649**	3.9221**	9.317**
VU2 N	-3.649**	0	8.1309**	14.607**
VU3 N	3.9221**	8.1309**	0	5.0725**
VU4 N	9.317**	14.607**	5.0725**	0

** p<.01 * p<.05

MT BRUCE QUADRATS
numeric values

VAR NAME	SIZE	MEAN	SAMPLE STD DEV	SAMPLE VARIANCE	COEF. OF VARIATION
VU1 N	53	19.43396	6.9849	48.78883	.35942
VU2 N	81	21.88889	5.52494	30.525	.25241
VU3 N	89	15.30337	5.85508	34.28192	.3826
VU4 N	94	11.43617	3.08154	9.49588	.26946

--PAIRWISE COMPARISONS--

	1 VU1 N	3 VU2 N	5 VU3 N	7 VU4 N
VU1 N	0	-2.2616*	3.7785**	9.5715**
VU2 N	-2.2616*	0	7.5234**	15.723**
VU3 N	3.7785**	7.5234**	0	5.6325**
VU4 N	9.5715**	15.723**	5.6325**	0

** p<.01 * p<.05

PACKSADDLE
numeric values

VAR NAME	SIZE	MEAN	SAMPLE STD DEV	SAMPLE VARIANCE	COEF. OF VARIATION
VU1 N	50	15.52	5.02337	25.23428	.32367
VU2 N	58	18.15517	5.34364	28.55445	.29433
VU3 N	23	11.39131	2.18963	4.79447	.19222
VU4 N	15	11.33333	3.47782	12.09524	.30687

--PAIRWISE COMPARISONS--

	1 VU1 N	3 VU2 N	5 VU3 N	7 VU4 N
VU1 N	0	-2.6271*	3.78**	3.0182**
VU2 N	-2.6271*	0	5.8779**	4.6939**
VU3 N	3.78**	5.8779**	0	.0631
VU4 N	3.0182**	4.6939**	.0631	0

** p<.01 * p<.05

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

To: Tony Start
CALM Woodvale

From: Stephen van Leeuwen, KARRATHA
Phone: (091) 868 290

Subject: **MULGA FIRE STUDY**

Please find enclosed numerous graphs of the transect data from Mt Bruce and Packsaddle. I have also enclosed copies of the dendogram and two-way table from the PATN analysis that we performed in January.

The graphs are of two types. First there is the basic graph with the vegetation units plotted against the catena profile for each transect. There are four vegetation units based on our interpretation of the PATN analysis, types 1 - 4. Type 1 is at the top of the dendogram descending chronologically to type 4 at the bottom. It is clear from these graphs that veg type 4 occurs on the flats and veg type 1 is on the steep scree slopes. Veg types 2 & 3 are spread throughout the catena profile on the gently stony slopes.

The second type of graph contains all the information that was present in the previous graph with the additions of grass type and fire history information. Grass type is divided into four categories:

1. no dominant grass
2. hummock grass dominant
3. themeda grass dominant
4. bunch grass dominant

Likewise fire history has been divided into four categories:

1. no/little evidence of fire
2. pre-1986
3. 1986
4. post-1986

Information used to determine the placement of these values was obtained from data recorded in the field.

To determine if any relationships existed between veg type, grass type and fire history I performed some simple statistics on the data (X^2 & contingency tables). Before performing these test however, I reduced fire history to two categories, burnt and unburnt. It seemed pointless to have four categories when the burnt in 1986 and post-1986 categories where rarely, if at all recorded. The results of the statistics tests I performed are presented on the

attached sheets and summarised below (SS = statistically significant).

All quadrats combined.

- Veg type and fire history are dependant, strong relationship (P<0.0001).
- Unburnt quadrats are significantly more common in veg types 2 & 4.
- Veg types 1 & 3 significant more common in burnt quadrats (P<0.005 & P<0.001 respectively).
- Veg type 2 most common in unburnt quadrats but not significantly different from burnt quadrats.
- Veg type 4 most common in unburnt quadrats(P<0.001)
- No difference in the distribution of sampled quadrats it terms of their fire history, ie. equal numbers burnt & unburnt (very important when interpreting the results, ie. results no an artifact of sampling).
- As expected veg type and grass type are dependant (this result was expected because grass types were used to determine veg types).
- Hummock grass not recorded as dominant in veg type 4 however, is most common in veg type 1 & 3. Occurrence of hummock grass in veg type 2 is significant less that in veg types 1 & 3.
- Themeda occurs in veg types 2 & 4 but is absent or almost so from 1 & 3.
- Bunch grass occurs in all veg types but is greatest in veg type 4 (SS).
- Veg types 1, 2 & 3 dominated by hummock grass while veg type 4 dominated by bunch grass. Themeda does not occur in veg type 3 while hummock grass does not occur in veg type 4.
- Grass type and fire history are dependant (SS).
- Unburnt quadrats dominated by hummock grass but not significantly different from the number of quadrats with bunch grass.
- Burnt quadrats dominated by hummock grass (SS).
- Themeda & hummock grass dominated quadrats are mostly burnt (SS) while bunch grass & no grass dominated quadrats are mostly unburnt (SS).

Mt Bruce

- Fire history & veg type are associated (P<0.0001).
- Unburnt quadrats mostly recorded in veg type 4 (SS) while burnt quadrats mostly recorded in veg type 3 (P<0.05).
- At Mt Bruce more quadrats were burnt that unburnt (P<0.001).
- Grass type and veg type were significantly related.
- Hummock grass was dominant grass type in veg type 3 (SS).
- Veg type 3 quadrats never recorded with Themeda present.
- Veg type 2 has equal numbers of quadrats dominated by hummock, themeda and bunch grass.
- Grass type & fire history have a dependant association.

- Quadrats with hummock grass and themeda are mostly burnt while those with bunch grass are unburnt (SS).

PACKSADDLE
- Fire history and veg type have a dependant relationship (P<0.0001).
- Significantly more unburnt quadrats sampled than burnt (P<0.0001).
- No burnt quadrats recorded in veg type 4 quadrats.
- Grass type and veg type are associated (P<0.0001).
- Themeda not recorded as dominant species at any quadrat.
- Bunch grass recorded from veg type 2 quadrats.
- Veg type 1, 2 & 3 quadrats dominated by hummock grass (SS)
- Grass type & fire history are dependant (P<0.003)

I was unable to perform any elaborate statistics on the data because I do not have the books with the necessary procedures outlined. I have requested the appropriate books through interlibrary loan. When they arrives I will perform some detailed correlation analyses to determine if any overall relationship exists.

The statistics that I have already performed should help us locate and select site where we can establish permanent quadrats and trapping grids, ie. veg type 1 sites should be dominated by hummock grass and should have been burnt.

The remainder of this letter deals with my thoughts on how were should run the research project from here on it. It is by no means gospel and is only meant as food for thought and further discussion. I have put down my thoughts on paper and sent them to you because we need to plan now for the May trip and the years ahead. I think your idea of concentrating on the Packsaddle area is fine. The Mt Bruce area is significantly altered already by fire and access to some parts of it in the future may be restricted because of the Marandoo project. If I understood you properly after our last conversation we will use the Packsaddle area as our control and treatment area and the Mt Bruce area as the area for investigating and monitoring the effects of past fires. Is this interpretation correct?

We need to decide on the number of study sites in each of the four vegetation types we have identified. My initial thoughts are to have 4 at Packsaddle and 2 at Mt Bruce resulting in a total of 6 sites in each veg type. Two of each veg type at Packsaddle could then be treated experimentally and the remainder used as controls. Is it 24 practicable to operate ~~16~~ sites in this research program? Alternatively, we could have 3 site at Packsaddle and 1 at Mt Bruce for each veg type which would give us a total of 16 sites. Two of the Packsaddle site would be used as treatment sites but only after the collection of extensive pre-treatment data. However, if we only have one control we run the risk of losing the control as a result of fire (caused natural or otherwise). Personally I prefer the

design with 16 sites in total but can we manage this? Perhaps if we divided the Packsaddle area into two groups and worked 8 sites at a time.

At each site we could have 10 pits (buckets) laid out in a grid where the buckets are about 15 m apart and diagonally opposed. Each pit would have its own drift fence which would be about 10 m long (Gordon Friend's setup). Alternatively we could link two pits with fencing. Do you want to use drift fences? If we used this design we would require a total of 240 pits. I think we may have enough pits already. If we follow the design of one pit, one fence then we will need 240 fences or about 1 680 m of fly wire (= 20 rolls of 1.2m x 30m @ $135.95/roll = $2719). Alternatively if we have two pits per fence the we would only require 120 fences ($1359.50). As this approach is still quite expensive we may consider moving fences as were move to other sites. If we operated 8 sites at a time we would only require 40 fences ($543.80). I prefer the later option, what are your views?

Using the design where we operate 8 sites at a time a field trip from Perth would be 20 days duration as outlined below;

Day	Purpose/activity
1	depart Perth & travel
2	travel and arrive at Packsaddle
3	setup/open Packsaddle 1 sites
4	operate Packsaddle 1 sites
5	operate Packsaddle 1 sites
6	operate Packsaddle 1 sites
7	operate and close Packsaddle 1 sites
8	move and setup Packsaddle 2 sites
9	operate Packsaddle 2 sites
10	operate Packsaddle 2 sites
11	operate Packsaddle 2 sites
12	operate and close Packsaddle 2 sites
13	pack up and move to Karijini NP HQ
14	setup Mt Bruce 1 sites
15	operate Mt Bruce 1 sites
16	operate Mt Bruce 1 sites
17	operate Mt Bruce 1 sites
18	operate and close Mt Bruce 1 sites
19	depart KNP & travel
20	travel & arrive in Perth

This field trip schedule is similar to that which we have already experienced. If we followed this schedule each of the three groups of sites would receive a pit trapping effort of 320 trap nights per field trip. Over a short period of time this would amount to a considerable trapping effort.

After speaking with Nic Dunlop I think it may be wise to supplement our pits with Elliot traps. Nic said that on numerous occasions he has caught small rodents in Elliots while he has had little success in adjacent open pit traps.

We could use 10 Elliots per site and with eight site operational at any one time were would require 80 traps. We could slowly buy these over the coming years (standard size traps are $16 each) or perhaps beg, borrow or otherwise. What do you think?

Within each site I will be establishing one 15 m^2 invertebrate sampling grid which will comprise of 16 pits. The sampling design will be the same as that employed by Gordon Friend.

Each site will of course have a vegetation/flora quadrat. I am not sure of the size but it will probably be around 200 m^2. Within this area all plant species will be recorded and vegetation structure will be defined. How and using what method to define vegetation structure is yet to be decided. Any thoughts?

As far as the bird transects goes I suggest that if we use the sampling design outlined above (3 groups with 8 sites) each site should be sampled for a total of 3 hrs/field trip. This would mean the Phil would have to sample six bird transect per day. Is this realistic? Alternatively we could aim to have each site sample twice, meaning that Phil would have to sample four sites per day. Standardized sampling time for the bird transects is, as I understand, 1 hrs. This could be reduced to 30 minutes if two people undertook the sampling however, to ensure sampling continuity over time and reduce error those two personnel would always have to do it. Any comments Tony?

Besides sampling the biota in each site we need to define the physical features of the site and the soil characteristics. We need to determine soil texture , soil pH, soil moisture and soil nutrient status. Any thoughts on what we should do and how? We will be unable to do soil nutrient analysis at Karratha College because they do not have a digester however we will be able to determine pH and soil moisture. We will of course be able to determine soil moisture in the field if we have a balance and an oven as discussed previously. Andrew Storey has informed me the State Chemical Laboratories do not charge CALM for analytical work so perhaps we could get them to do the nutrient analysis. I think we will need to do soil moisture on every field trip but the other edaphic attributes will probably only need to be determine once. We will be unable to determine soil texture at Karratha College because they do not have the equipment. I am not sure where we can get access to the equipment, perhaps through one of the universities. Do you know anybody at Soil Sciences or Geography at UWA? It would also be a good idea to determine organic content of the soils.

As I understand, on our forthcoming trip we will be selecting the sites, installing trapping grids, and commencing work on the vegetation/flora. It may also be wise to commence some trapping to build up our reference

collection and determine what problems exist with the sampling design we have select before the next field trip.

As mentioned previously these are only my thoughts and are meant as a prompt for future discussions. Sorry for the length of the letter and I hope it readable.

Hope you had a good break.

Regards to all

Stephen van Leeuwen

15th March 1991

PARA 4

Tony ① we do 5 x 1 hour transects in desert & could no doubt manage 6 if required.

② would like to sample for and hear a site not 1/2 hour 1/2 and hour would not go far

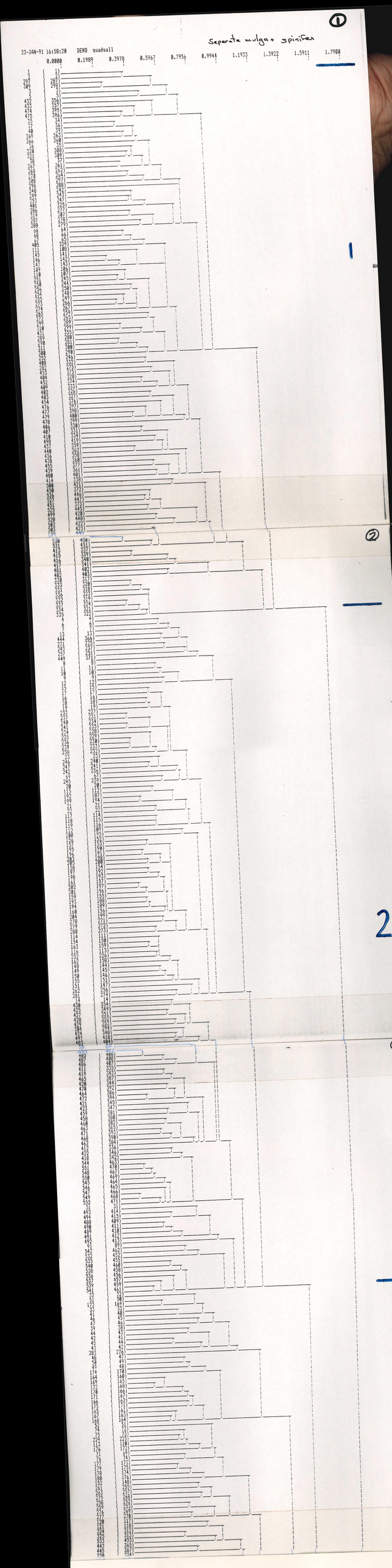
Just a thought and W.A. Govt Chem labs with the analysis of toatoire reserve water samples they cut us back from 3 to 1 collection of samples per winter. This was because of their high costs

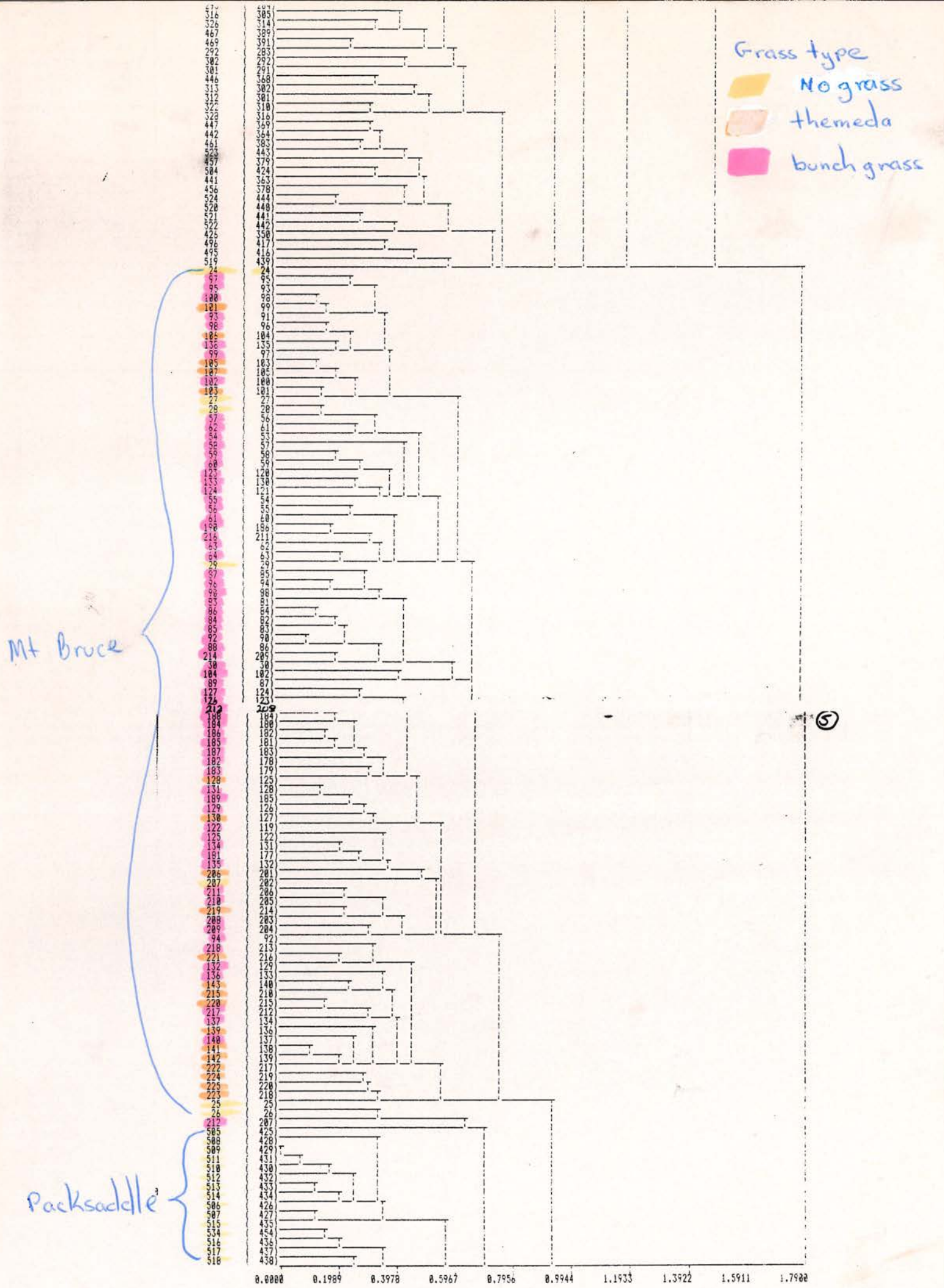
Also in sept/oct 1990 they placed on their letter for the 1st time here "none chargeable cost" (of $565) which may be a hint of things to come in future

Separate mulga + spinifex

23-JAN-91 16:58:20 DEND quadsall

0.0000 0.1989 0.3978 0.5967 0.7956 0.9944 1.1933 1.3922 1.5911 1.7900





Tony appears to be no relationship in terms of distribution of themeda dominated quadrats.

ENDEMIC SPECIES

Tony,

Below is a list of species which have only been recorded in one particular vegetation type. I am not sure what this information will be useful for, perhaps it will help in locating and identifying the different vegetation units. Values in square parentheses [] indicate number of time the species was recorded.

VEG UNIT	SPECIES
	OVERALL
VU 1	*Pittosporum* sp (48) [6], *Eucalyptus leucophloia* [33]
VU 2	-
VU 3	*Santalum lanceolatum* [4]
VU 4	-
	MT BRUCE
VU 1	*Pittosporum* sp (48) [5], *Eucalyptus leucophloia* [9]
VU 2	*Triodia longiceps* [4]
VU 3	*Santalum lanceolatum* [4]
VU 4	Gen. sp. nov. (216) [17], Triodia sp (225) [1]
	PACKSADDLE
VU 1	*Gompholobium polyzyga* [3], *Gossypium robinsonii* [3], *Acacia atkinsiana* [1], *Acacia marramamba* [3], *Acacia cowleana* [1], *Acacia tenuissima* [1], *Indigofera monophylla* [7], *Eucalyptus leucophloia* [19], *Tribulus platyptera* [8], *Acacia rhodophloia* [10], *Acacia maitlandii* [10], *Eulalia fulva* [2], *Acacia monticola* [2], *Stylobasium spathulatum* [2], *Tephrosia arenicola* [1], *Dodonaea viscosa* subsp. *angustissima* [2], *Eremophila* sp. (222) [5], *Ptilotus rotundifolius* [15], *Triodia wiseana* [13]
VU 2	*Senna notabilis* [2], *Malvastrum americanum* [1], *Solanum horridum* [1], *Crotalaria* sp. (107) [2], Gen. sp. nov. (162) [2], *Corchorus* sp (213) [1]
VU 3	Gen. sp. nov. (Chenopod) (220) [1]
VU 4	*Sida* sp. (56) [1]

ALL QUADRATS
Fire history vs Vegetation association

CONTINGENCY TABLE - 'Fire H' X 'Veget'

COLS:'Fire H' C1 BASE= 1 ,WIDTH= 1
ROWS:'Veget' R1 BASE= 1 ,WIDTH= 1

	F 1	2	TOT
1	37	66	103
	.359	.641	1
	.162	.282	.223
	.08	.143	.223
2	79	59	138
	.572	.428	1
	.346	.252	.299
	.171	.128	.299
3	35	77	112
	.313	.688	1
	.154	.329	.242
	.076	.167	.242
4	77	32	109
	.706	.294	1
	.338	.137	.236
	.167	.069	.236
TOT	228	234	462
	.494	.506	1
	1	1	1
	.494	.506	1

- unburnt sites most commonly recorded in VA 2+4. significantly more than in VA 1+3.
- burnt sites most commonly recorded in VA 1,2+3. significantly different from VA 4

SUMMARY STATISTICS

D.F. = 3

CHI-SQUARE = 45.32

PROB < .0001

CRAMER'S V = .313

CONTINGENCY COEF = .299

strong relationship between VA and fire history are dependant.

Veg. assoc. 1 most commonly recorded in burnt sites ($P<0.005$)
Veg assoc. 2 most occurs in unburnt but not significantly so.
Veg assoc 3 most occurs in burnt sites ($P<0.001$)
Veg assoc 4 most significantly occurs in unburnt sites ($P<0.001$)
No difference in sample size number of burnt + unburnt quadrats.

ALL QUADRATS
Grass type vs Vegetation association

CONTINGENCY TABLE - 'Grass' X 'Veget'

COLS:'Grass' C1 BASE= 1 ,WIDTH= 1
ROWS:'Veget' R1 BASE= 1 ,WIDTH= 1

VEG	Grass 1	2	3	4	TOT
1	0	100	1	2	103
	0	.971	.01	.019	1
	0	.362	.027	.016	.223
	0	.216	.002	.004	.223
2	14	71	16	37	138
	.101	.514	.116	.268	1
	.56	.257	.432	.298	.299
	.03	.154	.035	.08	.299
3	3	105	0	4	112
	.027	.938	0	.036	1
	.12	.38	0	.032	.242
	.006	.227	0	.009	.242
4	8	0	20	81	109
	.073	0	.183	.743	1
	.32	0	.541	.653	.236
	.017	0	.043	.175	.236
TOT	25	276	37	124	462
	.054	.597	.08	.268	1
	1	1	1	1	1
	.054	.597	.08	.268	1

- Bare ground most commonly recorded in V.A. 2 but not significantly different from VA 4. Bare ground not present in VA 1.
- Hummock grass most commonly occurs in VA1 + VA3. Is significantly greater than VA2. This grass doesn't occur in VA4 at all
- Themeda occurs in VA 2 + 4, absent or all but so from VA 1 + 3. No significant difference between VA2 + 4.
- Bunch-grass occurs in all sites, significantly greatest in VA 4.

∴ VA1 + 3 are dominated by Hummock grass exclusively, VA2 hummock grass with other grasses and VA4 by Bunchgrass.

SUMMARY STATISTICS

D.F. = 9

CHI-SQUARE = 296.03

PROB < .0001

As expected grass type and vegetation unit are associated.

CRAMER'S V = .462

CONTINGENCY COEF = .625

Result expected because grass types used in PATN analysis to determine assoc.

Veg. assoc. 1 significantly dominated by Hummock grass.
Veg assoc. 2 significantly ($P < 0.005$) dominated by Hummock grass
Veg assoc. 3 significantly dominated by Hummock grass.
Veg assoc 4 significantly dominated by Bunchgrass.
Themeda doesn't occur in Veg. assoc. 3 Hummock grass doesn't occur in veg assoc. 4.

ALL QUADRATS
Grass type vs Fire history

CONTINGENCY TABLE - 'Grass' X 'Fire H'

COLS:'Grass' C1 BASE= 1 ,WIDTH= 1
ROWS:'Fire H' R1 BASE= 1 ,WIDTH= 1

	1	2	3	4	TOT
1	22	104	9	93	228
	.096	.456	.039	.408	1 NS
	.88	.377	.243	.75	.494
	.048	.225	.019	.201	.494
2	3	172	28	31	234
	.013	.735	.12	.132	1 *
	.12	.623	.757	.25	.506
	.006	.372	.061	.067	.506
TOT	25	276	37	124	462
	.054	.597	.08	.268	1
	1	1	1	1	1
	.054	.597	.08	.268	1

SUMMARY STATISTICS

D.F. = 3

CHI-SQUARE = 71.88

PROB < .0001

CRAMER'S V = .394

CONTINGENCY COEF = .367

Grass type and Fire history are associated - Not independent

UNBurnt sites dominated by Hummock grass (45%) but not significally different in number from Bunch grass (40%)

Burnt site dominated significantly so by Hummock grass (75%) no difference between occurance of BG or T in burnt sites

38% of site which have no grass are unburnt (significant)
62% of Hummock Grass dominated sites burnt (significant)
76% of Themeda sites burnt (significant $p<0.005$)
75% of Bunch grass sites unburnt (significant)

MT BRUCE
Fire history vs Vegetation association

CONTINGENCY TABLE - 'Fire H' X 'Veget'

COLS:'Fire H' C1 BASE= 1 ,WIDTH= 1
ROWS:'Veget' R1 BASE= 1 ,WIDTH= 1

	1	2	TOT
1	12	41	53
	.226	.774	1
	.106	.203	.168
	.038	.13	.168
2	27	53	80
	.338	.663	1
	.239	.262	.254
	.086	.168	.254
3	12	76	88
	.136	.864	1
	.106	.376	.279
	.038	.241	.279
4	62	32	94
	.66	.34	1
	.549	.158	.298
	.197	.102	.298
TOT	113	202	315
	.359	.641	1
	1	1	1
	.359	.641	1

Most unburnt sites are in VA4 (significant)

Burnt sites most commonly recorded in VA3 ($P<0.05$)

SUMMARY STATISTICS

D.F. = 3

CHI-SQUARE = 60.09

PROB < .0001

Fire history + VA are associated (significant)

CRAMER'S V = .437

CONTINGENCY COEF = .4

Veg associations 1, 2 + 3 are most commonly found in burnt sites (signif.)
Veg association 4 most commonly found in unburnt (signific.ly)

AT Mt Bruce significantly more site were burnt than unburnt ($P<0.001$)

MT BRUCE
Grass type vs Vegetation association

CONTINGENCY TABLE - 'Grass' X 'Veget'

COLS:'Grass' C1 BASE= 1 ,WIDTH= 1
ROWS:'Veget' R1 BASE= 1 ,WIDTH= 1

	1	2	3	4	TOT
1	0	50	1	2	53
	0	.943	.019	.038	1
	0	.299	.027	.021	.168
	0	.159	.003	.006	.168
2	6	33	16	25	80
	.075	.413	.2	.313	1
	.429	.198	.432	.258	.254
	.019	.105	.051	.079	.254
3	0	84	0	4	88
	0	.955	0	.045	1
	0	.503	0	.041	.279
	0	.267	0	.013	.279
4	8	0	20	66	94
	.085	0	.213	.702	1
	.571	0	.541	.68	.298
	.025	0	.063	.21	.298
TOT	14	167	37	97	315
	.044	.53	.117	.308	1
	1	1	1	1	1
	.044	.53	.117	.308	1

Hummock grass not present in VH4, most common statistically in VH3.

Themeda absent from VH3, most common in VH2 + VH4

Bunch Grass most common (significant) in VH4.

SUMMARY STATISTICS

D.F. = 9

CHI-SQUARE = 216.66

PROB < .0001

Grass type + VA are significantly associated

CRAMER'S V = .479

CONTINGENCY COEF = .638

VA 1 + 3 dominated by Hummock grass. Both always have a grass of some types present

VH 3 also doesn't have Themeda present.

VH2 has equal numbers of sites with hummock, Themeda and Bunchgrass (raw values may look different but statistically not)

VH4 dominated by Bunch grass.

MT BRUCE
Grass type vs Fire history

CONTINGENCY TABLE - 'Grass' X 'Fire H'

COLS:'Grass' C1 BASE= 1 ,WIDTH= 1
ROWS:'Fire H' R1 BASE= 1 ,WIDTH= 1

	1	2	3	4	TOT
1	12	26	9	66	113
	.106	.23	.08	.584	1
	.857	.156	.243	.68	.359
	.038	.083	.029	.21	.359
2	2	141	28	31	202
	.01	.698	.139	.153	1
	.143	.844	.757	.32	.641
	.006	.448	.089	.098	.641
TOT	14	167	37	97	315
	.044	.53	.117	.308	1
	1	1	1	1	1
	.044	.53	.117	.308	1

SUMMARY STATISTICS

D.F. = 3

CHI-SQUARE = 90.82

PROB < .0001

CRAMER'S V = .537

CONTINGENCY COEF = .473

Gt + FH significantly associated

Unburnt sites most common in Bunch grass sites
Burnt sites most common in Hummock grass sites

Hummock grass sites mostly burnt (significant)
Themeda grass sites mostly burnt (significant)
Bunch grass sites mostly unburnt (significant)

PACKSADDLE
Fire history vs Vegetation association

CONTINGENCY TABLE - 'Fire H' X 'Veget'

COLS:'Fire H' C1 BASE= 1 ,WIDTH= 1
ROWS:'Veget' R1 BASE= 1 ,WIDTH= 1

	1	2	TOT
1	25	25	50
	.5	.5	1
	.217	.781	.34
	.17	.17	.34
2	52	6	58
	.897	.103	1
	.452	.188	.395
	.354	.041	.395
3	23	1	24
	.958	.042	1
	.2	.031	.163
	.156	.007	.163
4	15	0	15
	1	0	1
	.13	0	.102
	.102	0	.102
TOT	115	32	147
	.782	.218	1
	1	1	1
	.782	.218	1

UNBurnt sites most commonly recorded in VA2.

Burnt sites mostly in VA1. no burnt sites recorded in VA 4

SUMMARY STATISTICS

D.F. = 3

CHI-SQUARE = 36.39

PROB < .0001

Fire history + VA are associated (significantly)

CRAMER'S V = .498

CONTINGENCY COEF = .445

Veg assoc. 1,3+4 most commonly in unburnt sites (significant)

Significantly more unburnt sites sampled than burnt
P = 46.8 < 0.001.

PACKSADDLE
Grass type vs Vegetation association

CONTINGENCY TABLE - 'Grass' X 'Veget'

COLS:'Grass' C1 BASE= 1 ,WIDTH= 1
ROWS:'Veget' R1 BASE= 1 ,WIDTH= 1

	1	2	3	4	TOT
1	0	50	0	0	50
	0	1	0	0	1
	0	.459	0	0	.34
	0	.34	0	0	.34
2	8	38	0	12	58
	.138	.655	0	.207	1
	.727	.349	0	.444	.395
	.054	.259	0	.082	.395
3	3	21	0	0	24
	.125	.875	0	0	1
	.273	.193	0	0	.163
	.02	.143	0	0	.163
4	0	0	0	15	15
	0	0	0	1	1
	0	0	0	.556	.102
	0	0	0	.102	.102
TOT	11	109	0	27	147
	.075	.741	0	.184	1
	1	1	0	1	1
	.075	.741	0	.184	1

Themeda not dominant at any site or veg association

Bunch grass occurs in both VA 2+4, no difference.

Hummock grass most common in VA1 sites followed by VA 2 + VA3

SUMMARY STATISTICS

D.F. = 6

CHI-SQUARE = 93.73

PROB < .0001

Grass type + VA are significantly associated

CRAMER'S V = .565

CONTINGENCY COEF = .624

Veg Assoc. 1 exclusively dominated by Hummock grass.
Veg Assoc 2 dominated by Hummock grass (statistically significant)
Veg Assoc 3 dominated by Hummock grass (significant)
Veg Association 4 exclusively dominated by Bunch grass

PACKSADDLE
Grass type vs Fire history

CONTINGENCY TABLE - 'Grass' X 'Fire H'

COLS:'Grass' C1 BASE= 1 ,WIDTH= 1
ROWS:'Fire H' R1 BASE= 1 ,WIDTH= 1

	1	2	3	4	TOT
1	10	78	0	27	115
	.087	.678	0	.235	1
	.909	.716	0	1	.782
	.068	.531	0	.184	.782
2	1	31	0	0	32
	.031	.969	0	0	1
	.091	.284	0	0	.218
	.007	.211	0	0	.218
TOT	11	109	0	27	147
	.075	.741	0	.184	1
	1	1	0	1	1
	.075	.741	0	.184	1

SUMMARY STATISTICS

D.F. = 2

CHI-SQUARE = 11.4

PROB = .003 significant //

GT + FH are significantly associated.

CRAMER'S V = .278

CONTINGENCY COEF = .268

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unburnt sites dominated by Hummock grass
Burnt sites dominated by Hummock grass

Hummock grass sites most common sites sampled (74%)

Most Hummock grass sites unburnt
No Bunch grass sites burnt.

ANS Copy

Exm. 31/91.

Rec 15/4

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

RESEARCH PROJECT PLAN

SOHQ File No.
(to be assigned by records)

RPP No. 54/91
(to be assigned by biometritian)

1. Title of investigation:

FIRE-MULGA STUDY. PROJECT 1.

2. Background/Justification:
Areas of mulga woodland that have been destroyed by fire are abundant in the southern and eastern Pilbara, including Hamersley Range National Park. It has been suggested by many people that the woodlands are not regenerating and that the fires are driving a change to hummock grasslands.

Many species (animal and plant) are supposedly limited, at least in the Pilbara, to Mulga woodlands. However Mulga woodlands grow on a wide array of very different sites many of which are characterised by different soils, surface hydrology and dominant plants in the understory. Some assemblages appear to have little in common besides Mulga as a dominant upper stratum. However there have been no systematic attempts in the Pilbara to define distinctive assemblages or relate animals or plants of mulga woodlands to them.

Preliminary surveys have shown that in the northern part of the N.P. much of the mulga woodland grew on gentle slopes. However there is now virtually no area of unburnt woodland on these slopes in the N.P. They are currently dominated by hummock grasses but dead Mulga stags, stumps and some live Mulga seedlings persist. Apparently similar assemblages grow on similar sites near Packsaddle (out side the N.P) where there are both burnt and unburnt examples.

These assertions pose questions such as:-
What are the effects of fire on mulga woodlands in this area?
Are we losing community or species diversity in the N.P.?
How should we manage Mulga woodlands on CALM lands?

To answer these questions we have set out to test the following hypotheses.

1. In the Hamersley Range, Mulga dominates a variety of distinct and definable plant and animal assemblages each of which occupies sites with characteristic edaphic and geomorphic features.

2. Some species in the mulga dominated assemblages (MDA) are endemic to them in the Hamersley Range.

3. In the Hamersley Range, species composition and vegetation structure of some or all MDA and the balance between MDA and hummock grasslands are changing.

4. Assuming Hypothesis 3 to be true, fire is an important causative factor but MDAs vary in their vulnerability and resilience to fire.

5. Modification of MDAs by fire is reducing biological diversity.

The ultimate objective is to provide the information on management of fire in and around Mulga woodlands needed by the Region for effective and economical management of the CALM Estate in accordance with CALM's objectives, particularly the maintenance of diversity.

3. Aim:
The fire mulga study will be a long term study which will comprise a sequence of dependent or related projects. Each component project will be the subject of a RPP.
The aims of **Project 1** are to:-

a. Define and map recognisably distinct Mulga-dominated plant assemblages in the Mount Bruce and Packsaddle areas of the Hamersley Range.

b. Relate each assemblage to its position in the landscape and to gross characteristics of the physical environment.

c. Assess the vulnerability of each assemblage to fire .

d. Develop sampling parameters for subsequent projects (establishment of experimental and control plots for detailed sampling, experimental burning and long term monitoring of the assemblages). These projects will be subject to separate RPPs.

4. Target users:
Initially CALM Operations, Planning and Fire Protection Branches. Ultimately, hopefully, other land managers with responsibility for Mulga lands in the Pilbara.

5. Supervising Scientists:
A.N. Start and S. van Leeuwen.

6. Associated staff:
Technical Officers P.J. Fuller and B. Bromilow.

7. Associated institutions:
Nil but the Marandoo Joint Venturers (including HI/CRA) are providing access to pertinent data collected for them in the early 1970s. Some of our sites are located on the Marandoo project area and we anticipate continued co-operation with their Environmental consultants including access to remote sensing and other data.

8. Location:
Pilbara Region. Two sites:-

a. Mount Bruce area, Hamersley Range National Park.
b. Mount Meharry area south east of (but sought for inclusion into) HRNP.

9. Study design:
Survey.

10. Statistical analysis:
PATN and, for appropriate attributes, tests for significance of differences between and degrees of similarity within the groupings suggested by PATN.

11. Proposed starting date and expected duration of study:
Study started in 1989. with a recce trip to locate sites and establish methods for this stage. In 1990 we conducted two three-week field trips to establish transects and quadrats. This stage will conclude by end of 1991 with completion of field work and analysis of the data.

12. Method:

1. Transects. 13 transects ranging from 1.0km to 4.6km (total 31.4km) are located in the Mt. Bruce area and 7 transects ranging from 0.9km to 3.3km (total 14.7km) are located in the Mt. Meharry area. The transects traverse all major land units supporting mulga in these areas. Each transect comprises a continuous straight series of 100m sections . For each section we:-

   * count all trees (including Mulga) within 2.5m of the centre line (effectively a continuous series of 100X5m quadrats) and score each as reproductively mature or seedling or resprout.
   * record dominant tree species (for mulga also tree form)
   * record dominant grass species, if any.
   * measure overall slope to +/- 1° using a clinometer.
   * record basic soil types.
   * record evidence of fire.
   * note any extensive area of bare ground as "intergrove" or "other"
   * note evidence of past fire history.
   * note significant change, if any, in these attributes over the length of each transect.

b. Quadrats. Each 100m transect section-marker is used as a corner for a 40X40m quadrat. Each perennial plant species present within each quadrat is recorded. This provides us with presence absence data for the PATN matrix.

   The size of the quadrats was decided by graphing the mean cumulative total of perennial species present in ten series of nested quadrats that ranged from 5X5m (25sqm) to 50X50m (2500sqm). The ten sample sites were on consecutive sections of a transect that intersected hummock grassland and mulga woodland.

Reports:

I.R. Presented at Spinifex workshop.

P.R. July 1991 at departmental Seminar.

F.R. July 1992. written up manuscript.

14. Costs: CRF Allocation to ANS 10,700
CRF Allocation to SvL 9,610
TOTAL $ 20,310

15. Other file numbers: Nil

Research Centre local files

Associated existing RPPs:

16. Signature, Supervising Scientist [signature]

Date: 10/4/91.

Attachments:

17. Comments:

Program Leader O.K. Neil Sassows. 1/5/91

Regional ~~District~~ Manager

No problems with this phase of the work. The experimental burns will probably stretch the resources of the region, requiring outside assistance to be provided.
H. Chevis 19/4/91

Biometrician

In place MRW 18/4/91

18 Approval of the relevant SPRS [signature] 3/5/91
If not approved return to the Supervising scientist for reconsideration.

19. Approval noted by Divisional Admin Assistant:

Initial [signature] Date 3/5/91

rpp/mulga-1.doc

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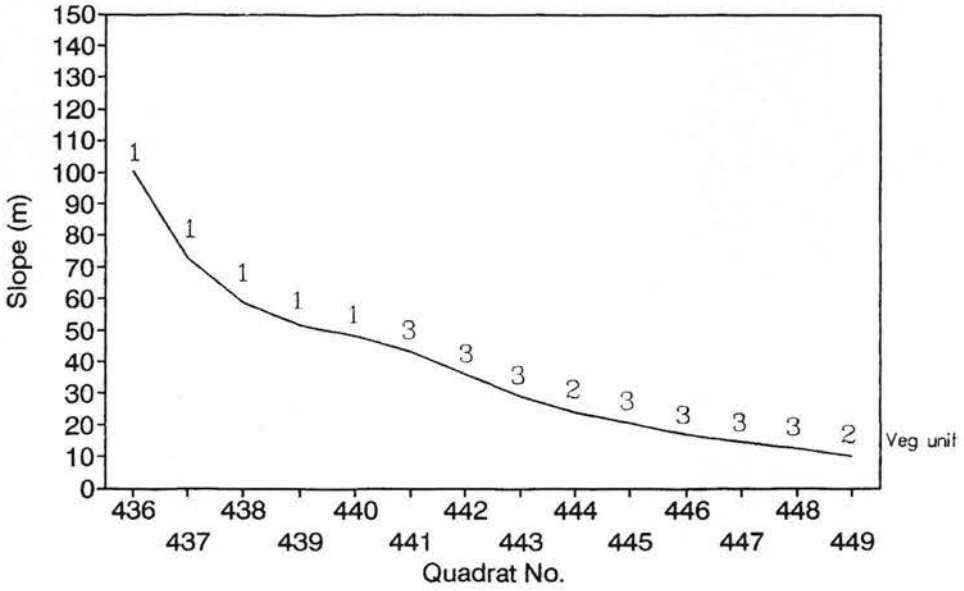

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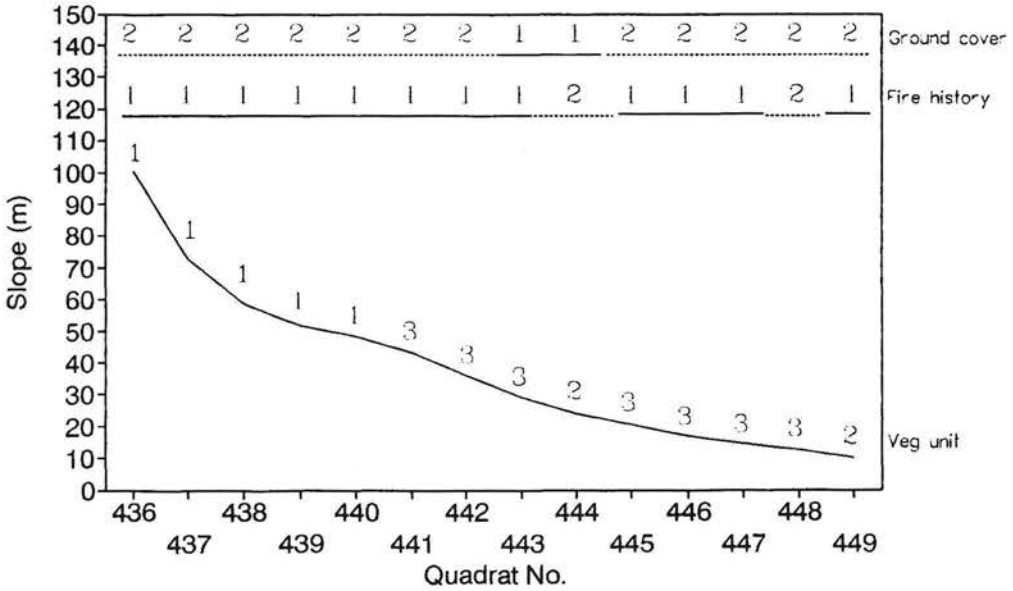

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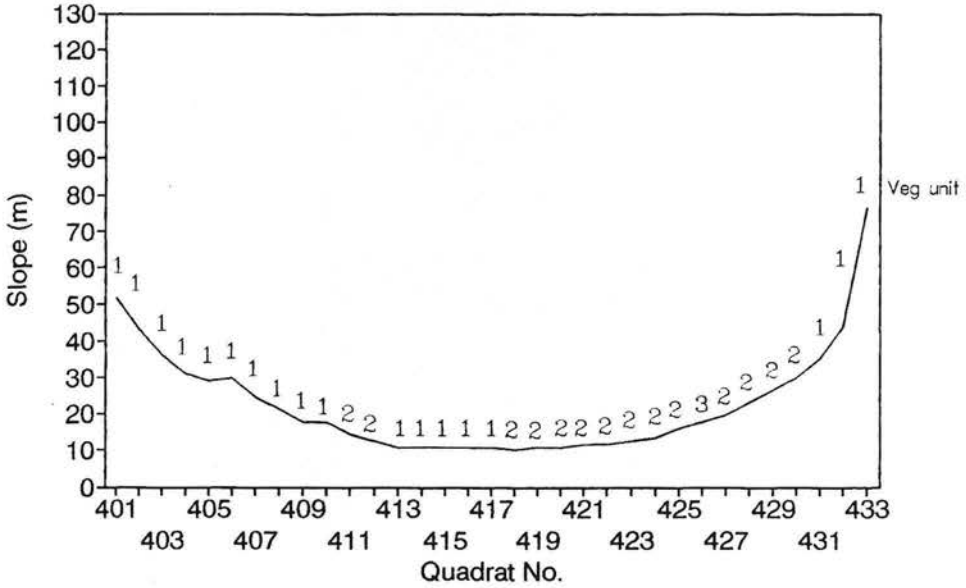

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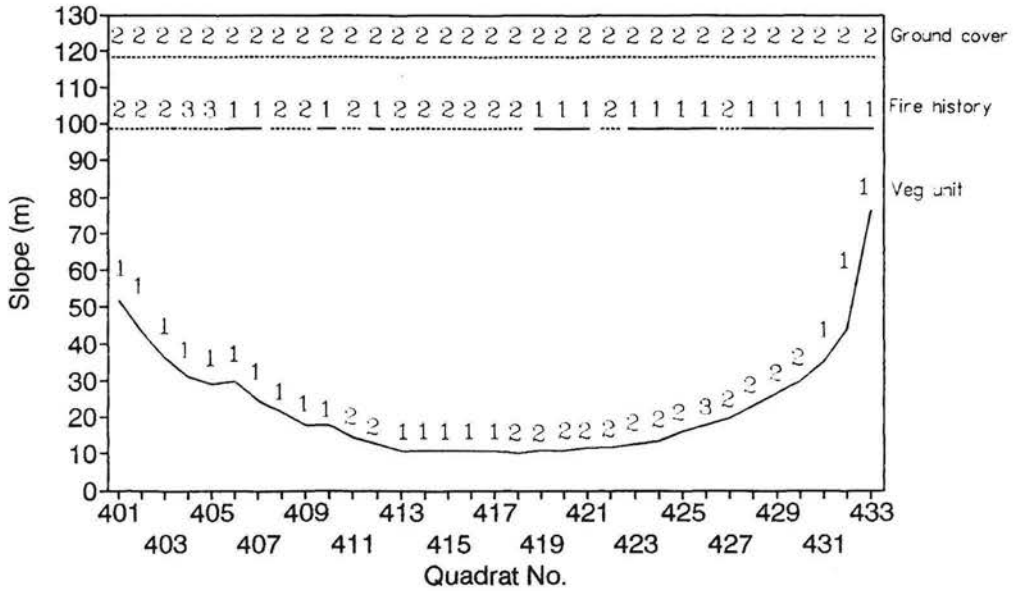

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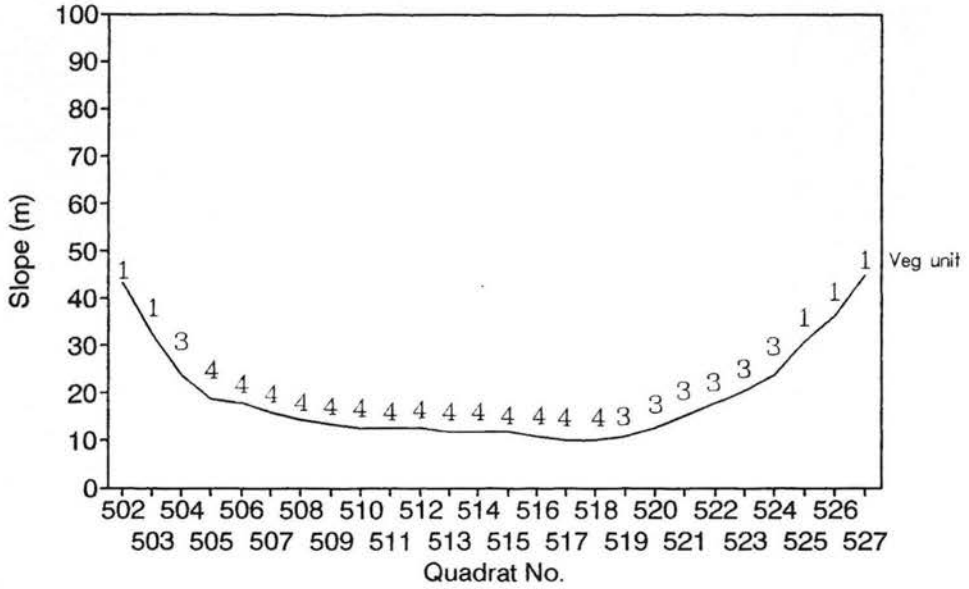

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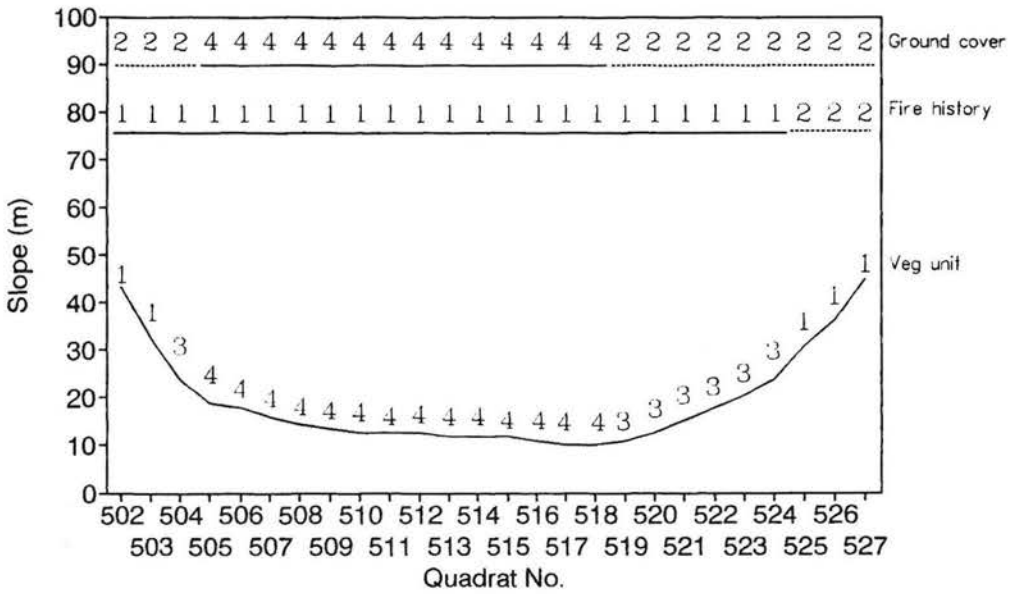

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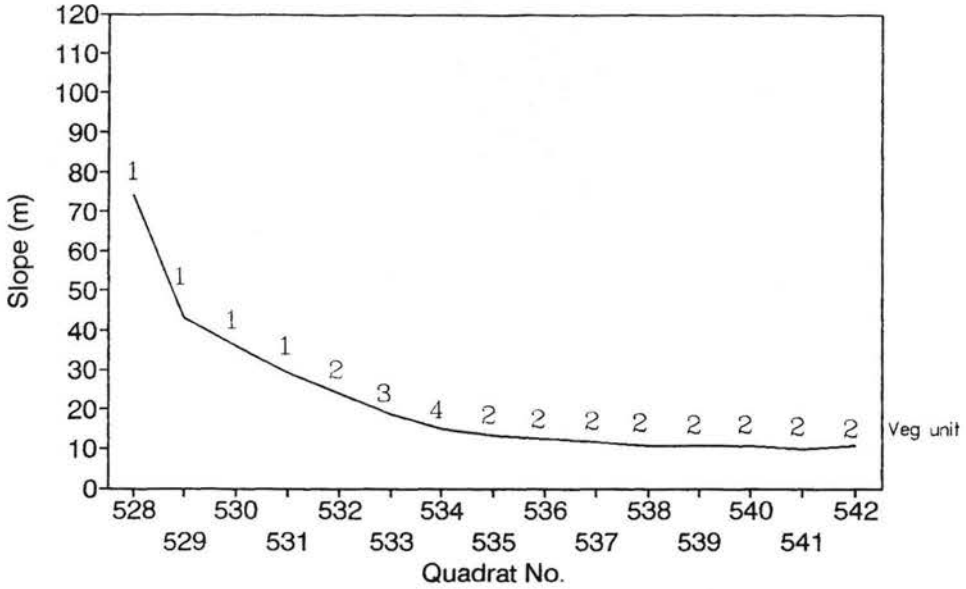

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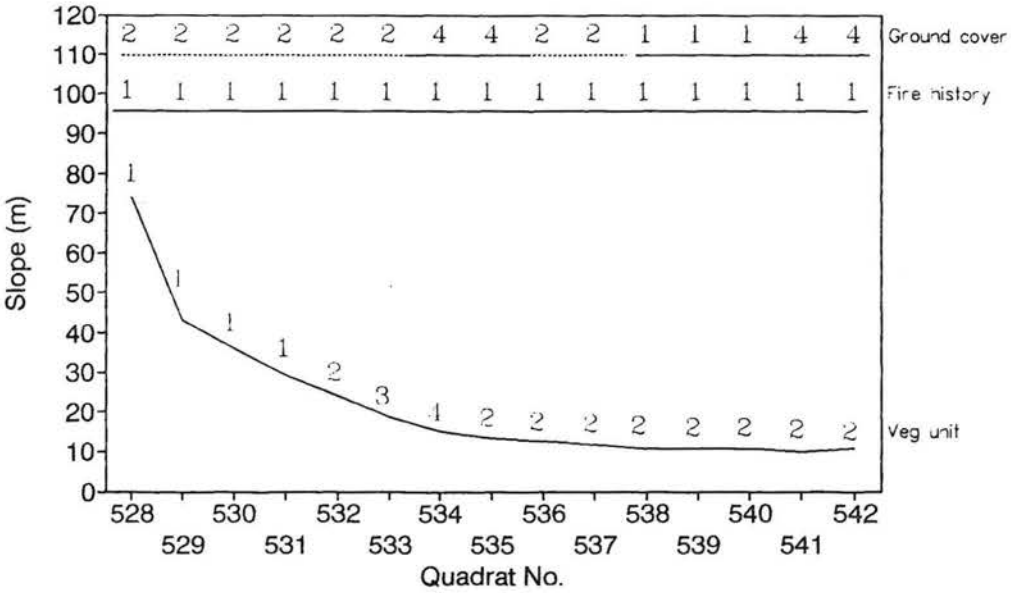

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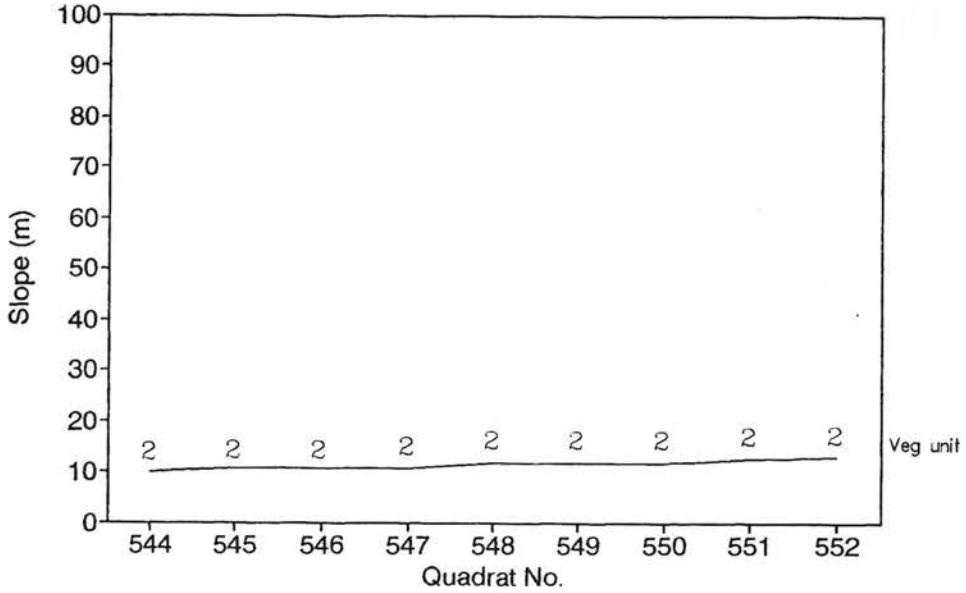

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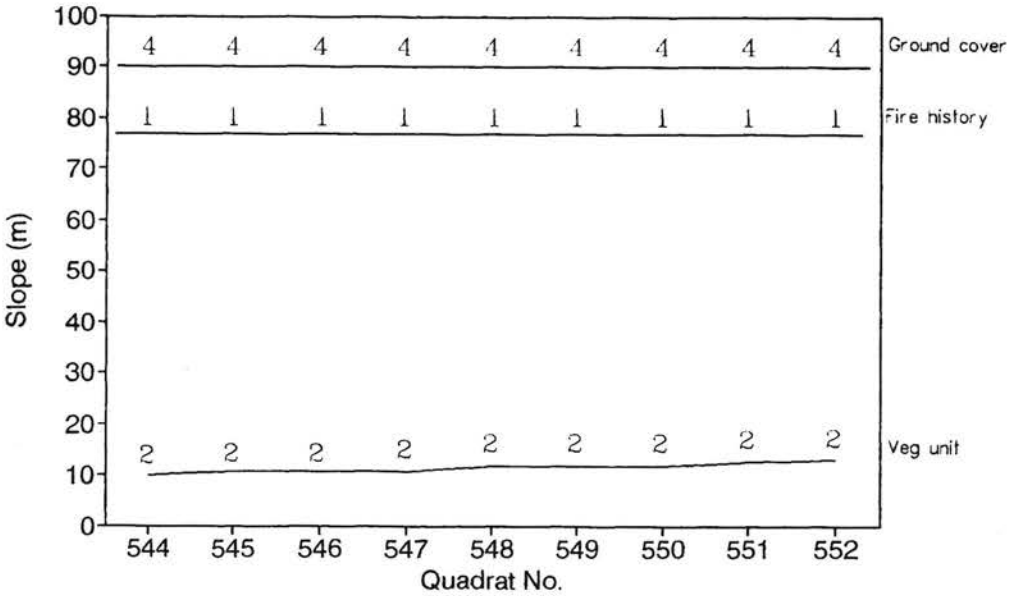

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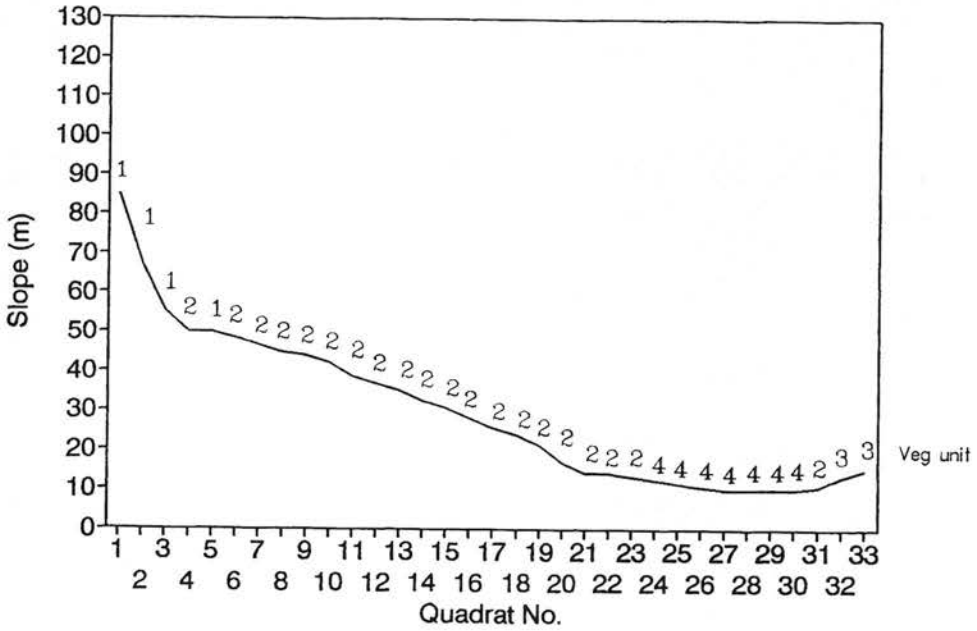

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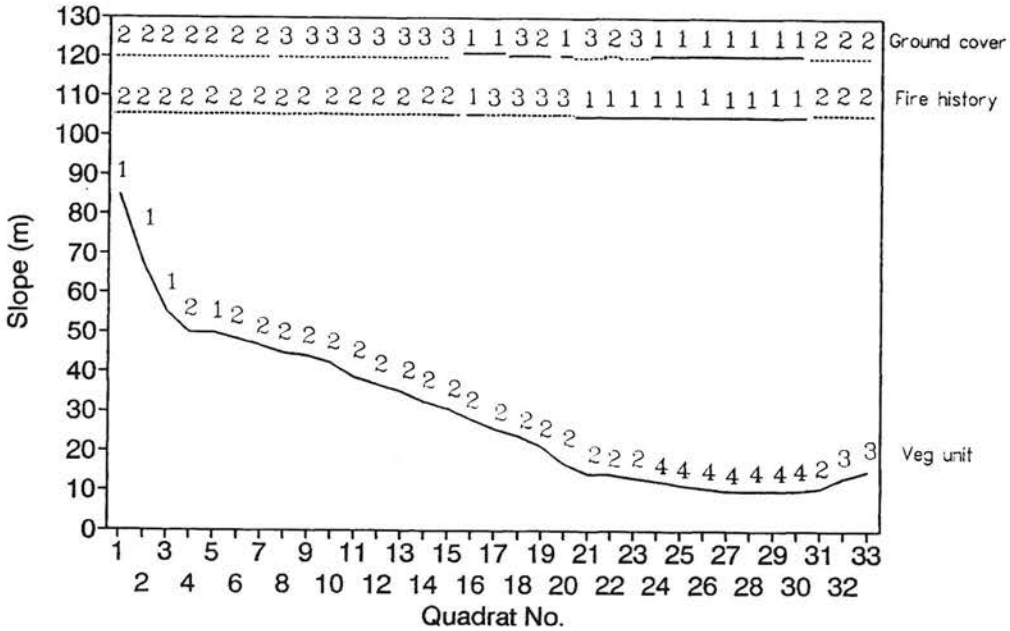

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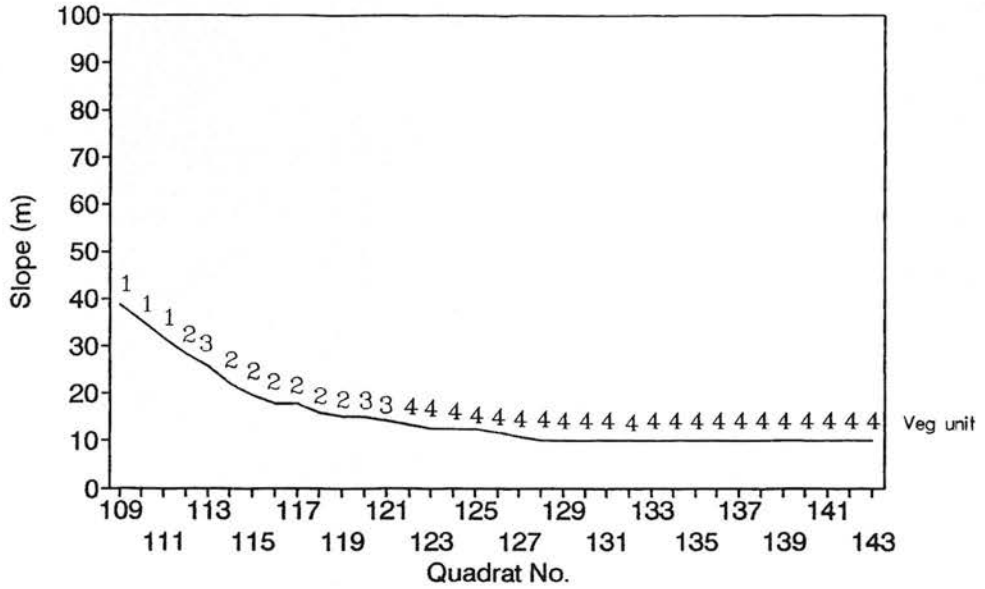

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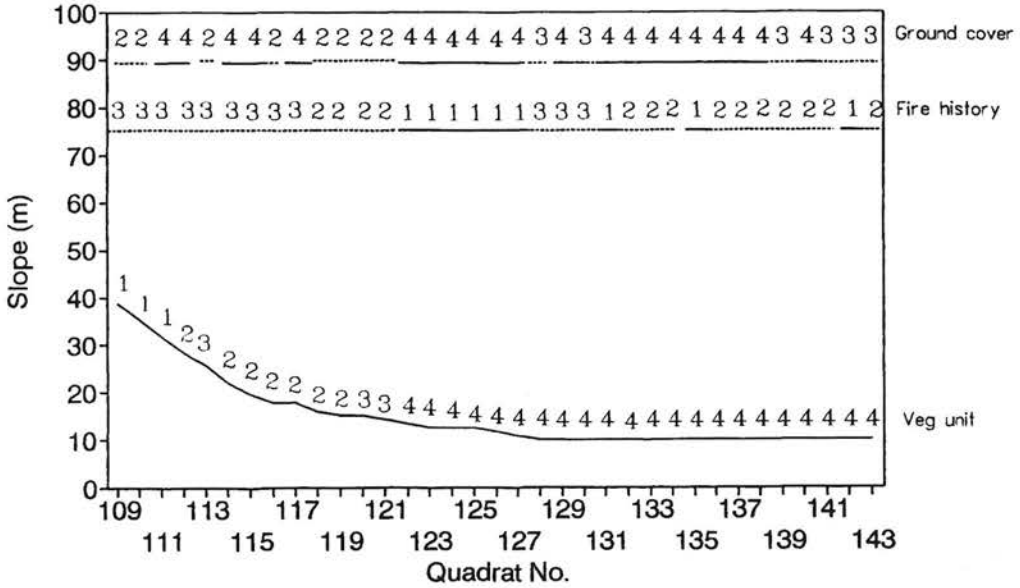

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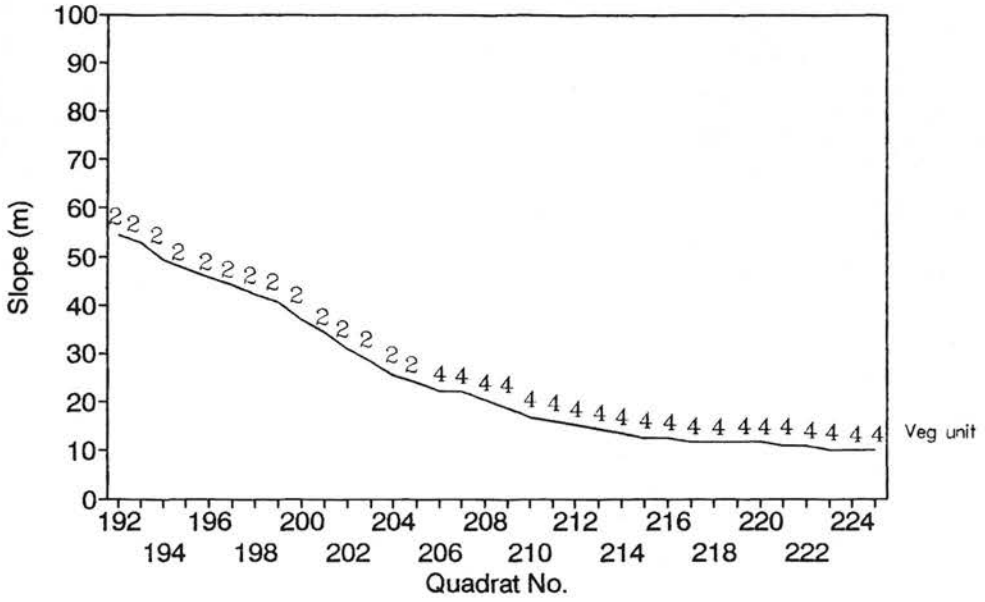

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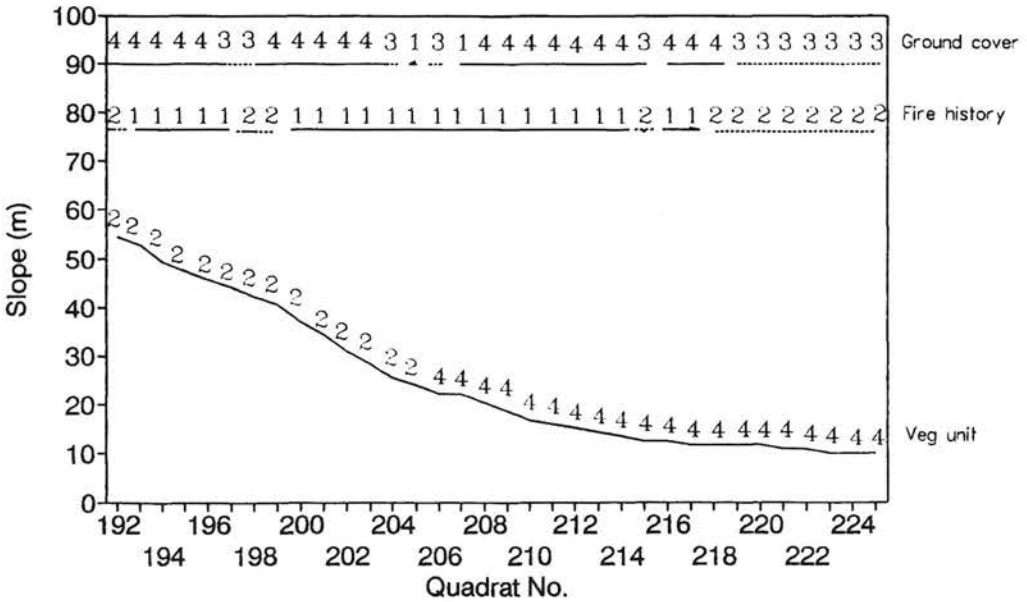

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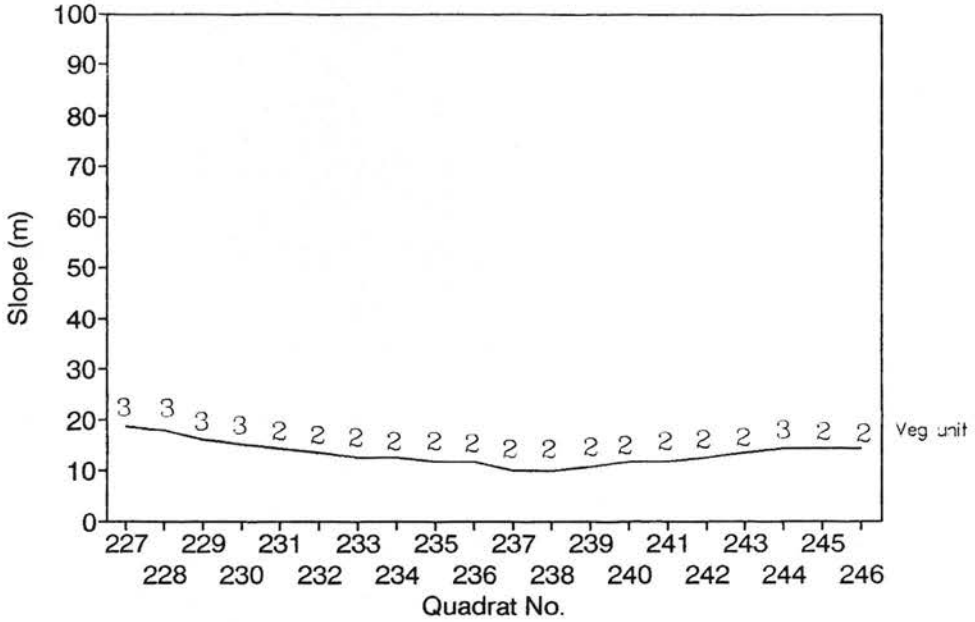

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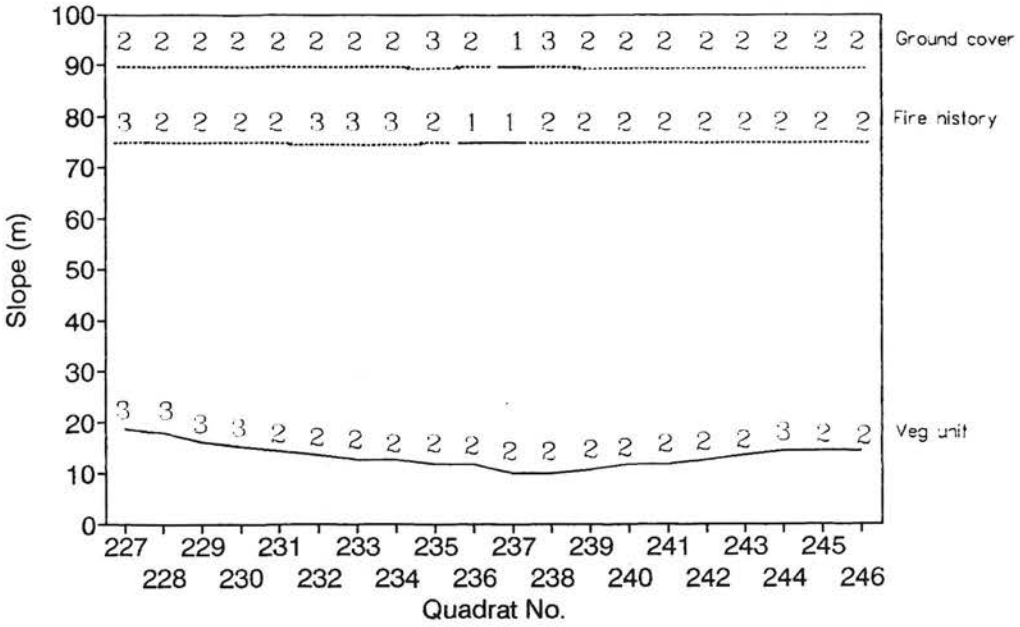

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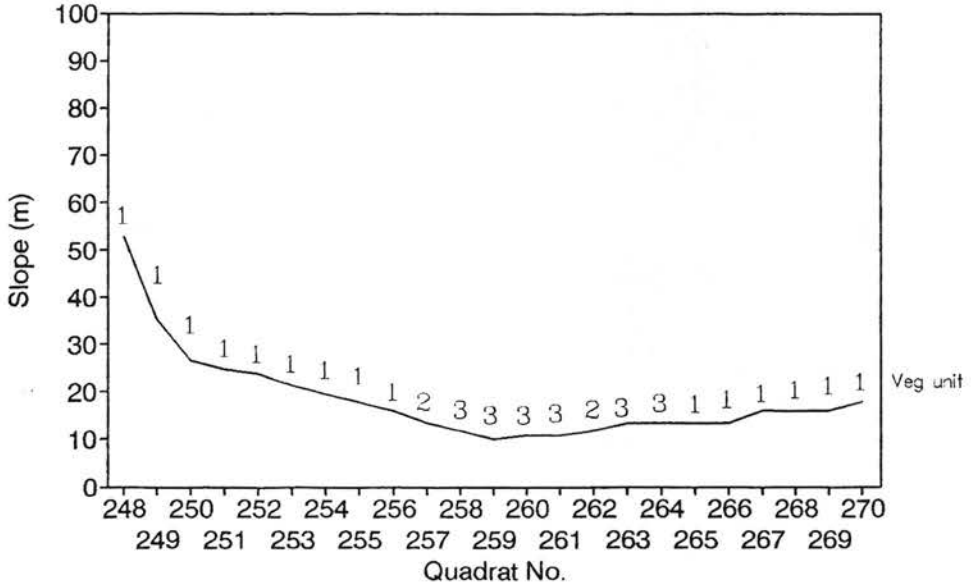

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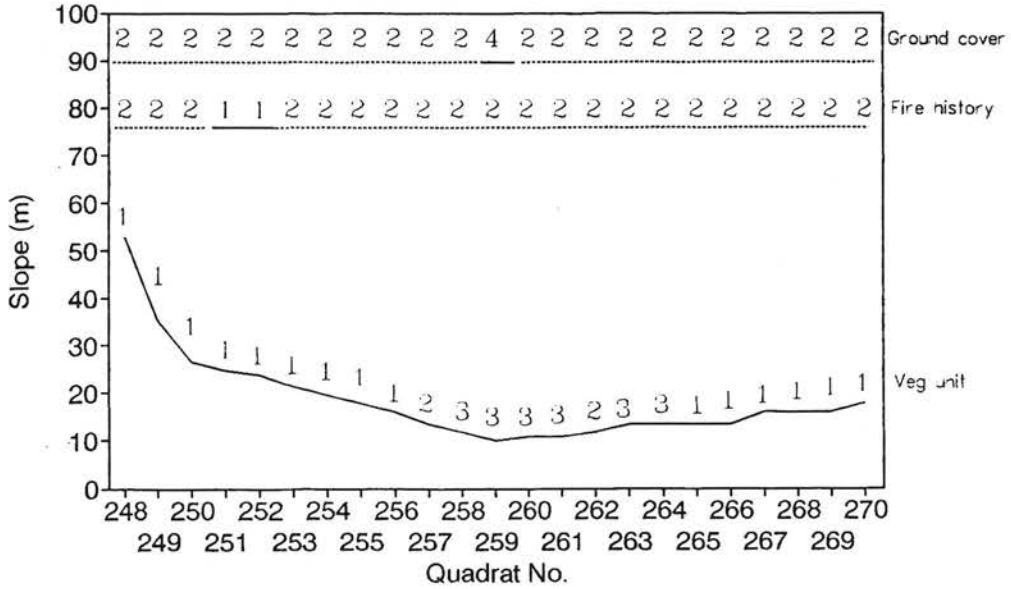

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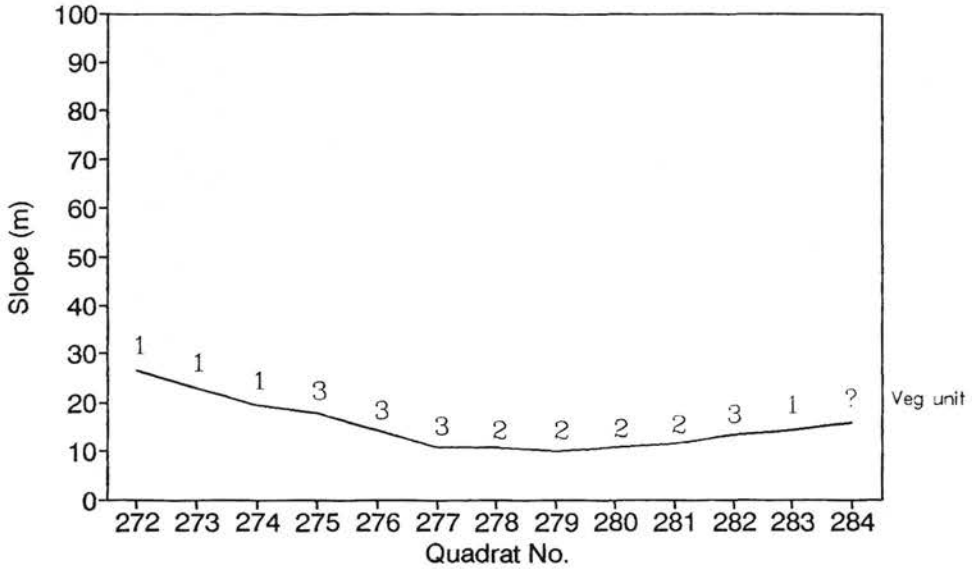

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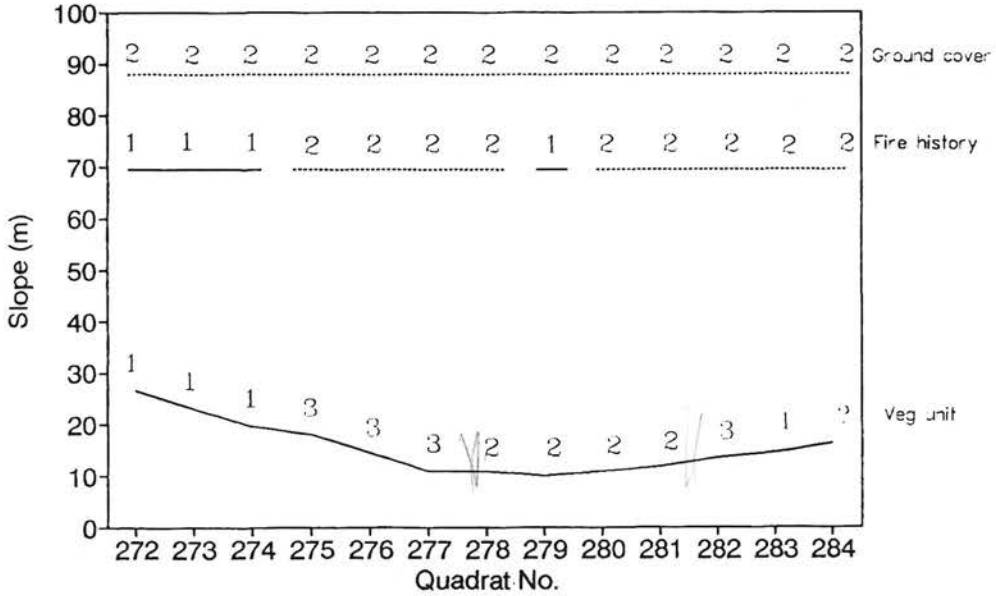

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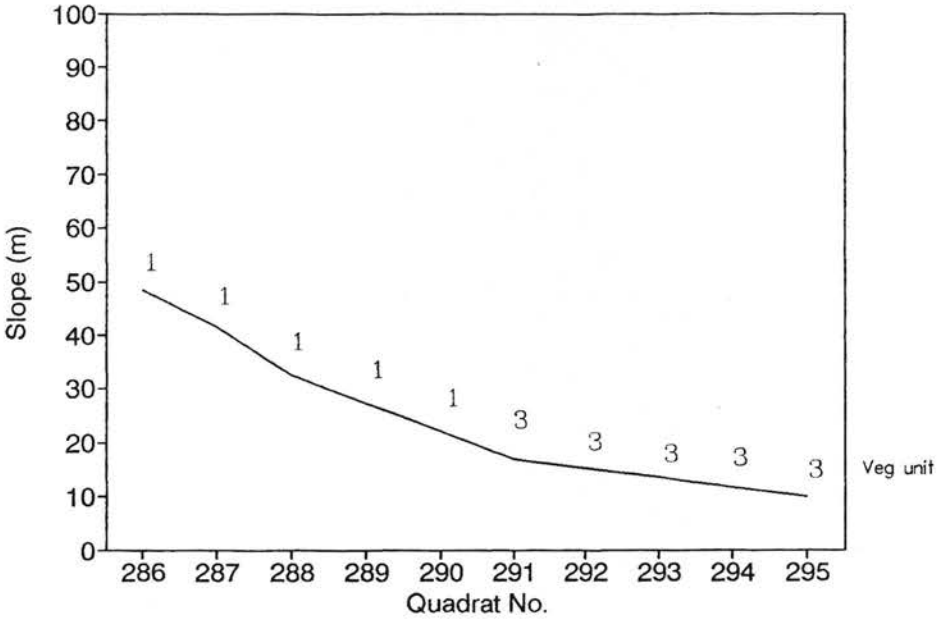

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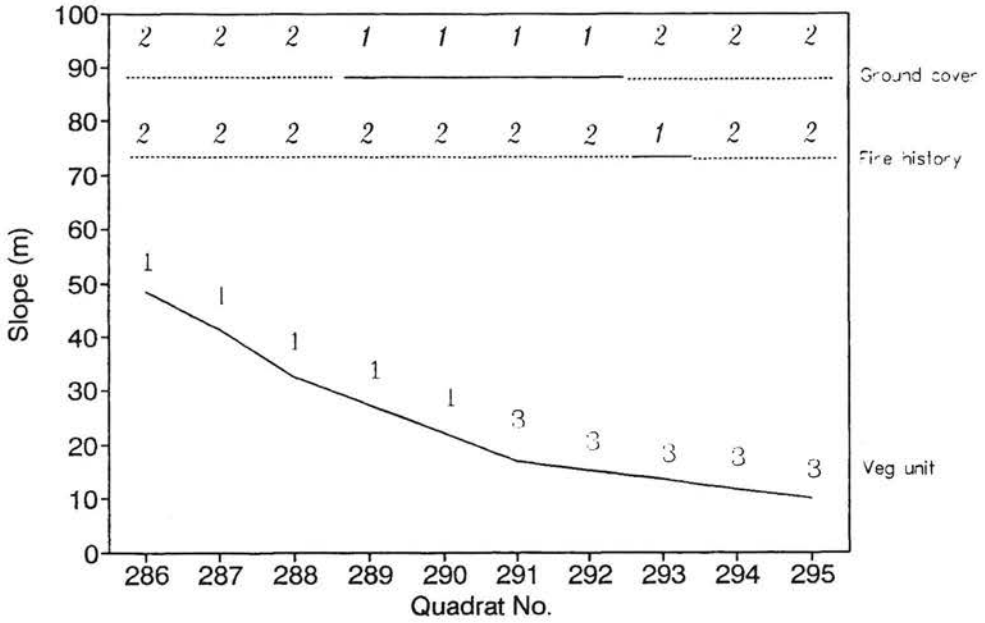

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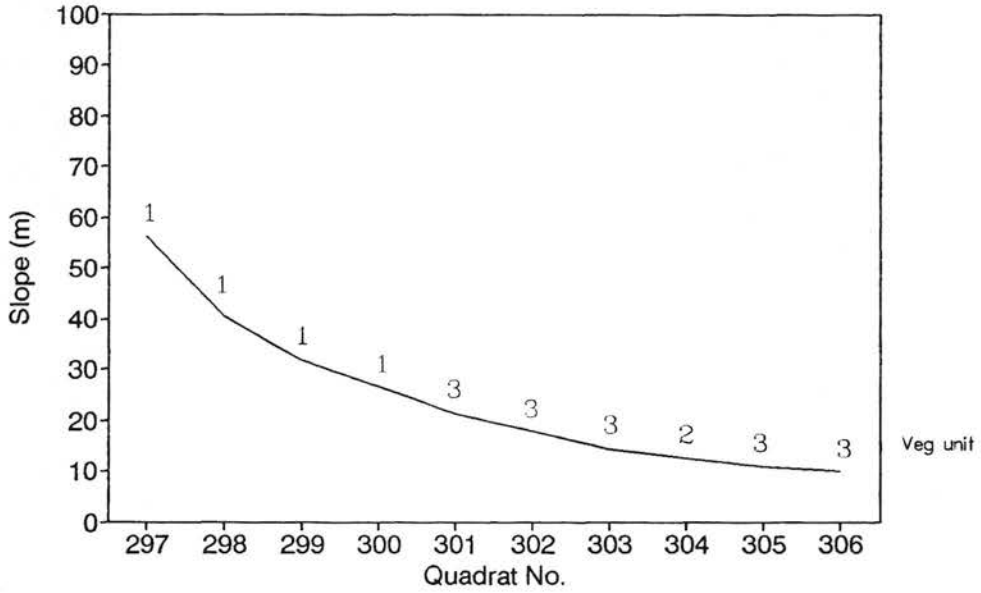

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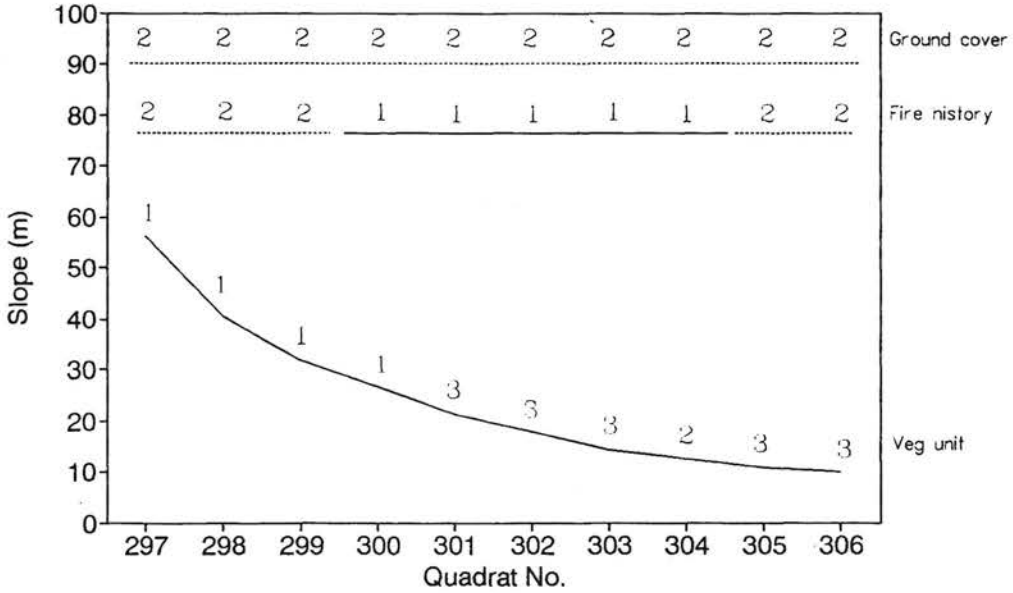

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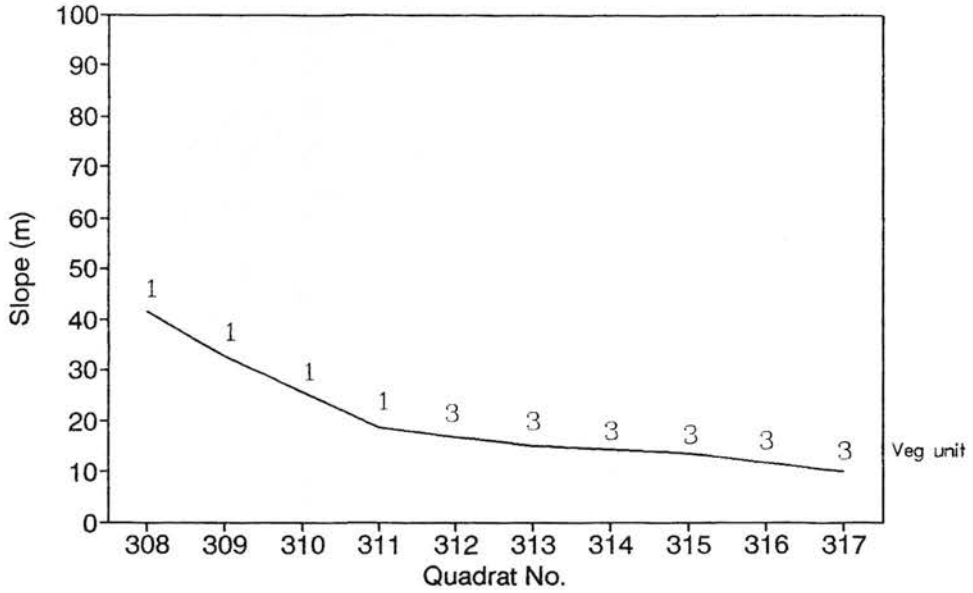

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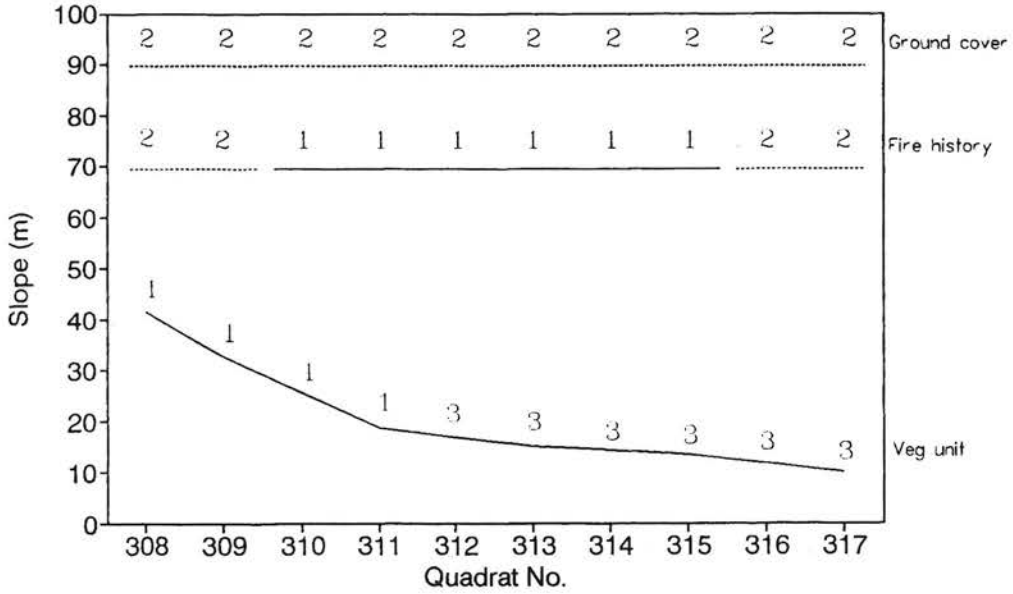

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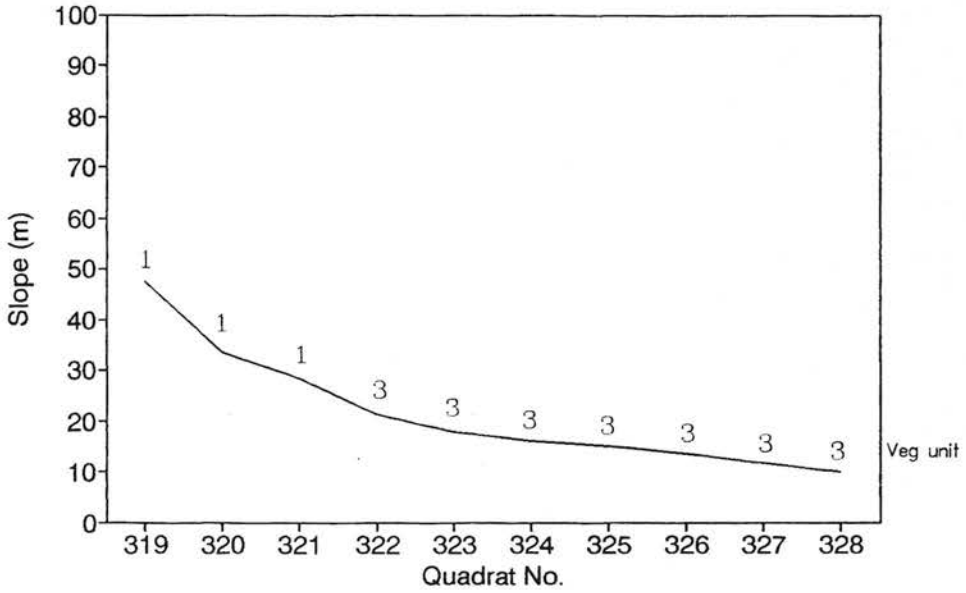

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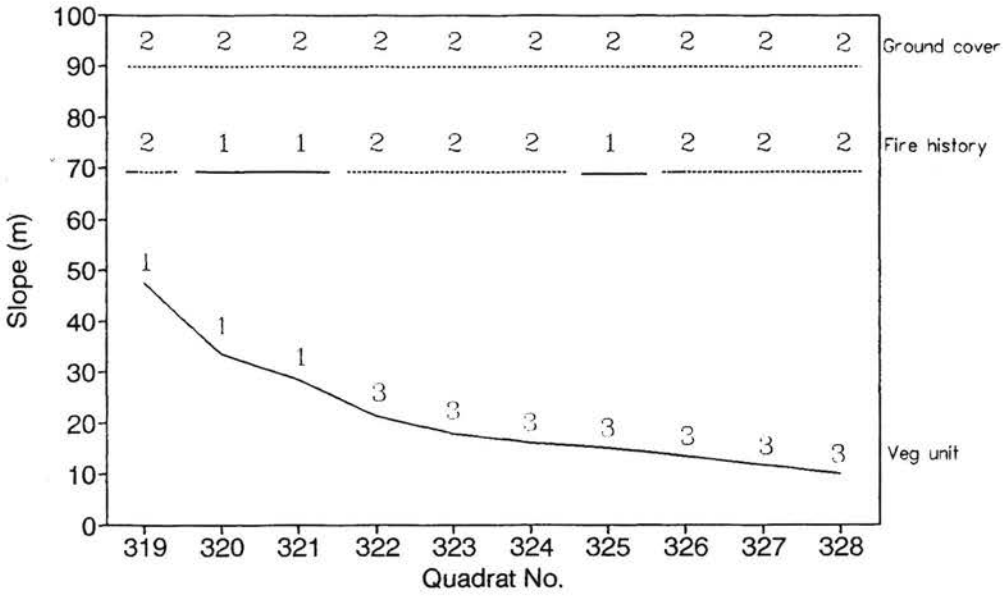

FIRE AND MULGA COMMUNITIES IN HAMERSLEY RANGE NATIONAL PARK A PRELIMINARY SURVEY.

A.N. Start and S. van Leeuwen

Hamersley Range National Park, in the Pilbara region of W.A. straddles the boundary between tree or shrub steppe dominated by hummock grasses (Triodia and Plectracne spp.) and Mulga (Acacia aneura) woodlands. At their northern limit the woodlands occur as patches occupying specific sites. Southwards they become more extensive until they are more or less continuous towards the southern and south-eastern boundary of the Region.

Even at the margin of their occurrence the woodlands occupy a variety of very different sites supporting different understories. To the east of Mt. Bruce in Hamersley Range National Park, there is a large internally draining "flat" separated from surrounding ridges and mountains by alluvial slopes, typically at 1° to 3°.

On the "flat" itself there is considerable variation from low lying sites with cracking soils that support dense Themida australis under a fairly uniform Mulga canopy to the margins where the woodland is very open or sparsely groved. Here, after rain, Aristida contorta may form swards and other annuals flourish but perennial shrubs are few and the ground is often bare. Throughout the "flat" occasional charred stumps are evidence of old fires but the woodland persists essentially intact.

The alluvial slopes consist of deep stony loams. They now support a Plectrachne grassland with hummocks frequently up to 0.75m high and contiguous. Charred Mulga stumps and young Mulga shoots occur throughout but there are only two very small (and doubtfully typical) remnants patches of live, mature Mulga trees. The likelihood of fires in the Plectrachne is high and fires before the regenerating Mulga matures may eliminate it from the slopes. A rapid survey of the northern half of the National Park showed that the Mt. Bruce pattern is typical and intact "slope mulga" communities are all but gone from that area.

Preliminary results suggest "slope mulga" had a relatively diverse understory rich in shrubs which are absent from the "flat". However we do not yet have a detailed knowledge of the faunal or floral components of intact "slope mulga" communities or their capacity to survive in Plectrachne hummock grasslands. However our preliminary observations suggest that some mulga dominated communities are significantly more vulnerable to fire than others and may be replaced by hummock grasslands.

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DEPARTMENT OF CONSERVATION & LAND MANAGEMENT

KARRATHA OFFICE

FAX NO. (091) 441 118
TELEPHONE NO. (091) 868 288

TO Tony Start

FROM: Stephen van Leeuwen

RE: Mt Bruce Flats area

DATE: 18.5.90

NO. OF PAGES: 1

URGENT: ~~YES/ NO~~

If this massage is illegible please call the above telephone no.

Recalculation of areas on Mt Bruce Flats.

Total area including gentle slopes. - 145 Km^2

Area of mulga on flats and major drainage lines - 108 Km^2

(based on 1970 aerial photography)

Regards

Steve

PEDIMENT — The headings on site sections "Gorge" "Drainage Line" etc are useful in relating these codes to Appendices & site lists of text.

Acacia cuspidifolia Open Scrub

STUDY: Kennedy Range Survey SITE No: KR001 SURVEYOR: NEWK

LOCATION: 17.5 km WSW of "Lyons River" Homestead

Lat. 24 40'15" Long. 115 20'25" AMG: 314950E 7270250N 18/08/1987

MAP SCALE: 1:250,000 SERIES: Geol. Survey TITLE: Kennedy Range

No: SG 50-1 SITE AREA: Plotless, 1.0 ha ASPECT: Level

1:250,000 SHEET: Kennedy Range ZONE: 50

LAND TENURE: National Park LAST BURNT: No evidence of burning

DISTURBANCE: Lightly grazed

ADMINISTRATION: Department of Conservation and Land Management AREA NAME: Kennedy Range

LAND REGION: Northwestern PROVINCE: Proterozic

SUB-PROVINCE: Gascoyne SYSTEM: Woogooloo

GEOL. REGION: Block LOCAL: Plateau

BEDROCK: Sandstone SURFACE: Pkm

LANDFORM

PATTERN TYPE: Gently Undulating Plain PATTERN: Plateau

DRAINAGE PATTERN: Dendritic SPACING: Very Close

UNIT: Cliff pediment ELEMENT: Well-drained plain

SLOPE LENGTH: 150-350 m INCLINATION: Very Gentle

EXPOSURE: Inland, moderate AGENT: Surface wash

LAND SURFACE

EROSION: Wholly stabilized WIND: Absent SHEET: Minor

RILL: Absent GULLY: Absent GULLY DEPTH: Absent

STREAM BANK: Absent TUNNEL: Absent WAVE: Absent

MASS MOVEMENT: Absent ACTIVITY: Aggraded = Eroded

FREQUENCY: Barely active MICRORELIEF: None

SOIL: Hardsetting

INUNDATION FREQUENCY: More than 1 per year } assumption or fact.

DEPTH: Less than 5 cm

DURATION: Less than 1 hour

RUN-OFF VELOCITY: Low

INFILTRATION: Not known

ROCK: No exposure

STONE: Frequent, subangular large pebbles and cobbles

PAVEMENT: Scattered, medium pebbles

LOGS: Absent

BRANCHES: Absent

LEAVES: Trace

SOIL PROFILE

OBSERVATION: No other

THICKNESS: Skeletal (2-35 cm)

MAIN ORIGIN: Colluvial

MINOR: In situ weathering

ATTRIBUTE: Skeletal

DRAINAGE: Excessive

SRT: Neutral

SALINITY: None

NORTHCOTE: Ucl.23-1/0/21+/1

SOIL GROUP: Lithosol

NAME: Not named

A 0-21 cm Yellowish red (5YR 4/6) loamy fine sand; humus content low; roots fine, few; inclusions 10-15% subangular to subrounded laterised sandstone 1-10 cm long; consistence very weak; pH 6.75; not water repellent; too stony to auger deeper.

VEGETATION

PROVINCE: Eremaean DISTRICT: Carnarvon SYSTEM: Lower Riverine Plains

MUIR: Sr.SCr.SDr

No of TAXA: 33

CC = ?canopy cover? needs to be defined in intro to Appendix

STRATUM 1: Shrubs 2.1-3.2 m, CC = 2.1, clumping slight Acacia cuspidifolia (2), A. pruinocarpa (+), A. tetragonophylla (+).

STRATUM 2: Shrubs 1.6-2.0 m, CC = 0.2, clumping slight Acacia victoriae (0.1), Hakea preissii (0.1), A. sclerosperma (+).

STRATUM 3: Shrubs 1.1-1.5 m, CC = 0.2, clumping slight Eremophila cuneata

→ Underline names.

Throughout Appendix

(0.1), E. leucophylla (0.1).

STRATUM 4: Shrubs 0.6-1.0 m, CC = 6, clumping slight Cassia aff. desolata (4), C. helmsii (2).

7.7?

STRATUM 5a: Shrubs 0.0-0.5 m, CC = 2, clumping slight Frankenia magnifica (6), Atriplex semilunaris (1), Enchylaena tomentosa var. tomentosa (0.2), Solanum lasiophyllum (0.2), Maireana villosa (0.1), Ptilotus obovatus (0.1), Sclerolaena eriacantha (0.1), S. horridum (+).

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.1
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7.7

STRATUM 5b: Misc. plants, CC = 0.5, clumping slight ANNUALS: Calotis hispidula (0.1), Streptoglossa latroides (0.1), Brachycome ciliaris var. ciliaris (+), Calandrinia papillata (+), Euphorbia drummondii (+), Gnephosis macrocephalus (+), Goodenia microptera (+), Iseilema eremaeum (+), Lepidium platypetalum (+), Nicotiana occidentalis ssp. obliqua (+), Trachymene glaucifolia (+), Tragus australianus (+). PERENNIAL GRASSES: Aristida contorta (+), Eragrostis dielsii (+).

FAUNA

BIRDS: No REPTILES: No MAMMALS: No AMPHIBIANS: No INVERTEBRATES: No

COMMENTS

Plant association is a fine-grained mosaic.

****

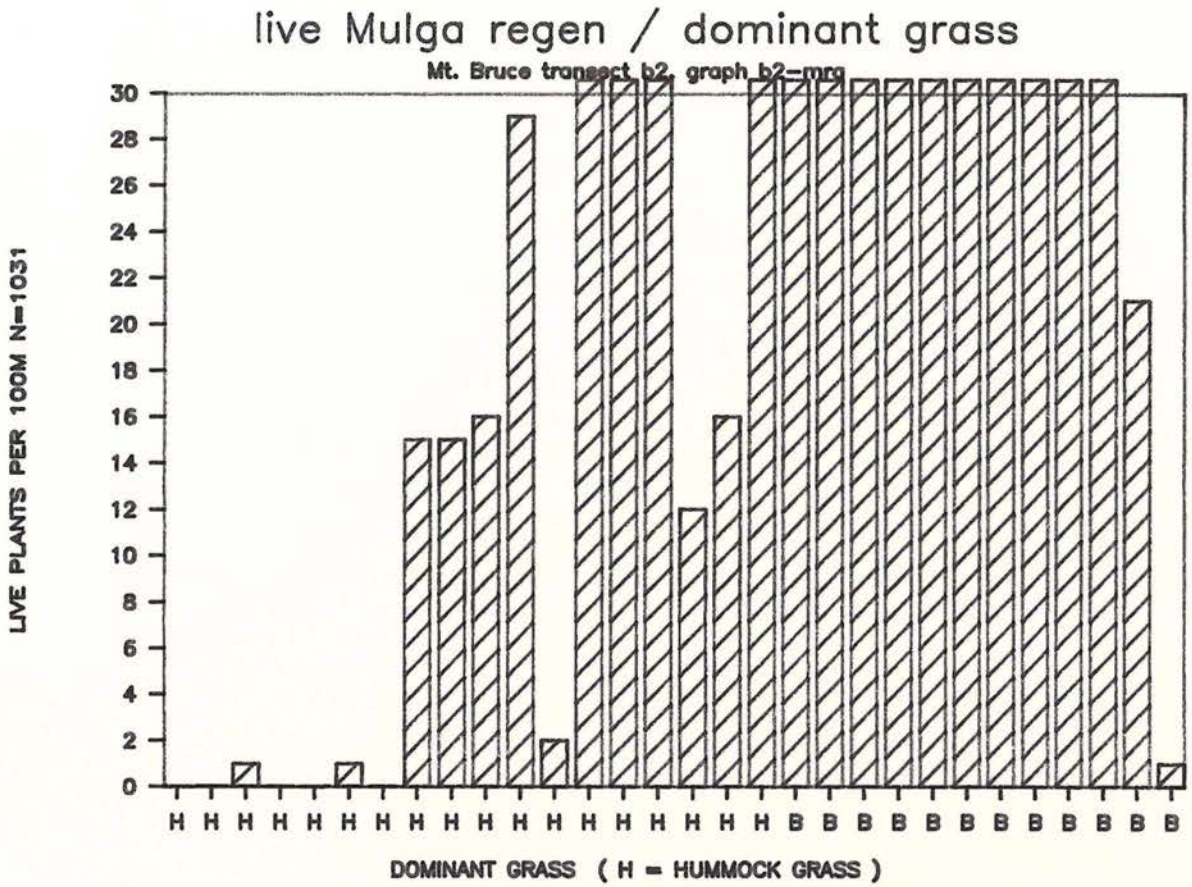
DRAINAGE LINE

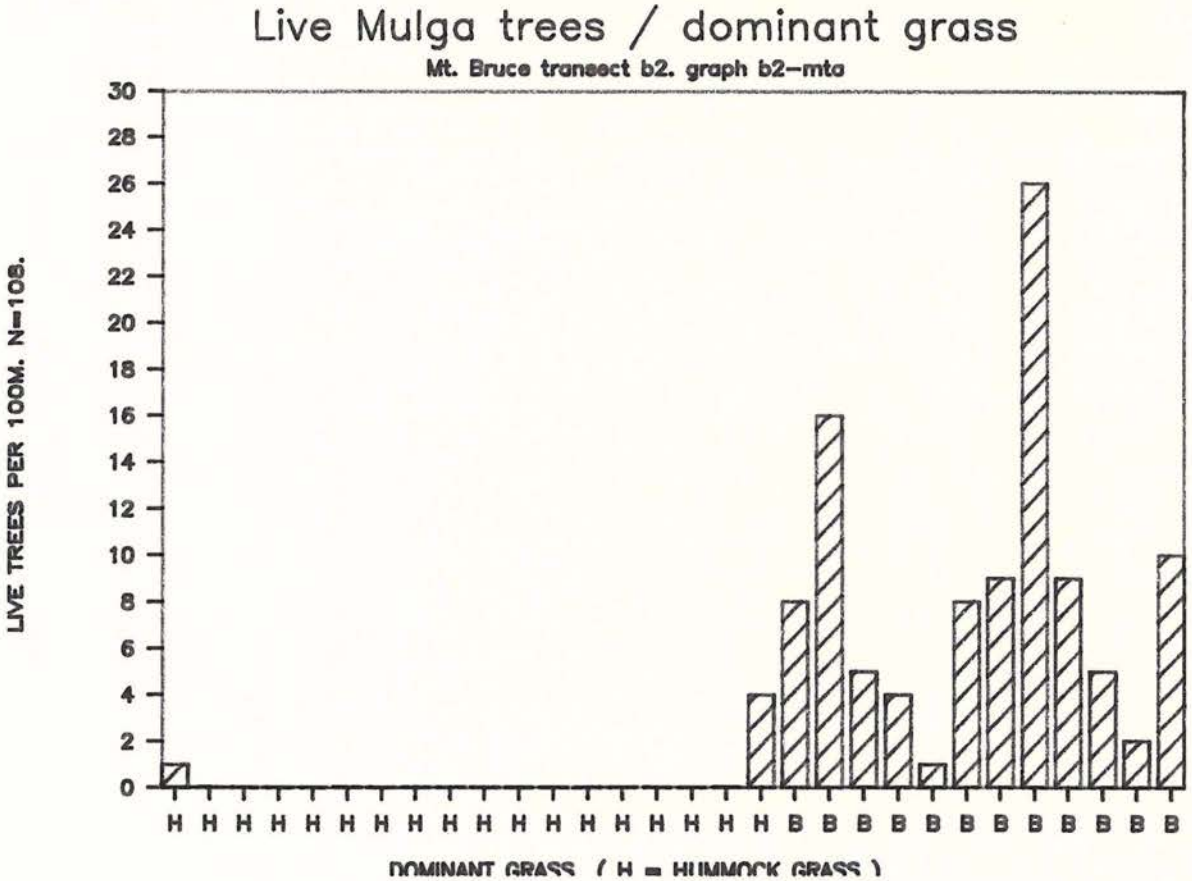
Acacia citrinoviridis Scrub

STUDY: Kennedy Range Survey SITE No: KR003 SURVEYOR: NEWK

LOCATION: 17.5 km WSW of "Lyons River" homestead

Lat. 24 40'25" Long. 115 10'40" AMG: 316000E 7270250N 20/08/1987


live Mulga regen / dominant grass
Mt. Bruce transect b2. graph b2-mrg
LIVE PLANTS PER 100M N=1031
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
H H H H H H H H H H H H H H H H H H H B B B B B B B B B B B B
DOMINANT GRASS (H = HUMMOCK GRASS)


Live Mulga trees / dominant grass
Mt. Bruce transect b2. graph b2-mta
LIVE TREES PER 100M. N=108.
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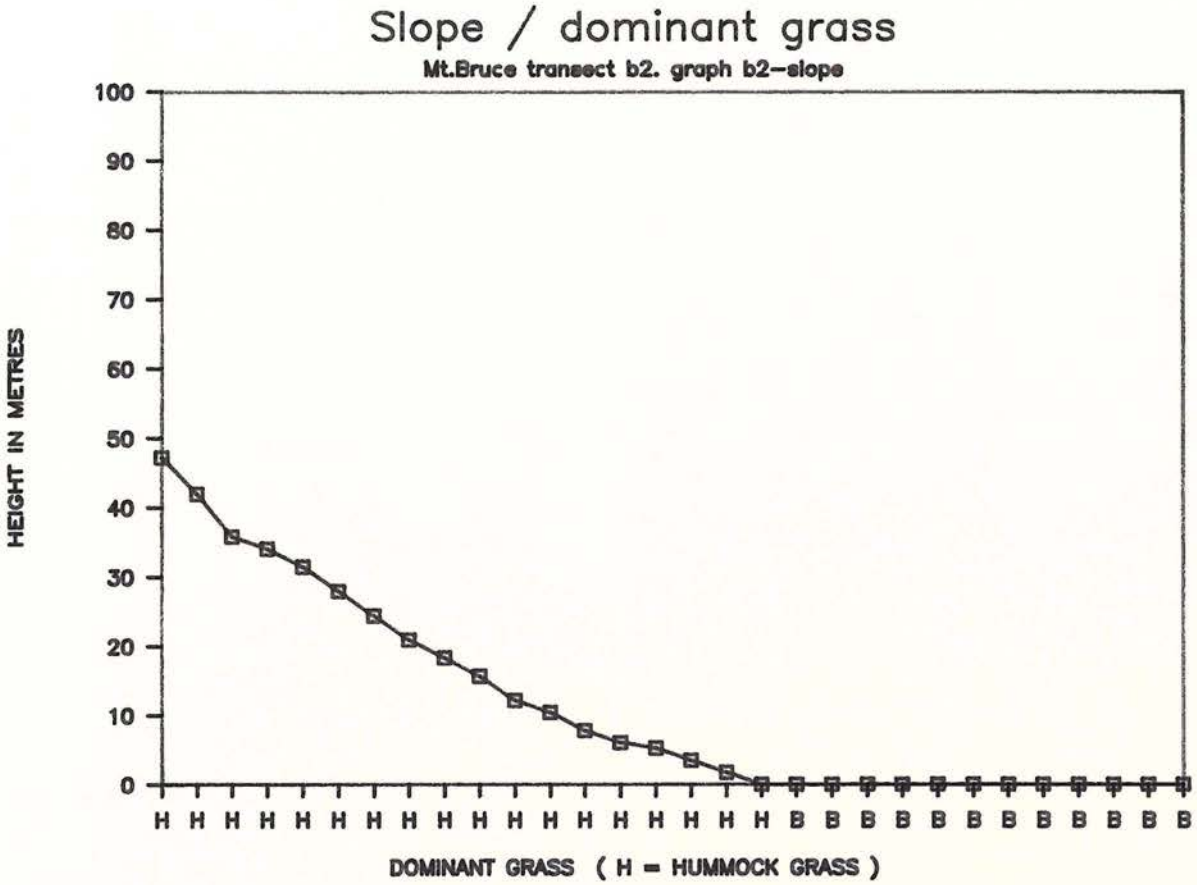
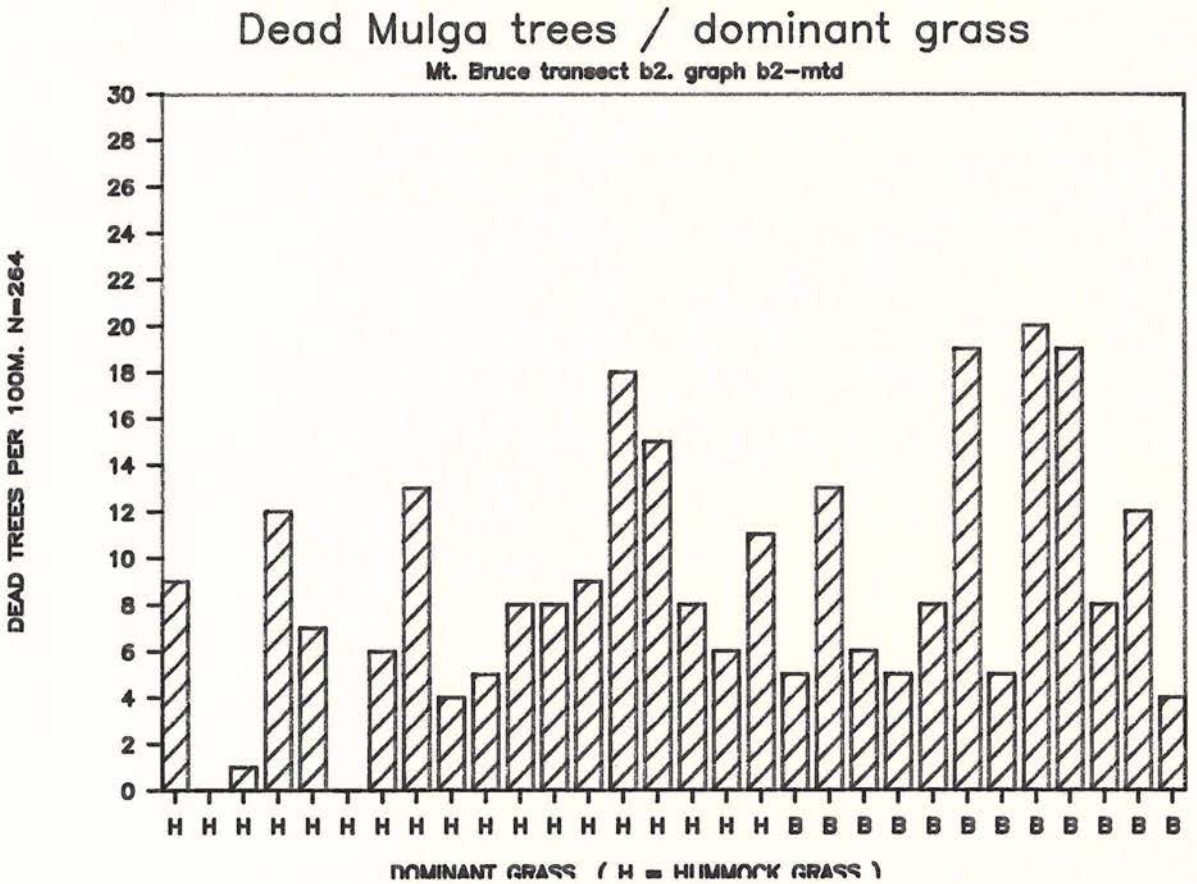
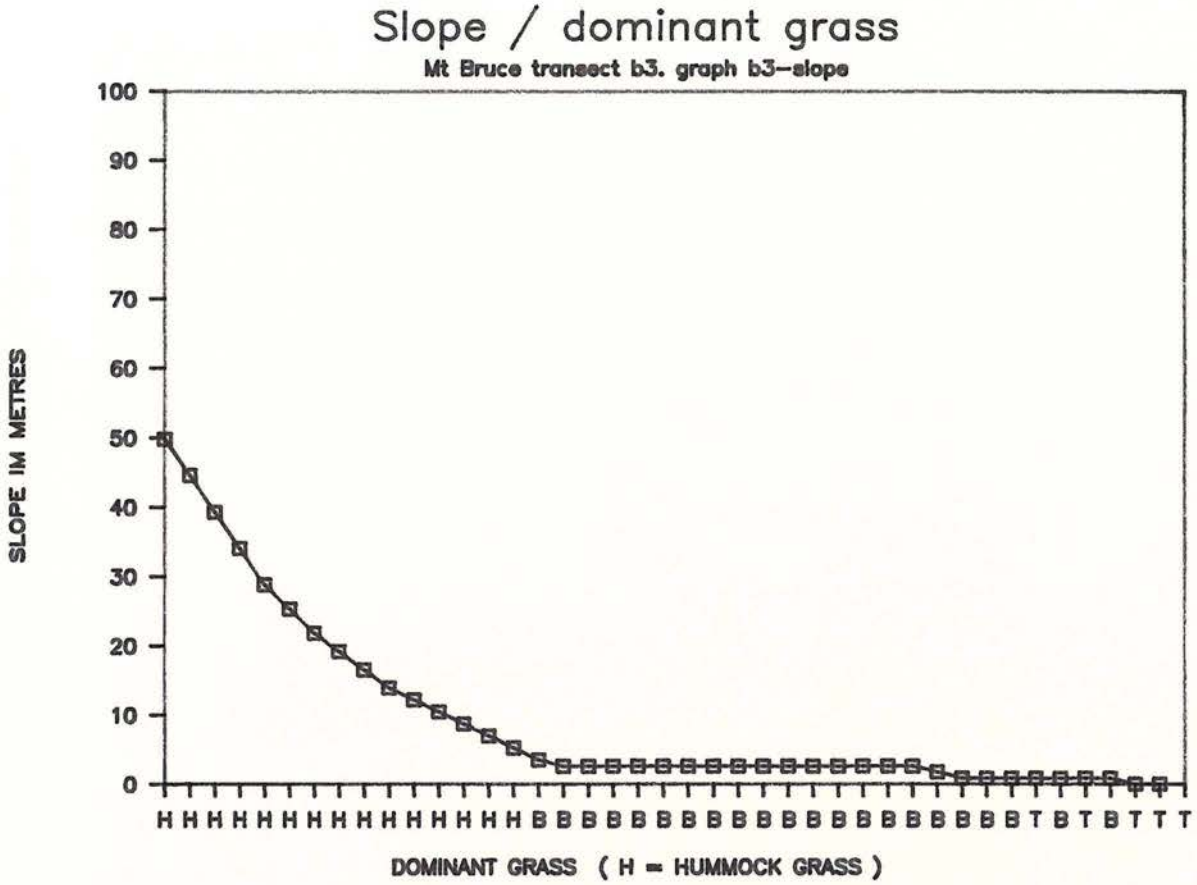
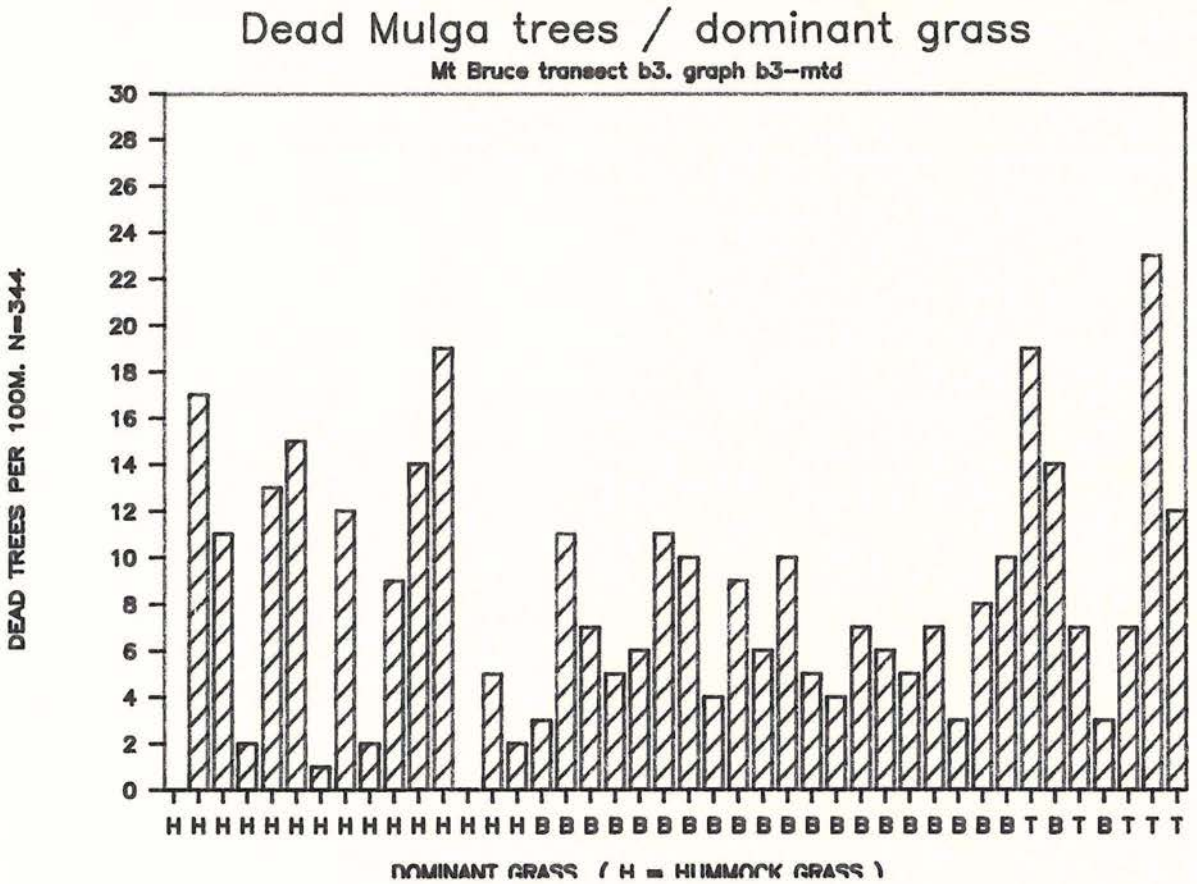
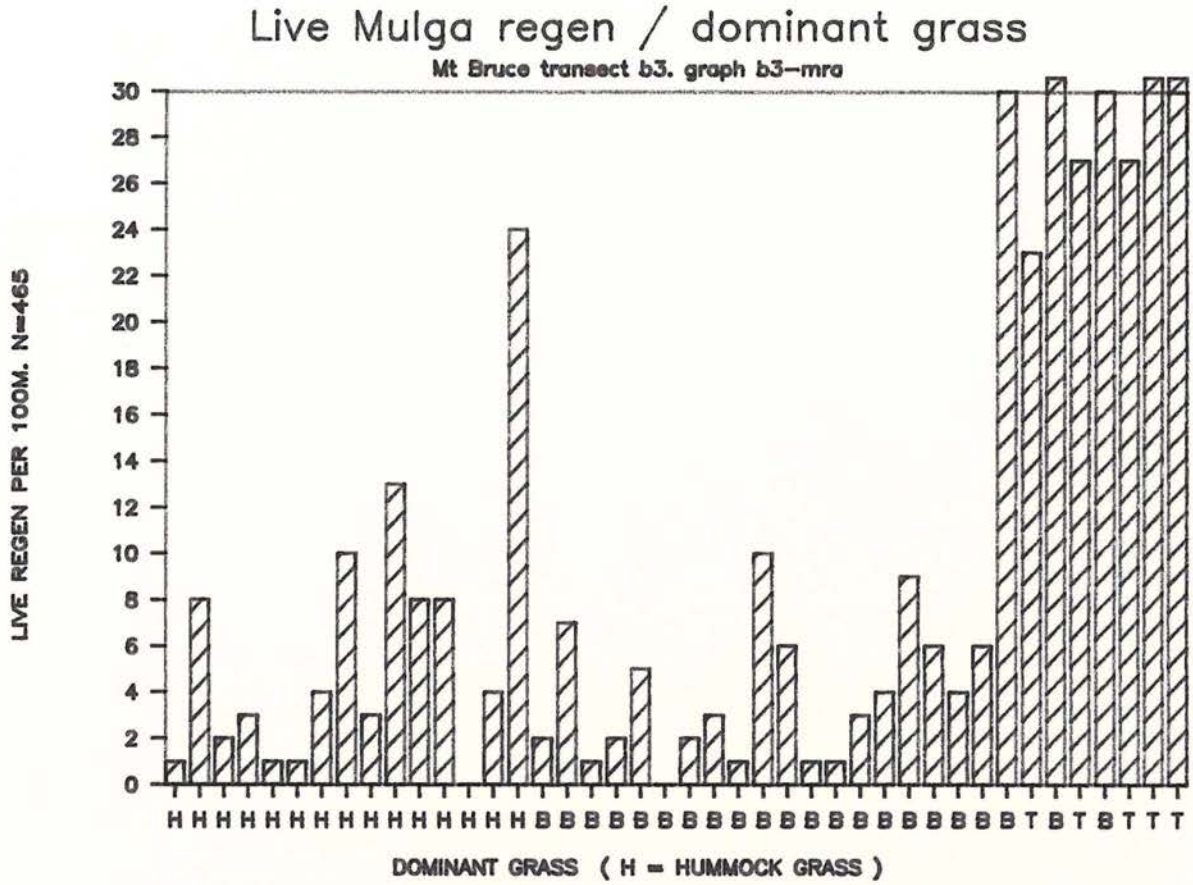
DOMINANT GRASS (H = HUMMOCK GRASS)

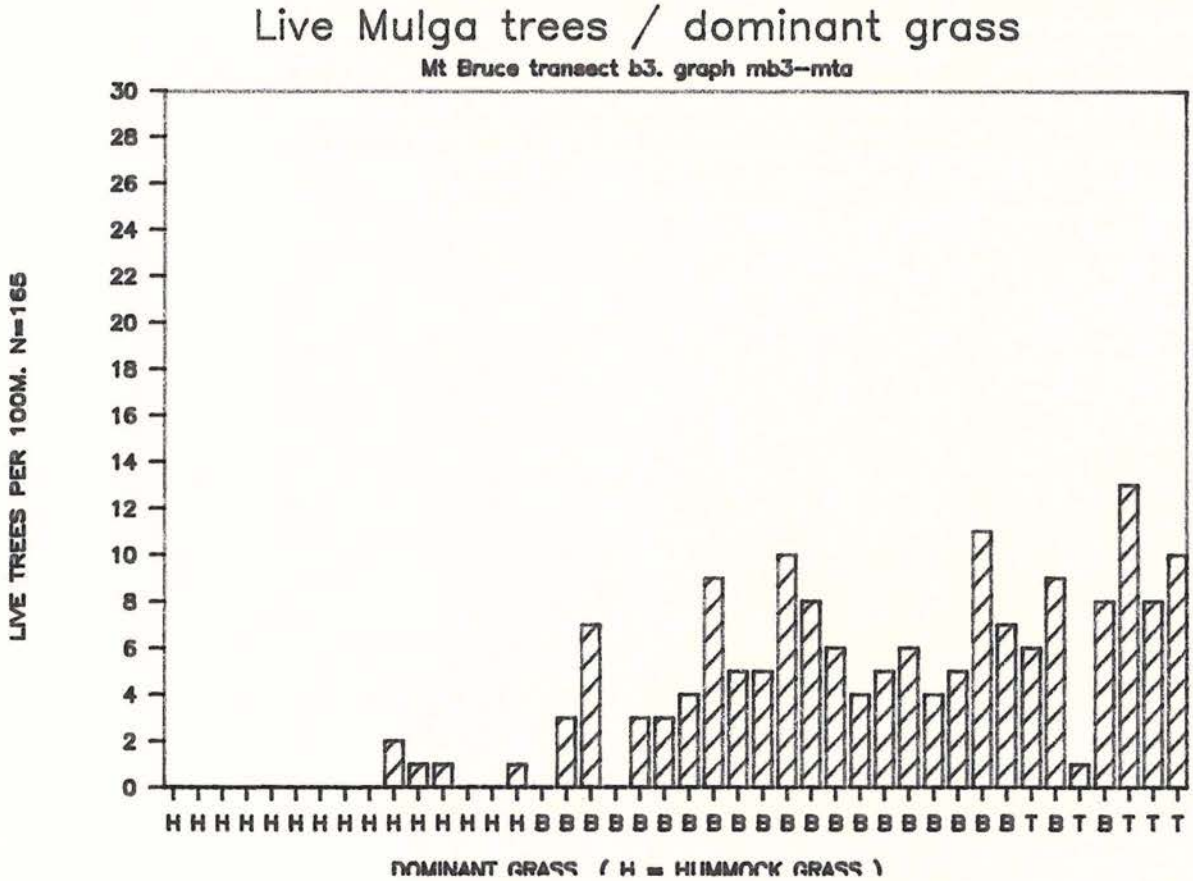

Slope / dominant grass
Mt.Bruce transect b2. graph b2-slope
HEIGHT IN METRES
100
90
80
70
60
50
40
30
20
10
0
H H H H H H H H H H H H H H H H H H B B B B B B B B B B B
DOMINANT GRASS (H = HUMMOCK GRASS)

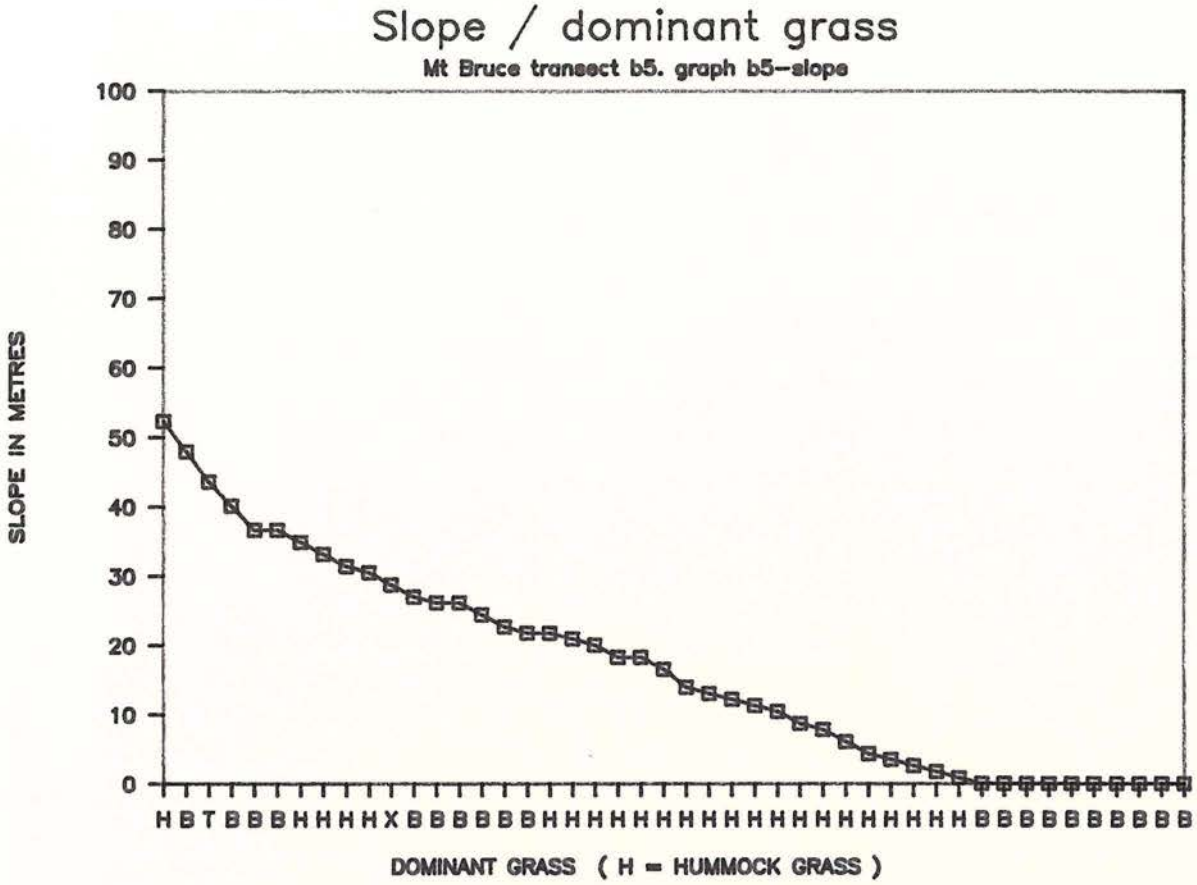

Dead Mulga trees / dominant grass
Mt. Bruce transect b2. graph b2-mtd
DEAD TREES PER 100M. N=264
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
H H H H H H H H H H H H H H H H H H B B B B B B B B B B B
DOMINANT GRASS (H = HUMMOCK GRASS)

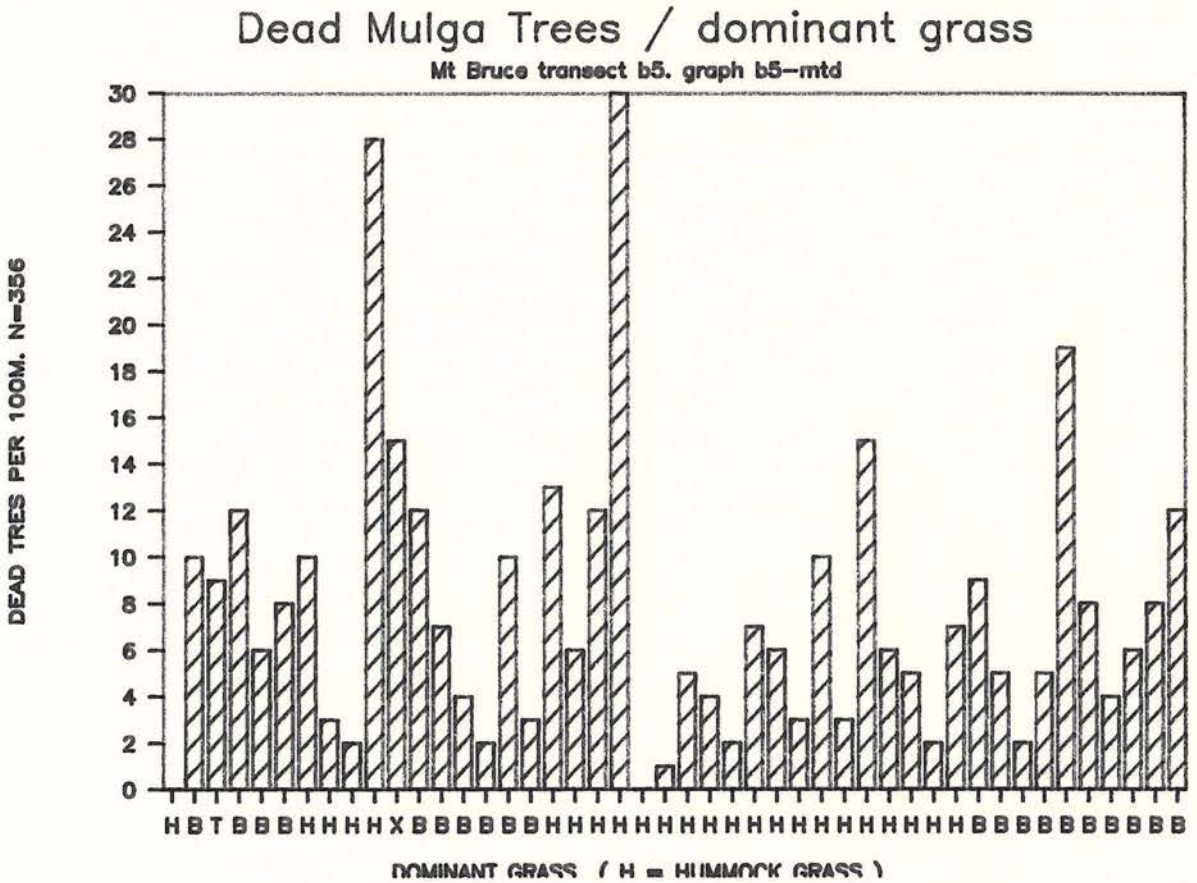

Slope / dominant grass
Mt Bruce transect b3. graph b3-slope
SLOPE IM METRES
100
90
80
70
60
50
40
30
20
10
0
H H H H H H H H H H H H H H H B B B B B B B B B B B B B B B B B B B B B T B T B T T T
DOMINANT GRASS (H = HUMMOCK GRASS)

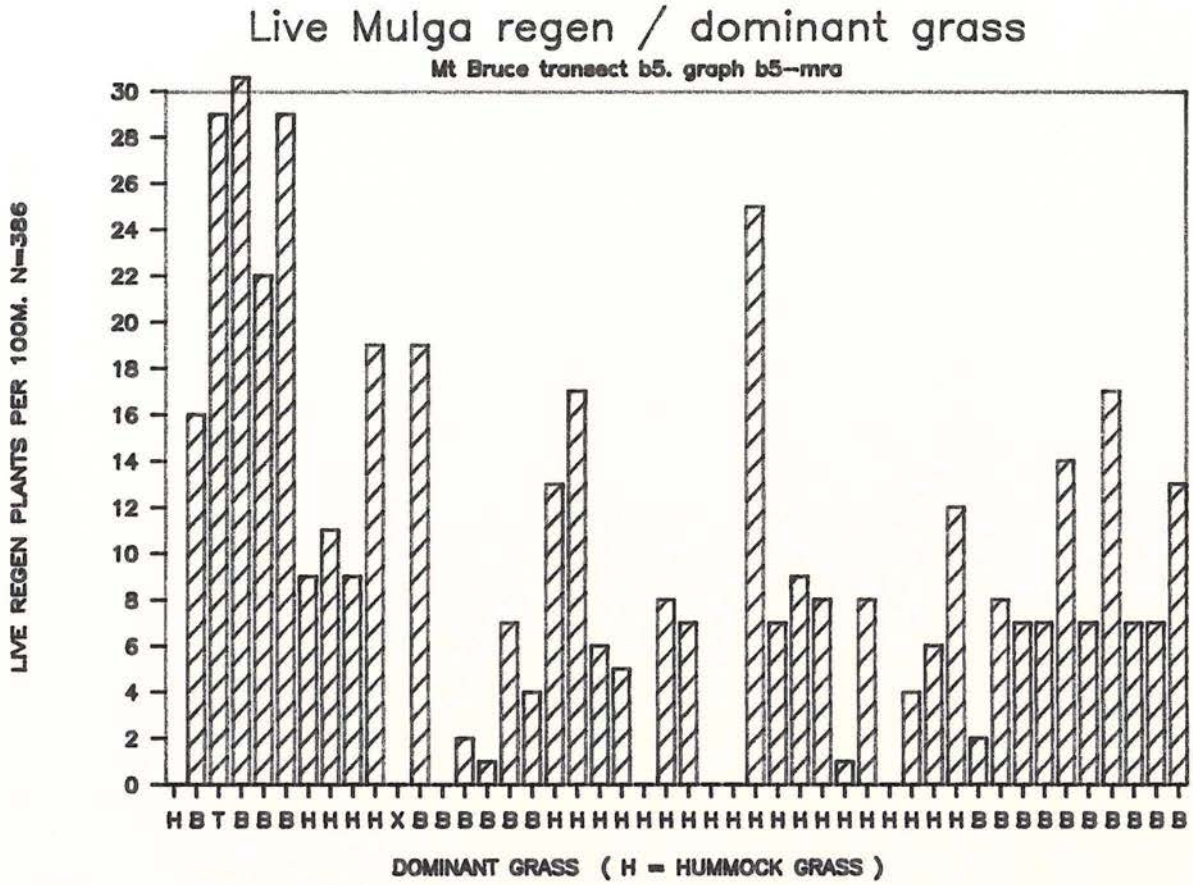

Dead Mulga trees / dominant grass
Mt Bruce transect b3. graph b3-mtd
DEAD TREES PER 100M. N=344
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
H H H H H H H H H H H H H H H B B B B B B B B B B B B B B B B B B B B B T B T B T T T
DOMINANT GRASS (H = HUMMOCK GRASS)

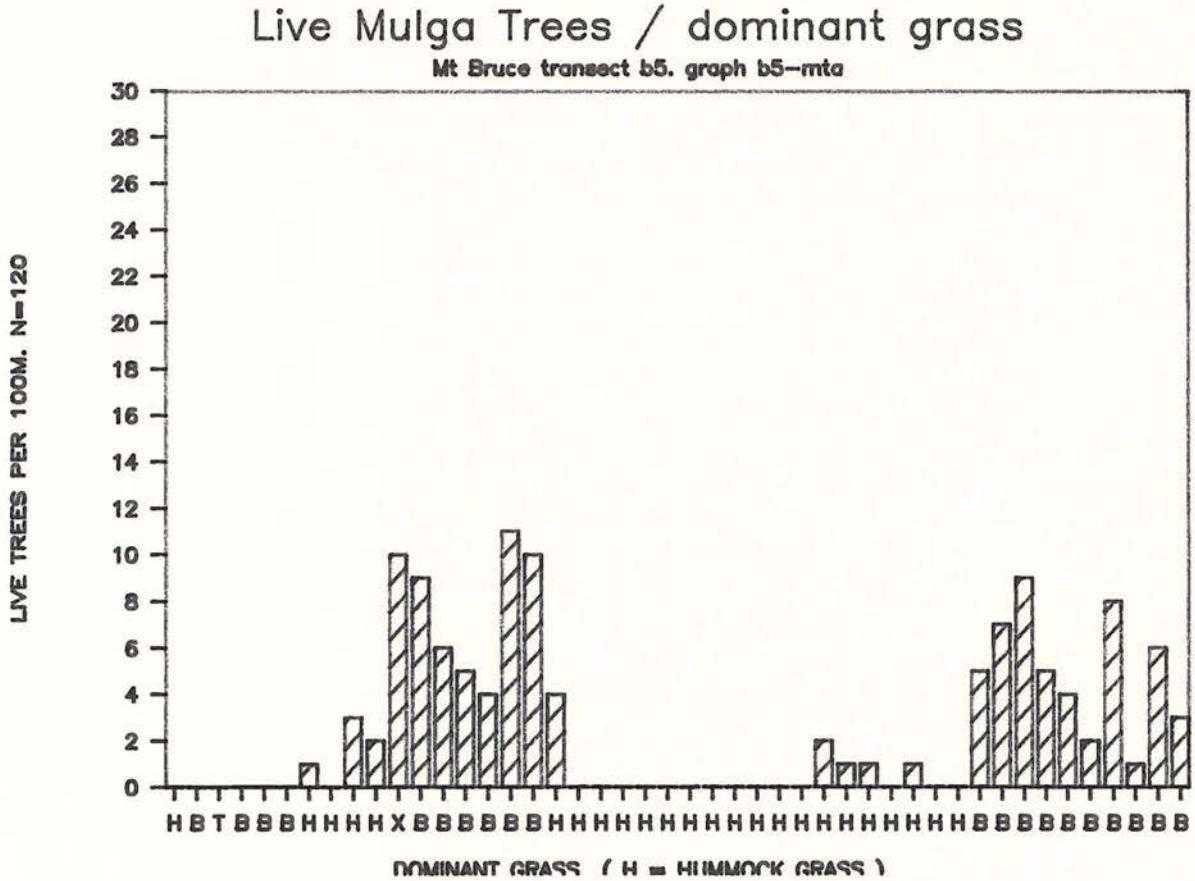

Live Mulga regen / dominant grass
Mt Bruce transect b3. graph b3–mra
LIVE REGEN PER 100M. N=465
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
H H H H H H H H H H H H H H H B B B B B B B B B B B B B B B B B B B B B T B T B T T T
DOMINANT GRASS (H = HUMMOCK GRASS)


Live Mulga trees / dominant grass
Mt Bruce transect b3. graph mb3–mta
LIVE TREES PER 100M. N=165
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
H H H H H H H H H H H H H H H B B B B B B B B B B B B B B B B B B B B B T B T B T T T
DOMINANT GRASS (H = HUMMOCK GRASS)


Slope / dominant grass
Mt Bruce transect b5. graph b5-slope
SLOPE IN METRES
100
90
80
70
60
50
40
30
20
10
0
H B T B B B H H H H X B B B B B B B H H H H H H H H H H H H H H H H H H H H H B B B B B B B B B B
DOMINANT GRASS (H = HUMMOCK GRASS)


Dead Mulga Trees / dominant grass
Mt Bruce transect b5. graph b5-mtd
DEAD TRES PER 100M. N=356
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
H B T B B B H H H H X B B B B B B B H H H H H H H H H H H H H H H H H H H H H B B B B B B B B B B
DOMINANT GRASS (H = HUMMOCK GRASS)


Live Mulga regen / dominant grass
Mt Bruce transect b5. graph b5-mra
LIVE REGEN PLANTS PER 100M. N=386
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
H B T B B B H H H H H X B B B B B B B H H H H H H H H H H H H H H H H H H H H H H B B B B B B B B B B
DOMINANT GRASS (H = HUMMOCK GRASS)


Live Mulga Trees / dominant grass
Mt Bruce transect b5. graph b5-mta
LIVE TREES PER 100M. N=120
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
H B T B B B H H H H H X B B B B B B B H H H H H H H H H H H H H H H H H H H H H H B B B B B B B B B B
DOMINANT GRASS (H = HUMMOCK GRASS)

PROPOSAL TO RESEARCH THE EFFECTS OF FIRE ON MULGA COMMUNITIES IN HAMERSLEY RANGE NATIONAL PARK.

A.N.Start and S.J.van Leeuwen

September 1989

OCCURRENCE OF MULGA IN THE PILBARA

The Eremaean Zone in W.A. can be broadly divided into two vegetation types. Hummock grasses (*Plectracne* and *Triodia* spp.) dominate the northern part and Mulga (*Acacia aneura*) woodlands dominate much of the southern part. Mulga extends north to about the Tropic of Capricorn. (Beard 1975). (Map 1)

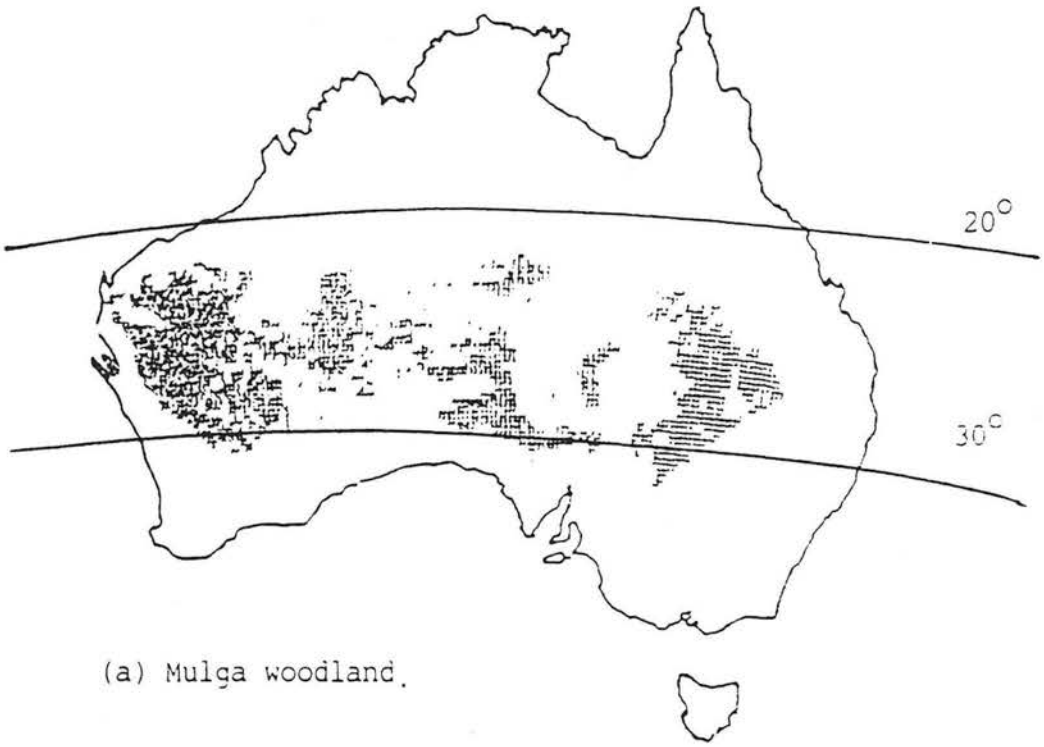
The Fortescue Botanical District is that part of the Eremaean Zone that occupies most of the Pilbara Region. It straddles the transition zone between the hummock grasslands and the mulga woodlands and is thus characterised by two very different vegetation types.

Within the Fortescue Botanical District Mulga is confined to the Fortescue Valley (where it forms extensive woodlands to the east of Wittenoom but gradually peters out to the west of the town) and the Hamersley Range. Within the northern Hamersley Range it tends to grow in deep soils on run-on areas including broad drainage lines. It occasionally forms pockets on steep scree slopes, particularly those facing south. Within the run-on areas it may form continuous woodlands but it frequently occurs as parallel groves across the slope. The intergroves are usually more or less devoid of vegetation.

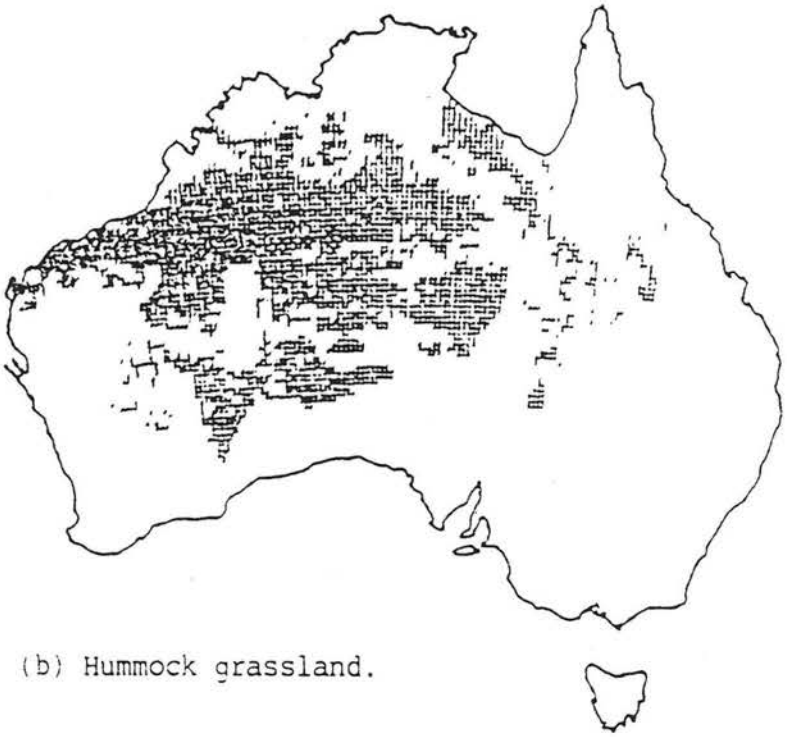
As one moves south Mulga becomes more widespread and occupies a greater range of sites until, near the boundary with the Ashburton Botanical District, it becomes more or less ubiquitous and hummock grass is confined to rocky hills.

Hamersley Range National Park (HRNP)(Map 2) is the only conservation reserve in the Fortescue Botanical District that contains Mulga. There is negligible representation of the Fortescue Valley in the Park but the rest of the north south transition is represented, although Mulga woodlands in the Park are not as extensive as many in adjacent areas. However most adjacent areas are threatened by grazing, mining and other factors.

Map 1

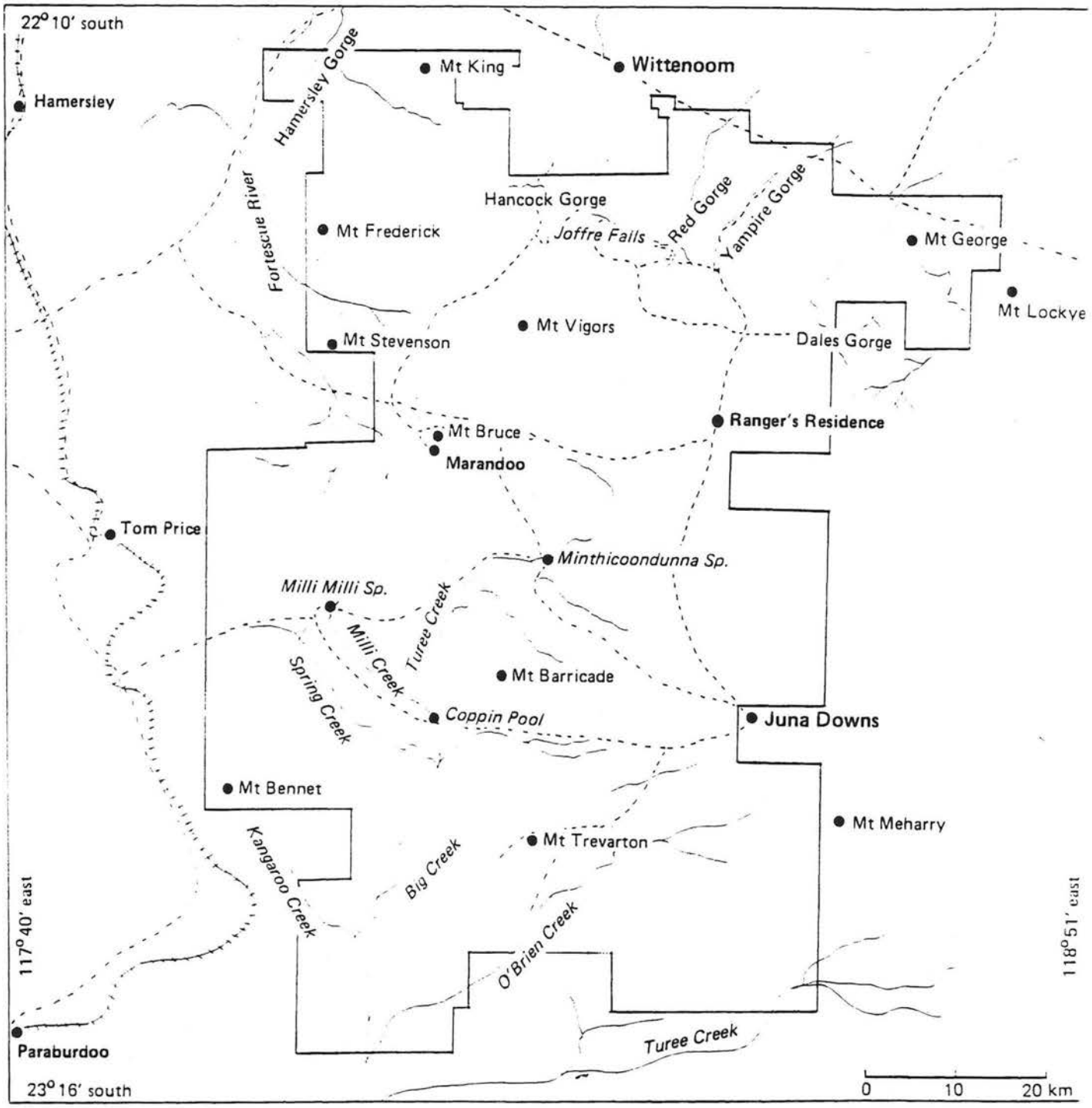


(a) Mulga woodland.



(b) Hummock grassland.

Map 2.



Map of the Hamersley Range National Park showing the location of access roads, creeks and major landmarks.

Maps
For the numerous locations mentioned in text and not shown on Figure 1, the reader is referred to National Topographic Map Series (1:100 000) sheets 2553, 2653, 2452, 2552, 2652, 2551 and 2657.

DIVERSITY IN MULGA IN THE PILBARA.

In the Pilbara, Mulga grows in a diverse range of topographical situations. These include drainage basins, elevated outwash plains, fluvial plains and steep hillsides. It also tolerates a wide array of different soil types including scree-covered, shallow, stony earths on hillsides, sandy and clay loams and even clays in some situations (Dunlop and Porter 1985)

It experiences a wide range of soil moisture conditions ranging from well-drained run-off sites on hillsides to drainage basins in run-on situations. Despite this variety, the redistribution of water has been recognised as an important factor influencing the distribution of Mulga (e.g. Morrisey 1984, van Leeuwen and Fox 1985).

It is not surprising, therefore, that Mulga dominates a diverse range of plant communities which often seem to have little in common apart from Mulga as the dominant component of the upper story. Hereafter mulga is used to refer to plant communities dominated by Mulga.

Four broad community types dominated by Mulga (Mulga dominated communities-MDC) may be recognised within HRNP. (pers. obs.) These are:

1. Small patches of continuous Mulga woodland over Cassia and Eremophila spp. on (usually) south facing slopes of rocky hillsides. They occur in the northern part of the Park. ('Scree mulga')
To the south a similar but more open community often containing many more Acacia species becomes widespread on undulating ground, in valleys and on hills. ('Hill mulga')

2.'Grove/intergrove mulga' in which the understory in the groves is apparently rich and variable. It is confined to extensive flats, either as internally draining depressions or broad drainage lines.

3. Continuous Mulga woodland over a diverse and sometimes moderately dense understory of shrubs and herbs. Tussock grasses may be a significant component and hummock grass may occur in openings. This MDC type seems to prefer gentle slopes, frequently on the margins of extensive flats and is often characterised by a significant stone component in the soil and on the surface.

4. Continuous Mulga woodland over tussock grasses, characteristically including Themida australis. This community type grows on deep soils on broad drainage lines.

In addition to these coarsely defined community types, Mulga may occur as scattered shrubs or trees over hummock grass particularly, but not always, along minor drainage lines.

Although these community-type descriptions are crude and tentative (they will be investigated and refined during the proposed study) similar communities have been recognised by other workers in the Pilbara.(e.g. Dunlop and Porter, 1985, Fox ****, **** , van Etten, 1987).

It can be seen that mulga communities are diverse. Many of them tend to be relatively species-rich (Fox ****, M.Trudgeon pers. comm., pers. obs.) and many of the component species, at least within the Pilbara, are largely endemic to mulga. (Species diversity, endemism within mulga as a whole and within particular MDC will be investigated in the proposed study).

The fauna of mulga in the Pilbara is not well known. There are a number of unpublished, site-specific studies undertaken for mining companies. One of the most useful is the study of the Channar mining area, just outside the south west corner of HRNP. (Anon. 1985)

For HRNP most of the available information is summarised in Muir (1983). On a regional basis the best known group is the birds (Blakers et al. 1984; Storr 1984). At least seven species of birds are more or less confined (in the Pilbara) to mulga. Many of them reach the northern limits of their distribution in these woodlands.

Despite the paucity of data it is clear that the fauna of mulga is relatively rich and diverse. (Species diversity and endemism within mulga as a whole as well as within particular community types will be investigated during the proposed study).

FIRE

In the southern Pilbara, mulga woodlands and hummock grasslands frequently exist as a complex mosaic of fire-sensitive and fire-tolerant communities (Start 1986). This is the situation in the northern part of HRNP.

The widespread occurrence of fire in hummock grasslands was recorded throughout arid Australia by the explorers of the last century and the early part of this century. (See Griffin and Friedel,1985 for a summary). Some ignitions were from lightning but fire was used extensively by Aboriginal people for many purposes.(eg.Kimber 1983 ; Jones 1969)

With the departure of Aboriginal people from their traditional land and their abandonment of traditional activities, the complex fire regime that they had maintaned has changed.(eg. Griffin and Friedel, opp.cit.)

In the pastoral lands fire management for fodder production is widespread but the regimes vary from Station to Station (Suidjendorp 1981). Elsewhere lightning is the principal cause of fire (Griffin et al. 1983) although there is a significant incidence of man-lit fire. In these situations fires are frequently very extensive. Three such fires have ocurred in HRNP in the last 10 years. The most recent in 1986 was estimated to have had a perimeter encompassing about 100,000 Ha.

Where these huge fires occur on land that has a mosaic of mulga and hummock grasslands, extensive areas of mulga may be burnt. Mulga is usually killed by fire. Regeneration is commonly from seed but, at least in the Pilbara, there may be some resprouting from root stock (Dunlop and Porter 1985: Pers. obs).

Following the removal of the canopy there may be an increase in the herbs and grasses of the understory, particularly if there are good following rains. This increases the risk of repeat burns that kill regenerating Mulga (Griffin et al. opp.cit.). We have observed this in HRNP where the situation appears to be compounded by the invasion of burnt mulga by hummock grasses.

Replacement of mulga by hummock grasslands has been shown to occur in the Central Ranges (Latz pers.comm.). Kimber (opp cit.) states (p.43) that "Aborigines knew the suceptibility of mulga to destruction by fire and preferred not to fire it". Aboriginal people of the Hamersley Range area have suggested to ANS that it is not good to burn mulga.

OBJECTIVES

The concept for this proposed study developed from a growing awareness by ANS during ten years as a manager in the Pilbara that substantial areas of some mulga dominated communities were apparently being replaced by hummock grasslands.

Fire seems to have been driving the shift which is taking place under a number of pastoral fire regimes as well as under the near natural (lightning) regime that has existed in HRNP for the last 15 or more years. The most likely explanation for the apparent change is linked to the change in fire regime since Aboriginal people abandoned traditional burning practises. (Start 1986)

The implication, if these suppositions are correct, is that diversity within HRNP may be diminishing. If that is happening an appropriate fire regime will need to be developed and implemented.

The primary objective of the proposed study is:

TO DETERMINE WHETHER DIVERSITY WITHIN HRNP IS DIMINISHING BECAUSE OF INAPPROPRIATE FIRE REGIMES

and if it is:

TO DEVELOP A PRACTICAL AND AFFORDABLE FIRE REGIME THAT, IF IMPLEMENTED, WILL MAINTAIN DIVERSITY.

In order to do this logically, we have developed a series of hypotheses to test and we have identified strategies that we propose to use for testing our hypotheses. Once the strategies are agreed we will develop and submit individual RPPs for the various components of the proposed study.

Besides pursuing our primary objectives, we anticipate that the data we will generate will be of considerable biogeographical value. In order to maximise that value we will be at pains to ensure that the methods used are compatible with the requirements for long term monitoring.

HYPOTHESES

1. In the HRNP Mulga dominates a variety of distinct and definable plant and animal communities. Each community occupies sites with characteristic edaphic and geomorphic features.

2. Some of the species in the mulga dominated communities (MDC) are endemic to them.

3. Changes have occurred in species composition and structure of some MDC and in the balance between MDC and hummock grasslands. Change is still occurring.

4. Fire is a major disturber which is modifying some MDC in the HRNP. The communities vary in their vulnerability and resilience to fire. Fire regimes can determine whether sites are dominated by mulga or hummock grassland communities.

5. Modification of MDC by fire is reducing biological diversity within the National Park.

IMPLICATIONS

If these hypotheses are correct the implications are;

1. On the conservation values of MDC and the HRNP

   1.1 Reduction of the total area of MDC in conservation reserves in the Fortescue Botanical District.

   1.2 Reduction of biological diversity in the national park and in the State's conservation reserve system.

   1.3 Possible loss of MDC from the HRNP.

   1.4 Possible elimination of some community types and/or species from conservation reserves.

   1.5 Possible change in the conservation status of those species endemic to MDC.

2. For land managers (CALM Regional staff).

   2.1. If managers are to implement the Department's policy of restoring the environment and maintaining biological diversity, it will be necessary to implement appropriate fire management programs which may be different from those currently operating.

3. For Research.

   3.1. If these Hypotheses are substantiated, further research will be required to provide the land managers with information on which to formulate appropriate management prescriptions.

STRATEGIES FOR TESTING THE HYPOTHESES.

1.1 Survey MDC growing on sites with different edaphic and geomorphic characteristics.

This will test for:

a. variation within and between MDC.
b. the similarity of MDC on sites with similar edaphic and geomorphic features.
c. the level of species endemism within particular MDC.

and enable:

a. different MDC to be described and mapped.

1.2 Survey other communities for the presence of species occurring in MDC.

This will test for:

a. the presence of species endemic to MDC within the HRNP.

2.1 Survey a number of sites supporting (or which can be shown to have supported) each of the MDC to identify and describe the nature and extent of change (if any) that may be evident in their species composition and structure.

This will test for:

a. Evidence of change having occurred in the structure and composition of the MDC.

2.2 Monitor sites (using permanent quadrats) in each MDC type.

This will test:

a. whether change is continuing to occur and the extent of such change.

3.1 By experiment, determine the effect of fire on each MDC.

This will test:

a. the importance and role of fire in modifying MDC
b. the resilience of MDC to fire induced change
c. whether observed patterns of community structure within and between MDC, and between MDC and hummock grasslands are a result of fire.
It will enable us to make an assessment of the importance of fire regimes in modifying species composition and community structure in MDC.

3.2 By experiment and monitoring, determine which MDC are vulnerable to exposure to fire.

This will test:

a. the vulnerability of MDC to fire.

4.1 By experiment determine if exposure to and modification of MDC by fire has a significant influence on species richness.

This will test the:

a. resilience of the component species of different MDC types to fire induced change.
b. potential for reduction of biological diversity in the HRNP as a consequence of the burning of MDC.

4.2 By survey compare the species richness of intact MDC to those that have been modified by different fire regimes.

This will test for:

a. past reduction in biological diversity of some MDC within the national park.

4.3 Map the distribution of each MDC and overlay fire history maps and/or survey data to determine the extent to which each MDC has been modified (degraded) by fire

This will enable:

a. determination of the area and distribution of each MDC in HRNP.
b. estimations of the areas of each MDC that may have been modified by fire.
c. identification of any MDC that are at risk from fire.
d. priorities to be set for fire management.

PROJECT DESIGN

Transects

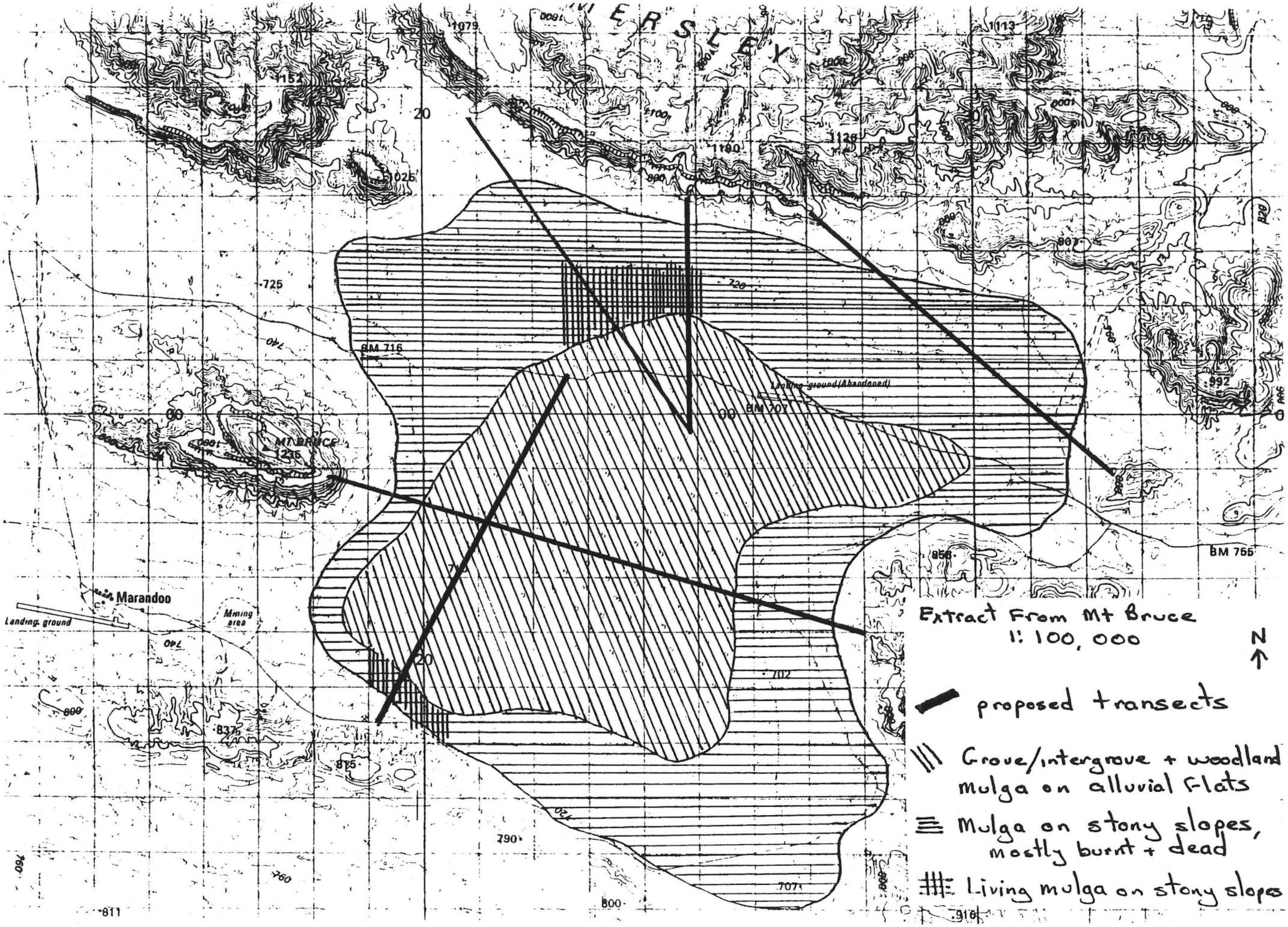
1. Mt.Bruce. To the east of Mt. Bruce there is a large out-wash plain of about 24 sq.km. It is surrounded by ridges and scree slopes from which it receives water. The soil is a red clayey loam and the vegetation consists of both mulga woodlands and grove-intergrove mulga.

Much of the mulga on the plain is intact. However there are areas that have burnt in fairly recent fires, including the major wildfire of 1986.

Surrounding the plain there is a strip of gently sloping land which varies in width from less than 1 km to more than 3 km. There is a significant stone content in the soil and a stony layer on the surface of the ground.

Currently it is dominated by hummock grasses, but there are numerous dead Mulga stags (and in some areas, Mulga shoots sprouting from rootstocks) throughout the area. On a recent reconnaissance trip we located only one small patch of unburnt mulga woodland growing on this site type. (Map 3)

Figs. 1 and 2 are air photos taken of this area in 1970 and 1986. Note the disappearance of mulga from the area adjacent to the flats (where grove-intergrove mulga is clearly visible.)



Extract From Mt Bruce
1: 100, 000
N
proposed transects
Grove/intergrove + woodland mulga on alluvial flats
Mulga on stony slopes, mostly burnt + dead
Living mulga on stony slopes
Marandoo
Landing ground
Mining area
MT BRUCE
BM 716
BM 707
BM 755
Landing ground (Abandoned)

Figure 1

1970 photography

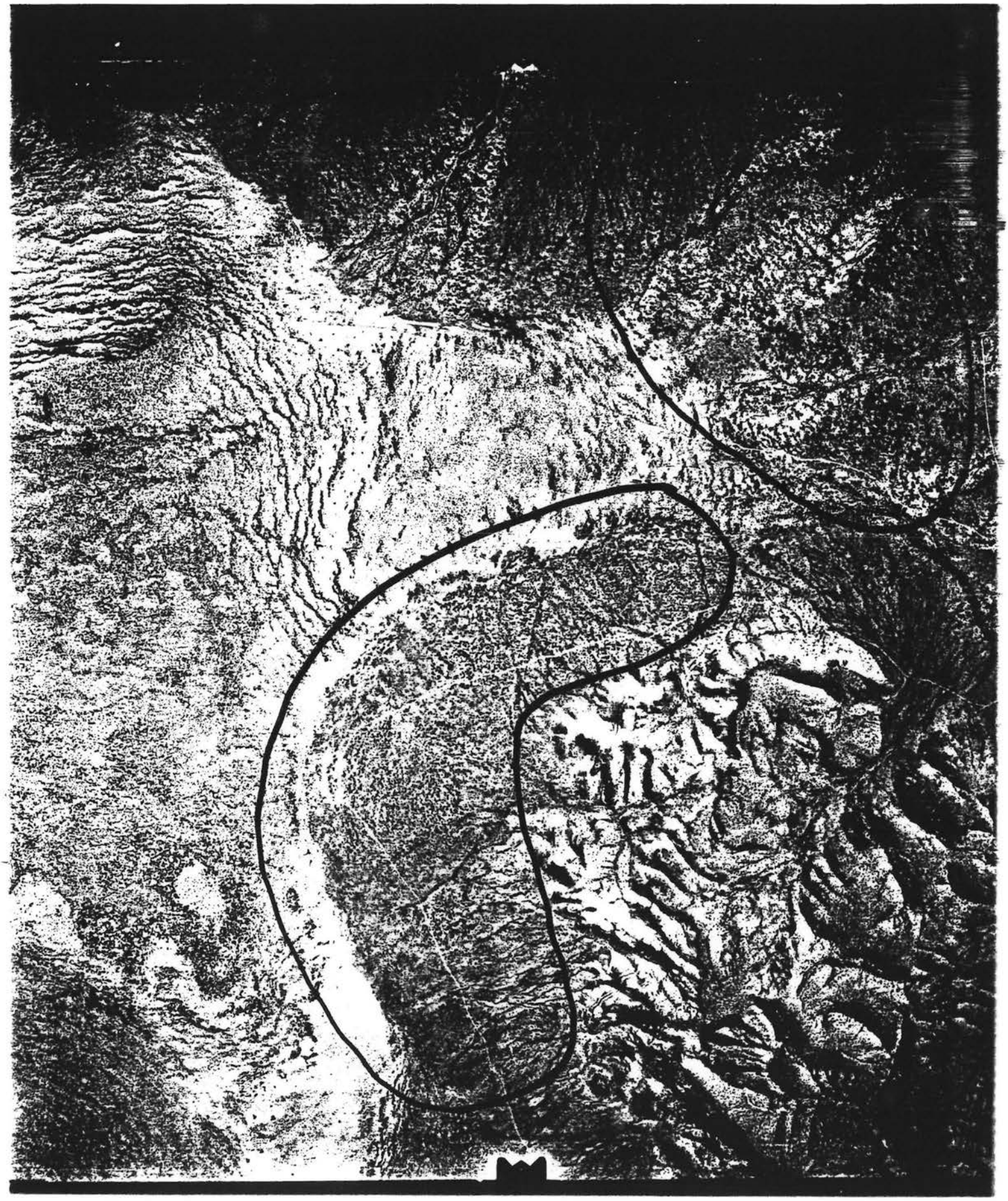


Figure 2
1986 photography

Inspection of many other mulga woodlands in the northern area of HRNP showed a similar pattern of more or less intact mulga on flats and evidence to suggest that Mulga woodlands on adjacent slopes have disappeared. In all cases there was evidence of fire. The slopes are now dominated by hummock grasslands.

Initially five transects will be established on the Mt Bruce flats. They will commence beyond the areas that are thought to have carried mulga in the recent (this century) past. They will traverse the stony slopes adjacent to the plain on which there are so many mulga stumps and stags as well as continuous Mulga woodland and grove-intergrove woodland communities on the plain. Additional transects will be established to the north-west of Mt Bruce to record mulga woodland on narrower drainage lines.
(Map 3)

2.Milli Milli Spring area. To the east of Milli Milli Spring there are two parallel valleys separated by a steep rocky ridge. There are no tracks in the northern valley which contains mulga woodland from side to side. However the southern valley has seen gold mining activity since the first decade of the century.

There is a track along the southern valley which probably dates back to the days of gold mining and has been used ever since by pastoralists (who grazed the area before the HRNP was declared) and by modern day prospectors and park Rangers.

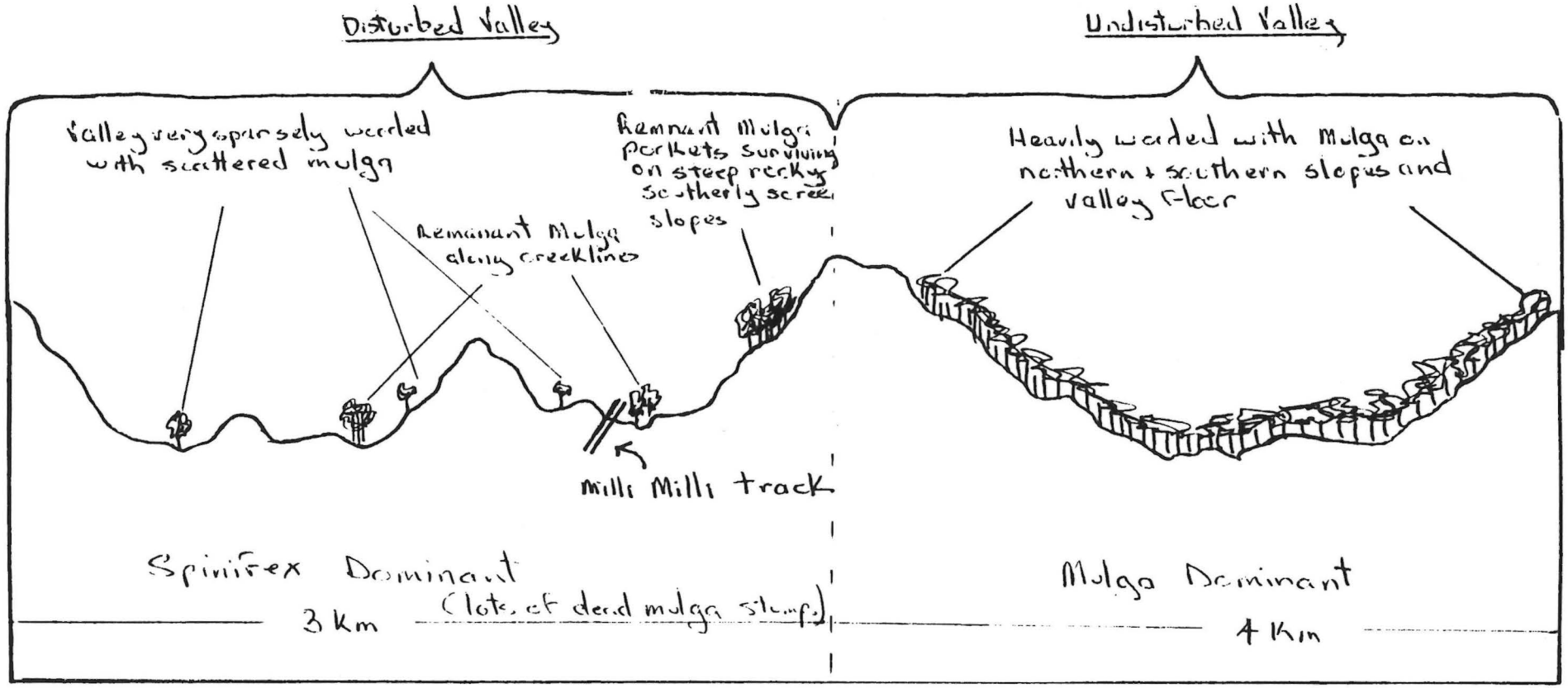
In the southern valley Mulga is now restricted to small patches, mostly on steep scree slopes where it is relatively well sheltered from fire, and along drainage lines. The rest of the valley carries hummock grassland, but there are numerous dead Mulga stags in many places. There is evidence of many fires in the southern valley.

When viewed from the top of the intervening ridge the vegetation of the two valleys stands in stark contrast. We suspect that frequent burning in the valley that has seen European passage over the last 80 years or so has eliminated much of its original Mulga woodland. Dead Mulga where recent fires have penetrated the edges of remnant mulga patches in the southern valley suggests that the process of hummock grasslands replacing mulga is continuing there. (Map 4)

Several transects (number to be decided) will be established in the Milli Milli Springs area to record 'Hill Mulga' community types.

Map 4

Cross-section of valleys to east of Milli Milli Springs



N

Not to Scale

Each transect will traverse both valleys and the intervening ridge, extending into communities beyond the original mulga edges to record the characteristics of adjacent non-mulga communities.

3. Additional transects. Additional transects will be located at sites to be determined in order to:

a. expand the data base on those MDC that have not been adequately covered.
b. extend the survey to other MDC at other sites thereby facilitating the determination of the representativeness of these communities with those elsewhere in the national park.

This will also facilitate future comparison of MDC in HRNP with those elsewhere

Data

Data that is to be collected along transects will include;

a. all living trees/shrubs- continuous.
b all stumps/stags - continuous.
c. spinifex/grass species turnover - continuous.
d. spinifex/grass species present and cover - fixed points.
e. presence of other species (small shrubs and annuals) - fixed point.
f. slope and aspect - fixed point
g. soil description - fixed point.
h. evidence of fire - continuous

N.B. Continuous sampling will occur within ? (5)m of centre-line of transect.
Fixed point sampling (quadrats) will occur at ?m intervals along transects and will cover the area in a radius of ?m of the centre-line. Dimensions will be determined by field trials.

Quadrats

Quadrat will be established at fixed points along transects in all MDC to be sampled. They will be established in all community types traversed by the transects. The positioning of quadrats and the number required (replicates) has yet to be determined. Experimentation will be required to define the most suitable design for quadrats (size and shape) in this semi-arid environment. Such experimentation will be undertaken in conjunction with a search of the relevant literature

Quadrats will be established in accordance with the Department's monitoring program. All quadrats established will be permanent and will include fixed photo points. Members of the Biogeography Program will be asked to assist with design.

Flora and vegetation

Data to be recorded within quadrats will relate to the flora, vegetation geomorphic and edaphic properties of the site. Data on fauna will be collected from sites adjacent to the quadrats (see below). Data to be recorded from quadrats will include;

- plant species prescence/absence
- plant species habit
- numerical abundance (density)
- percentage vegetation cover of entire quadrat
- percentage cover per species
- life history stage of plant species
- reproductive state
- evidence of fire and response of species to fire

(Research will need to be conducted to determine the most accurate and efficient method of assessing per percentage cover values for quadrats and species, especially in areas containing spinifex and other grasses.)

The edaphic and geomorphic features of the site that will be recorded will include;

a. soil structure and associated characteristics (water holding capacity, moisture content, pH, nutrient status, friability)
b slope and aspect

Fauna.

Vertebrates.

Replicate sites for monitoring terrestrial mammals, reptiles and amphibians will be established at both control and experimental areas at the Mt. Bruce and the Milli Milli Springs study sites. They will be located adjacent to vegetation quadrats in each MDC type. Each site will be monitored at least twice each year, in spring and autumn.

They will be established and monitored using survey techniques compatible with those used by Biogeography Program for long-term monitoring. However only live trapping techniques will be used because of the need for regular reappraisal. Taking of specimens will be limited to vouchers for identification at the beginning of the program or when

new species are first encountered. Non-destructive methods of surveying bats will be discussed with Norm McKenzie.

Birds will be recorded while walking fixed lengths of the transect lines within each MDC. The selected sections will pass adjacent vegetation quadrats. Appropriate parameters will be determined in the field. (Dunlop et al. 1985)

Invertebrates

The need to sample invertebrates has not been established and needs to be discussed. The literature suggests that it would be desirable. One group that may prove useful is ants as they have been shown to be good indicators of environmental quality.

Invertebrates would be sampled by means of pit traps and ground quadrats along the transect lines at both study areas. Design of the trap lines will be consistent with that used by Biogeography Program for long-term monitoring

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Fox

Fox

Fox

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MULGA3.DOC.

The primary objective of the proposed study is:

Mulga Dom Comm 1h'

TO DETERMINE WHETHER DIVERSITY WITHIN HRNP IS DIMINISHING BECAUSE OF INAPPROPRIATE FIRE REGIMES

and if it is:

TO DEVELOP A PRACTICAL AND AFFORDABLE FIRE REGIME THAT, IF IMPLEMENTED, WILL MAINTAIN DIVERSITY.

HYPOTHESES

1. In the HRNP Mulga dominates a variety of distinct and definable plant and animal communities. Each community occupies sites with characteristic edaphic and geomorphic features.

2. Some of the species in the mulga dominated communities (MDC) are endemic to them.

3. Changes have occurred in species composition and structure of some MDC and in the balance between MDC and hummock grasslands. Change is still occurring.

4. Fire is a major disturber which is modifying some MDC in the HRNP. The communities vary in their vulnerability and resilience to fire. Fire regimes can determine whether sites are dominated by mulga or hummock grassland communities.

5. Modification of MDC by fire is reducing biological diversity within the National Park.

The primary objective of the proposed study is:

TO DETERMINE WHETHER DIVERSITY WITHIN HRNP IS DIMINISHING BECAUSE OF INAPPROPRIATE FIRE REGIMES

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GUIDELINES FOR THE WORKSHOP SESSIONS

The Workshop sessions have been planned to discuss specific issues that participants have identified as major areas of concern or interest. Since limited time is available, questions to address on each of the topics have been listed below. They are not intended to restrict the scope of discussions, but rather to ensure the two workshop groups discuss similar material.

Lists of Workshop participants will be posted in the Training Centre at the commencement of each day. Each group is required to produce a one-page legible (!) summary of discussions for use in the final session, "Setting Research and Management Priorities".

A short (500-600 words max.) typed report of each group's discussion will be required within two weeks of the completion of the Workshop. We are all busy people and this short report is not designed to be a burden, but to be a record of the discussions which following collation, will be distributed to participants.

JULY 11 1530-1700hrs *DYNAMICS OF SPINIFEX COMMUNITIES*

What are the critical gaps in our knowledge in relation to spinifex communities ?
Define the minimum data set required to be able to manage spinifex areas, emphasising achievable management.

JULY 12 1300-1500hrs *INTERACTION OF LAND MANAGEMENT AGENCIES AND ABORIGINES.*

How can we achieve positive interaction to benefit both nature conservation and Aboriginal interests ? Avoid legislative restrictions and politics; identify what positive things can be achieved at the on-ground level.

1530-1700hrs *FIRE REGIMES AND MANAGEMENT OF SPINIFEX*

What should the objectives be ? What do we know ? (examine on a biome basis) What are the research priorities ?

JULY 13 0830-1030hrs *REINTRODUCTION OF LOCALLY-EXTINCT SPECIES AND FERAL ANIMAL CONTROL*

Is reintroduction worth it ? If so, which species are the priorities ?
Compile a checklist of the practical considerations necessary to undertake a reintroduction program.
Should we be attempting more broadscale feral animal control in areas not targeted for reintroductions ?

1100-1300hrs *TRANSFORMING RESEARCH RESULTS TO ON-GROUND MANAGEMENT ACTION*

Discuss the concept of "experimental management". Does it have a role ?
How do we motivate managers and the bureaucracy to commit more resources to the management of spinifex deserts ?
How do we better communicate the concept of needing to manage deserts to the public, bureaucrats and politicians
.

GRASS.	100	No dominant Grass
	110	Triodia pungens
	111	T basedowii
	112	T wiseana
	120	?
	130	Themeda
	140	Aristida
	150	
	160	
	170...	

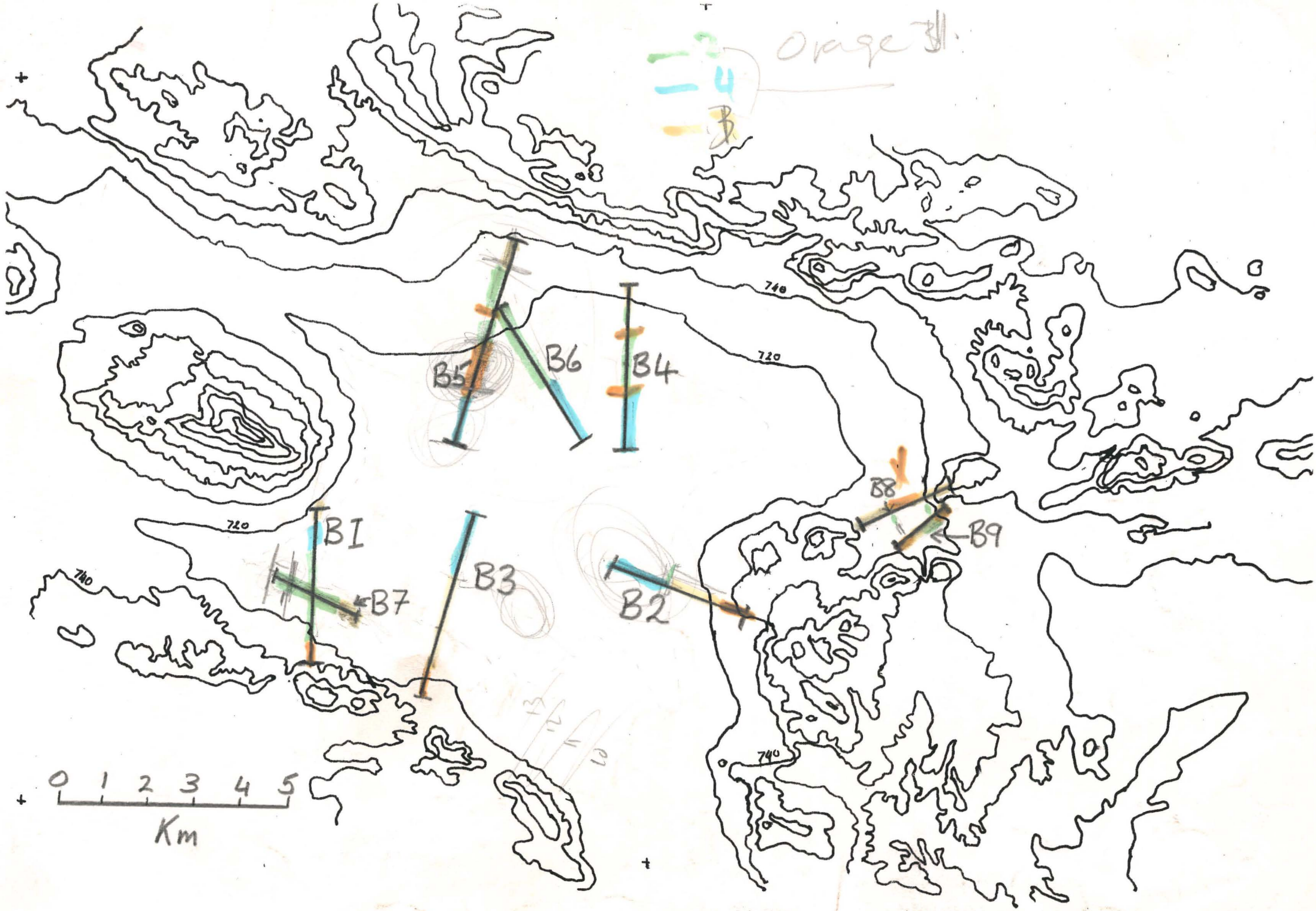
TREES.	200	No dominant trees
	210	Snappy Gum
	220	Bloodwood
	230	Mulga tenée tree
	231	" " shrub.
	232	" flat shrub.

BARE GROUND	300	No extensive bare ground.
	310	Grove / Intergrove
	320.	Other extensive bare ground.

FIRE	400	Little or no evidence of fire (may incl few old fire scars)
	410/1	Pre 1986 fire
	420/1	1986 fire
	430/1.	post-1986 fire

Fire

last fire 0/1. 0 = single fire
1 = multiple fire



Orage
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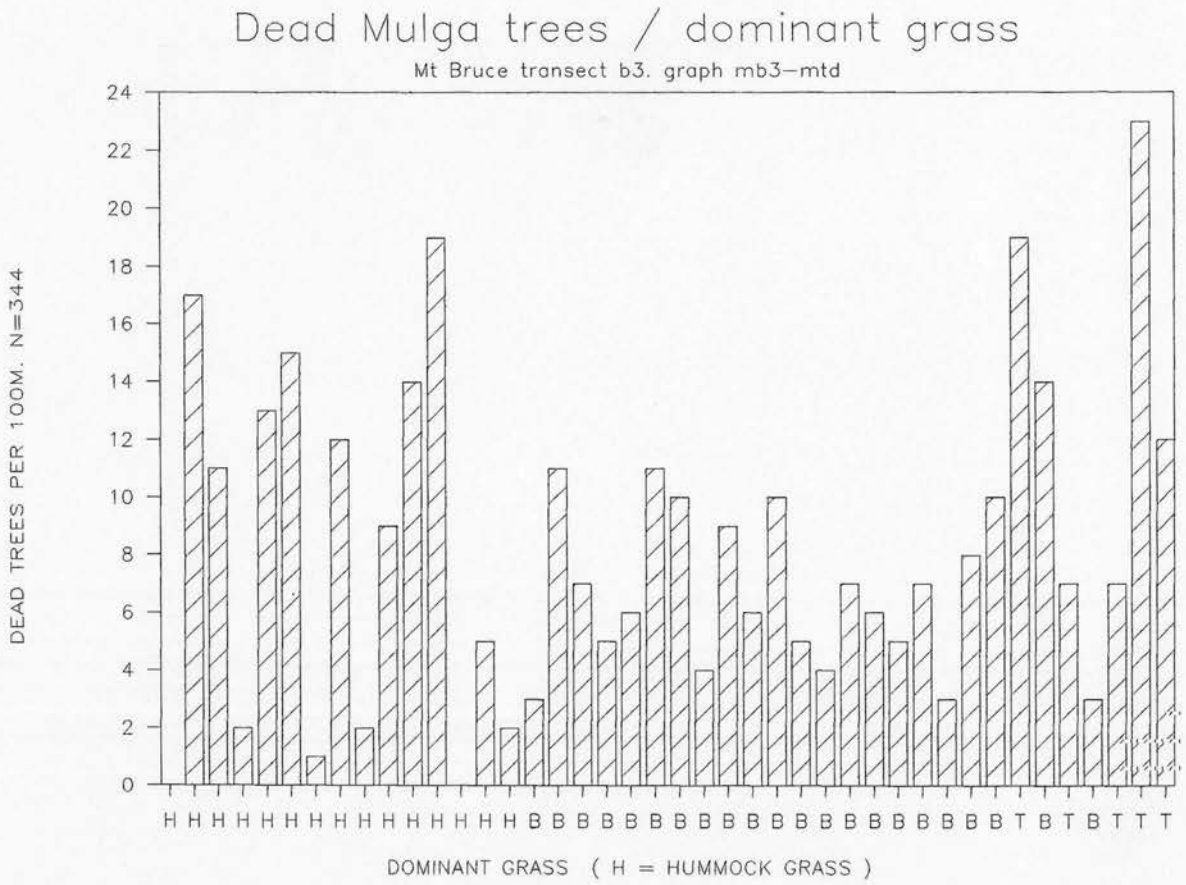
Km


Dead Mulga trees / dominant grass
Mt Bruce transect b3. graph mb3-mtd
DEAD TREES PER 100M. N=344
0
2
4
6
8
10
12
14
16
18
20
22
24
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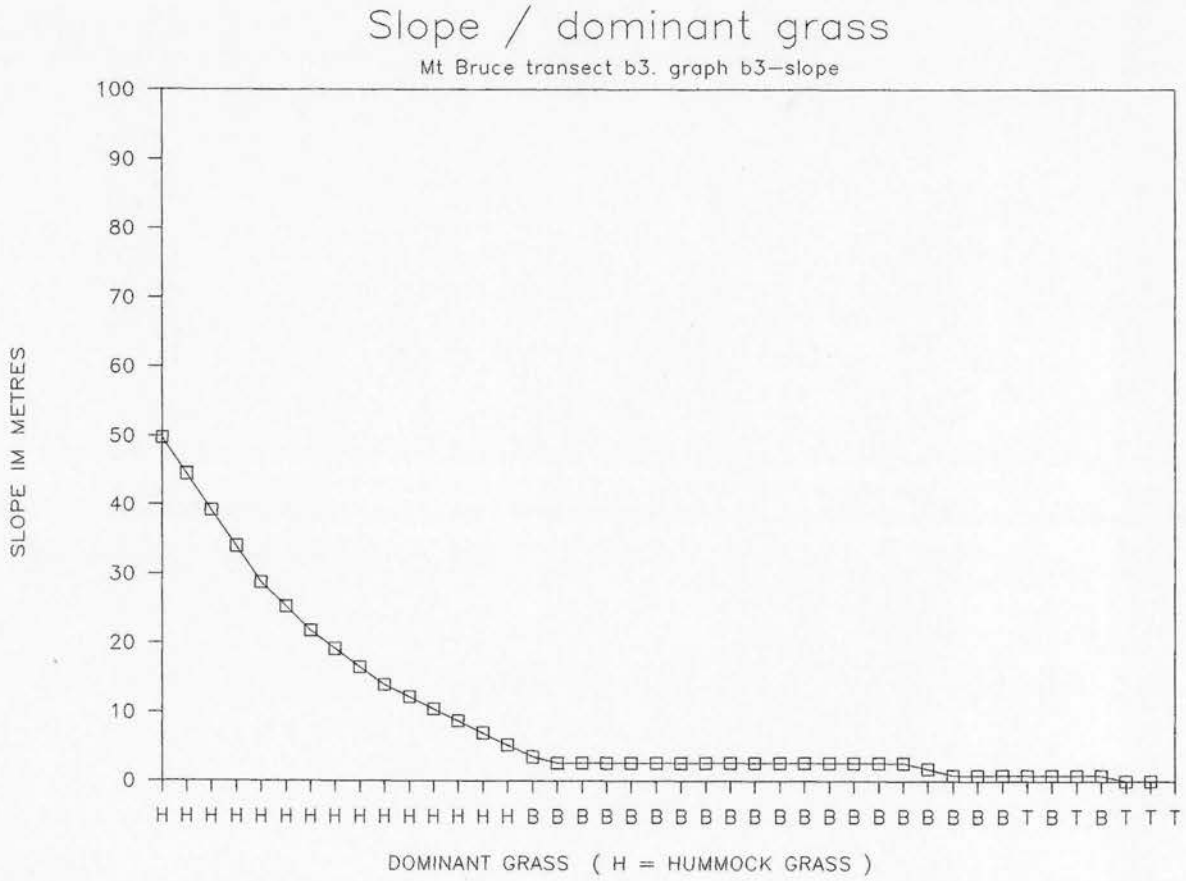
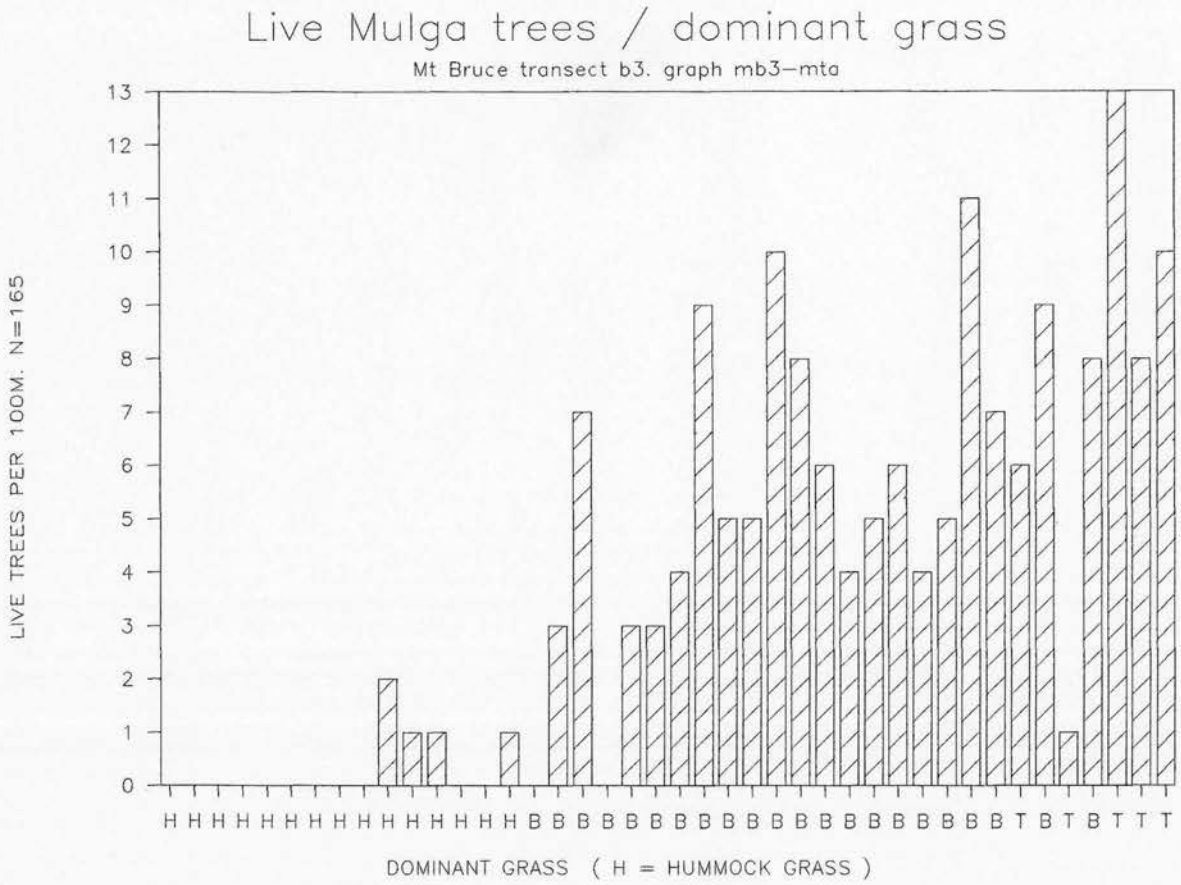
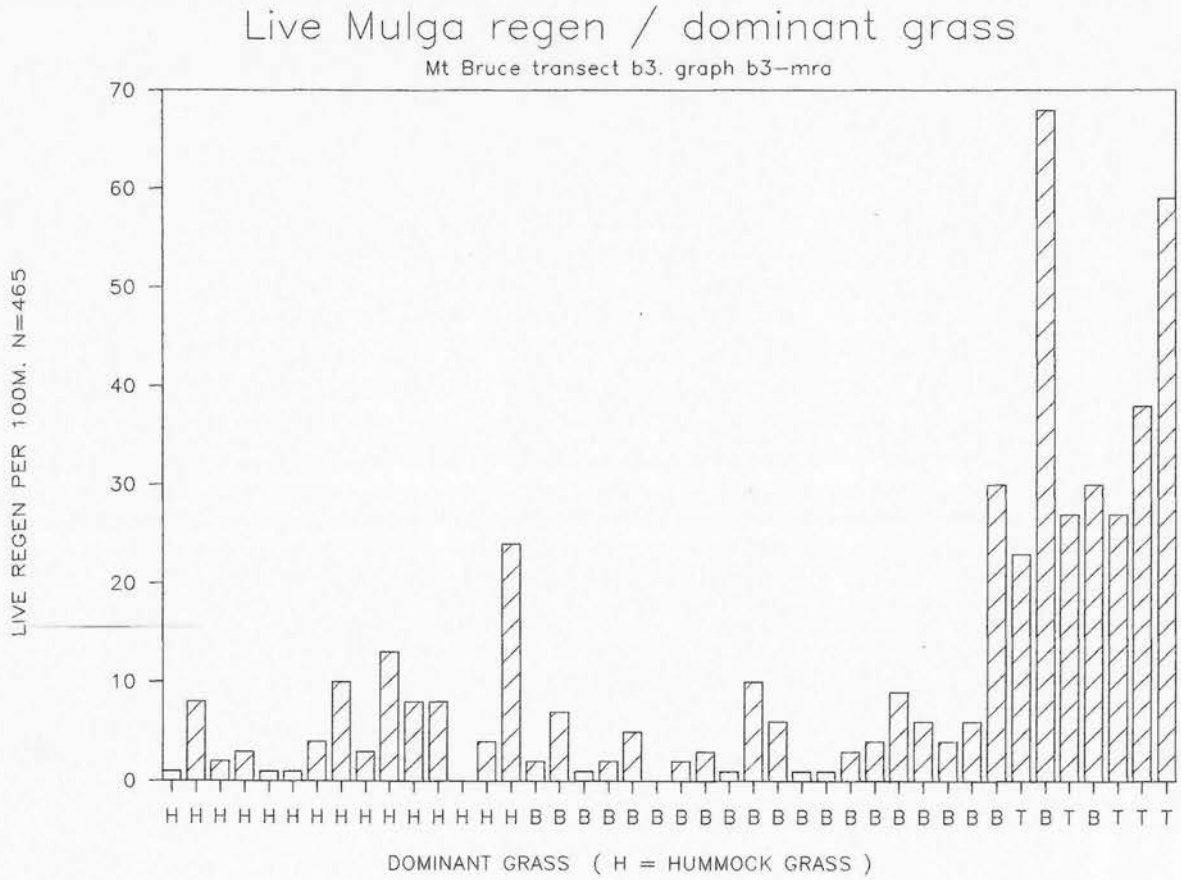
DOMINANT GRASS (H = HUMMOCK GRASS)


Slope / dominant grass
Mt Bruce transect b3. graph b3-slope
SLOPE IM METRES
0
10
20
30
40
50
60
70
80
90
100
H H H H H H H H H H H H H H H B B B B B B B B B B B B B B B B B B T B T B T T T
DOMINANT GRASS (H = HUMMOCK GRASS)


Live Mulga trees / dominant grass
Mt Bruce transect b3. graph mb3–mta
LIVE TREES PER 100M. N=165
0 1 2 3 4 5 6 7 8 9 10 11 12 13
H H H H H H H H H H H H H H H B B B B B B B B B B B B B B B B B B B B B B T B T B T T T
DOMINANT GRASS (H = HUMMOCK GRASS)


Live Mulga regen / dominant grass
Mt Bruce transect b3. graph b3–mra
LIVE REGEN PER 100M. N=465
0 10 20 30 40 50 60 70
H H H H H H H H H H H H H H H B B B B B B B B B B B B B B B B B B B B B B T B T B T T T
DOMINANT GRASS (H = HUMMOCK GRASS)

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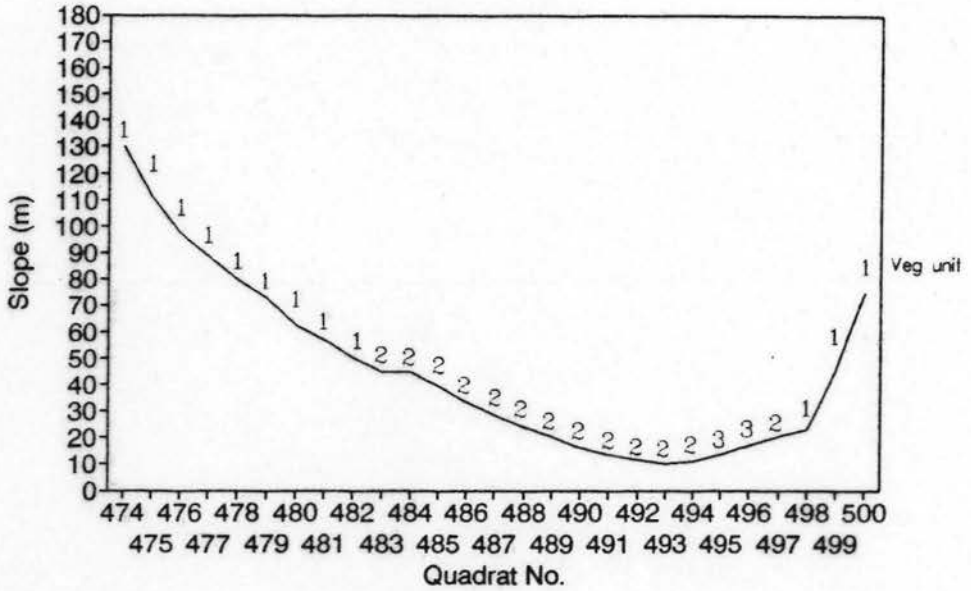
Transect P4



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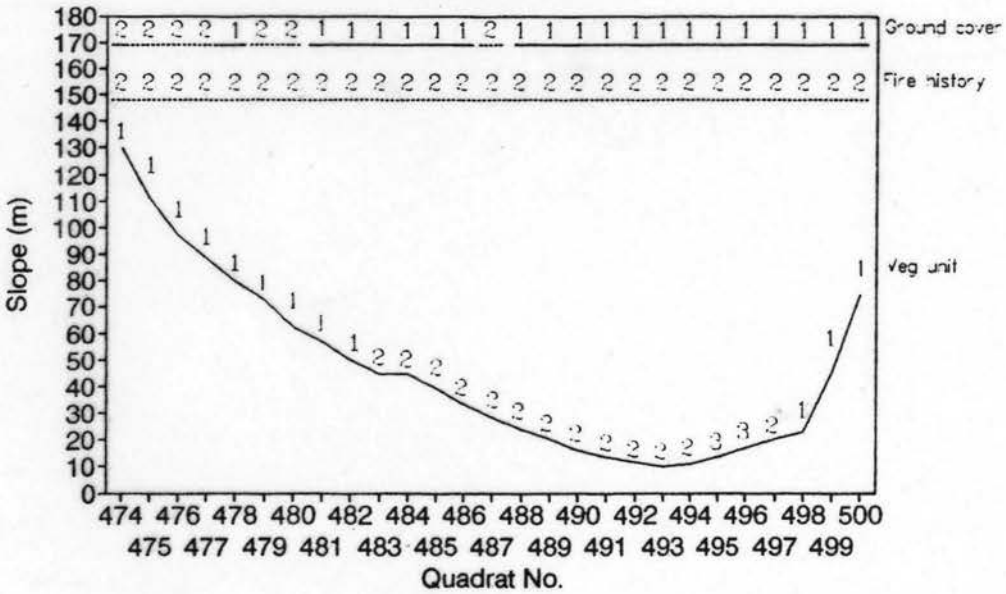

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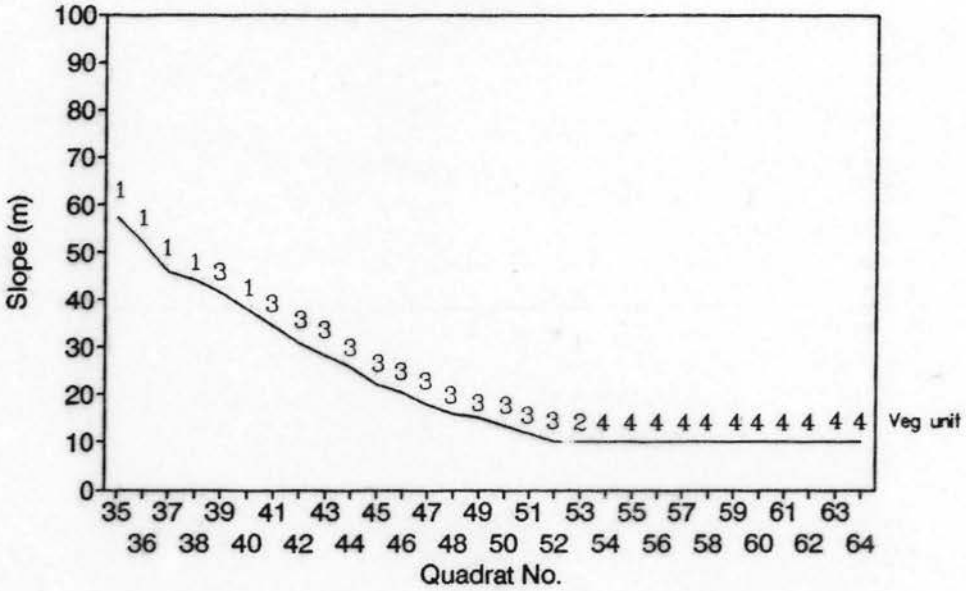

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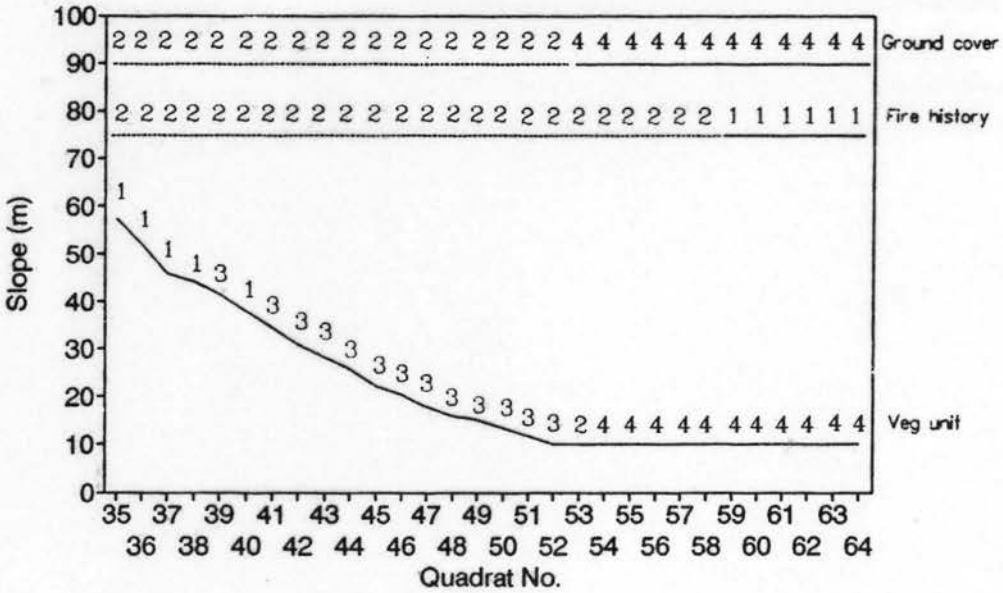

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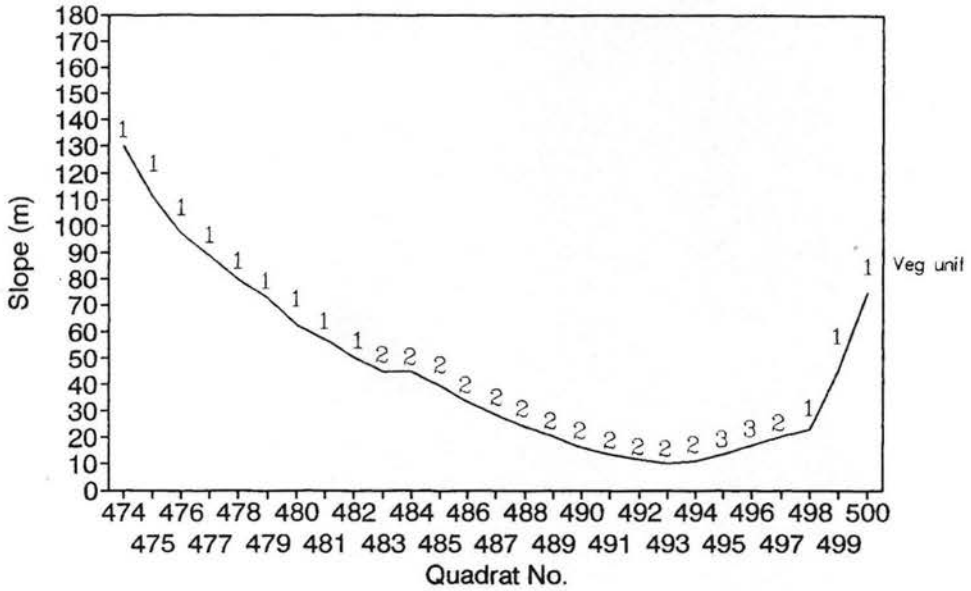

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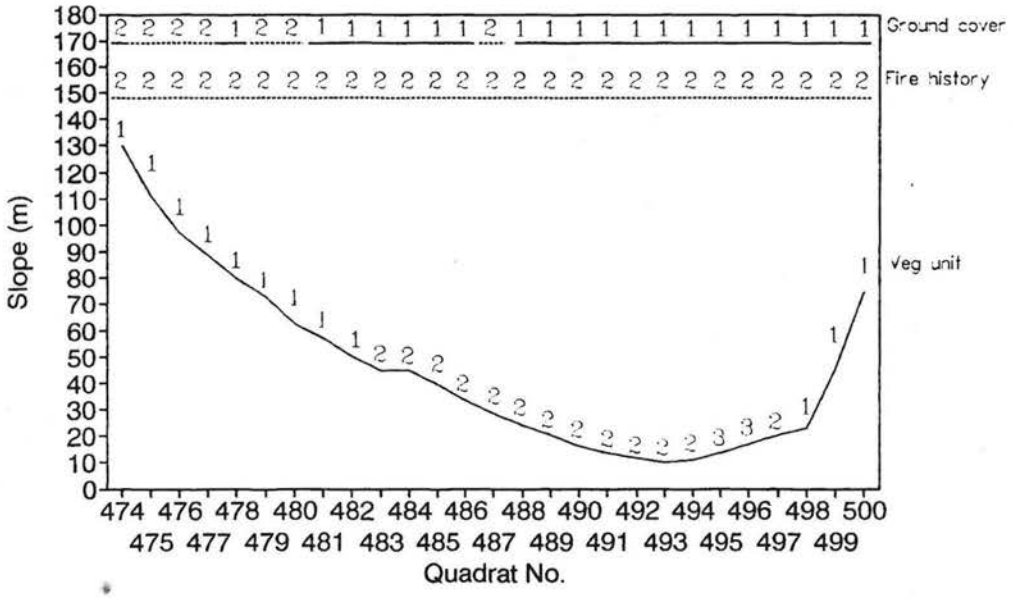

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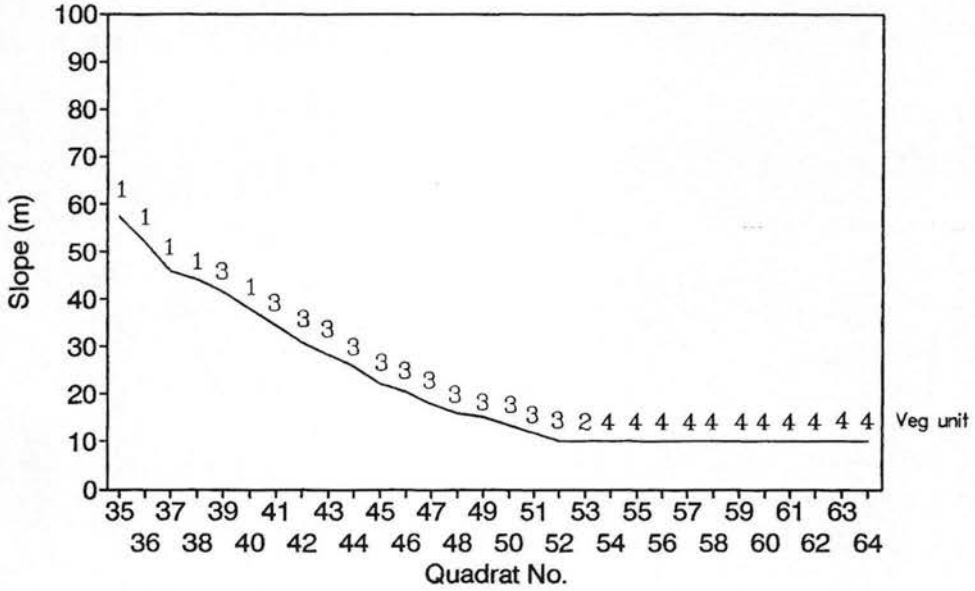

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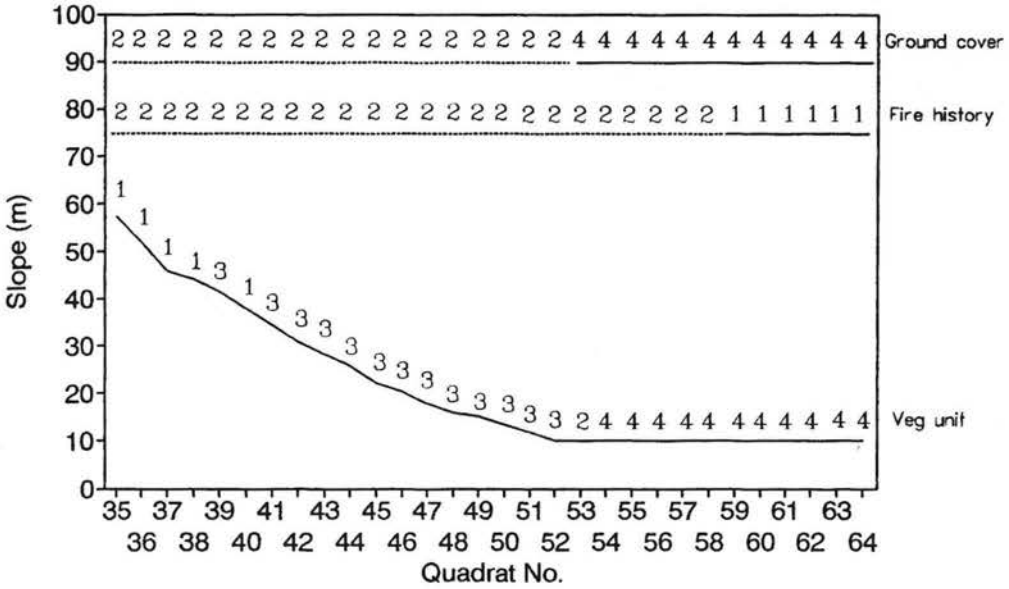

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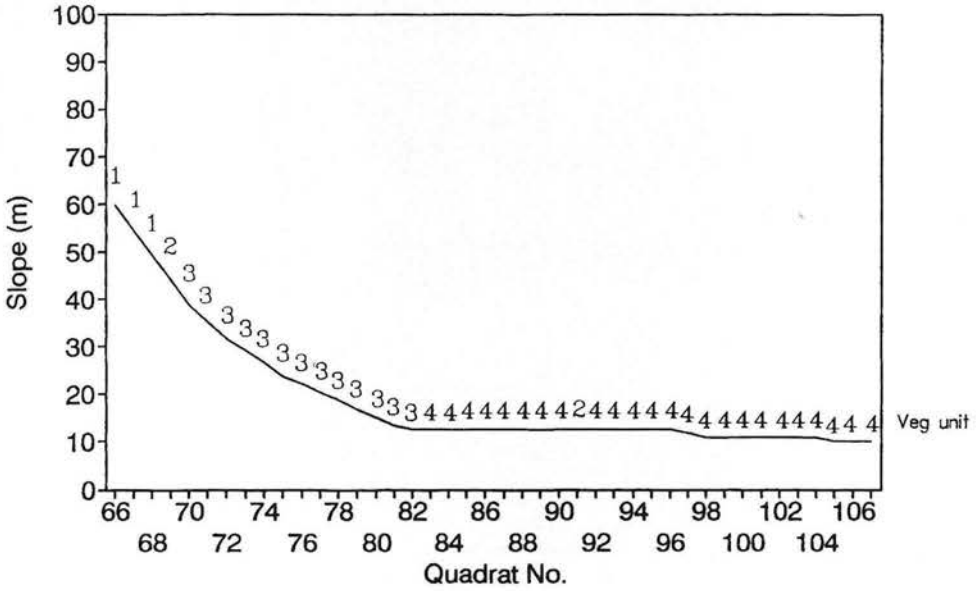

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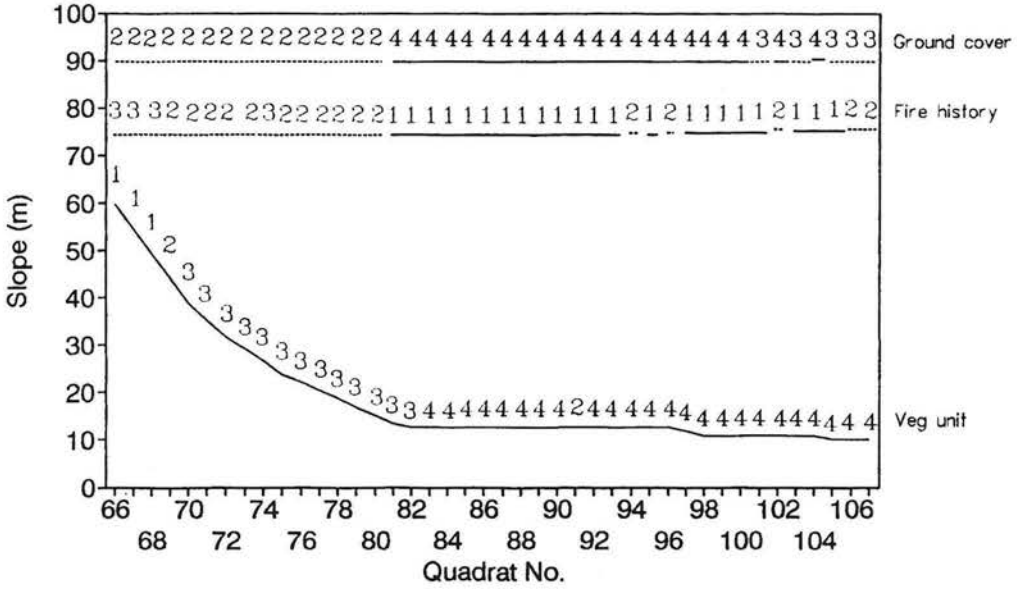

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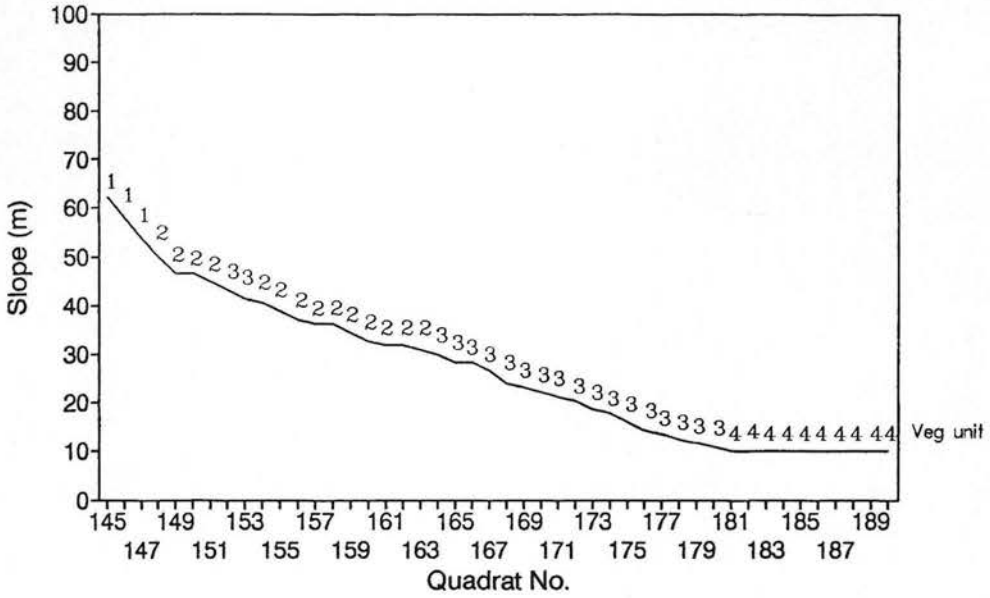

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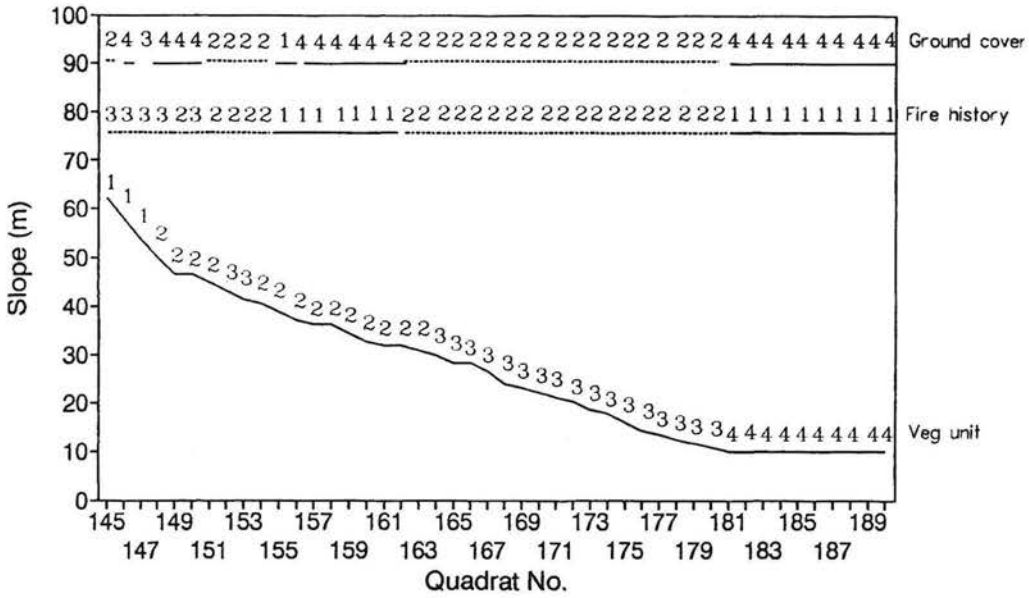
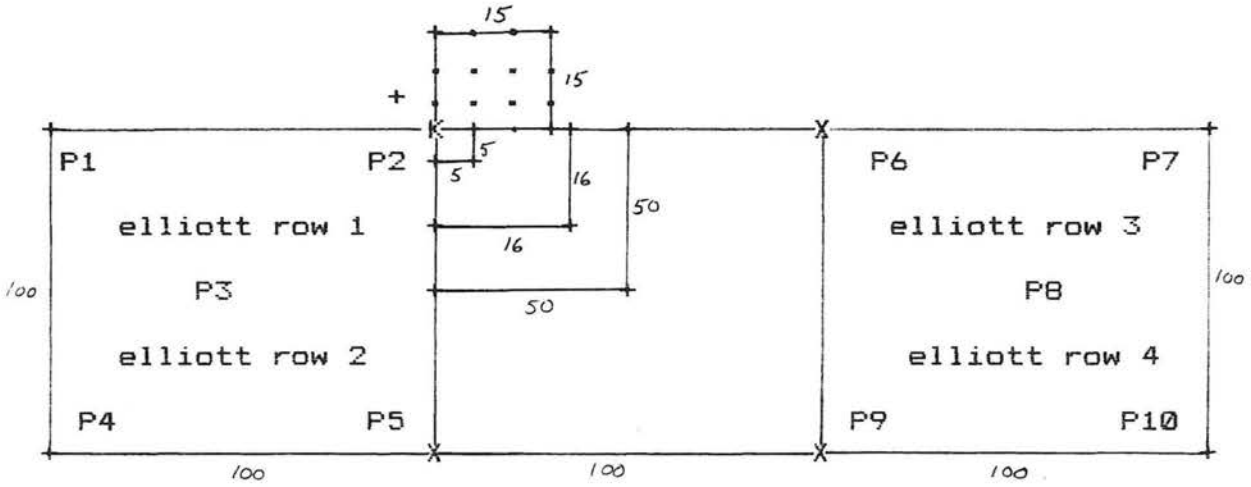


PLOT Nº.

Direction down slope

Key Peg:- Lat.....Long.....Altitude.....



Comment

Location mud-map

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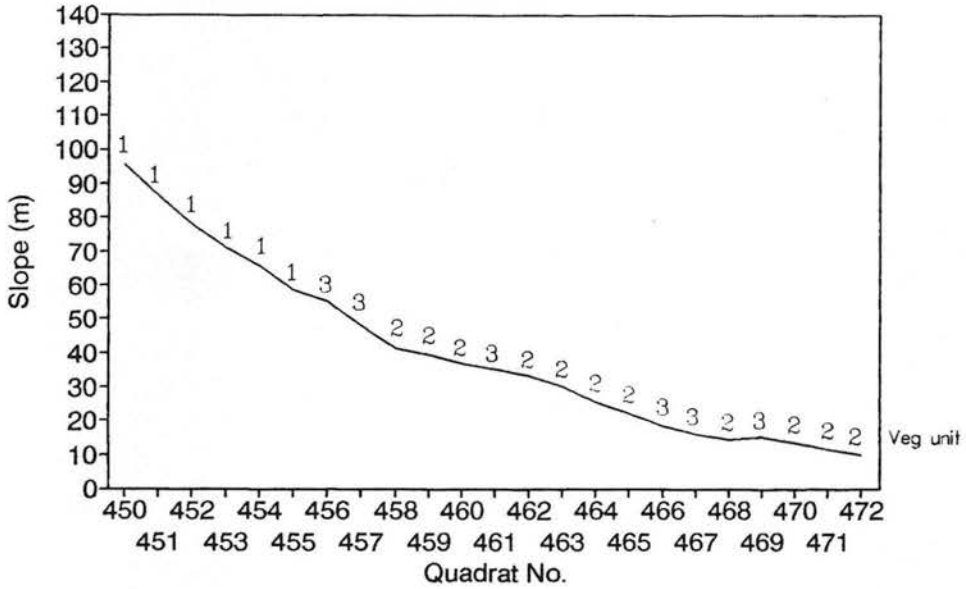
Transect P3



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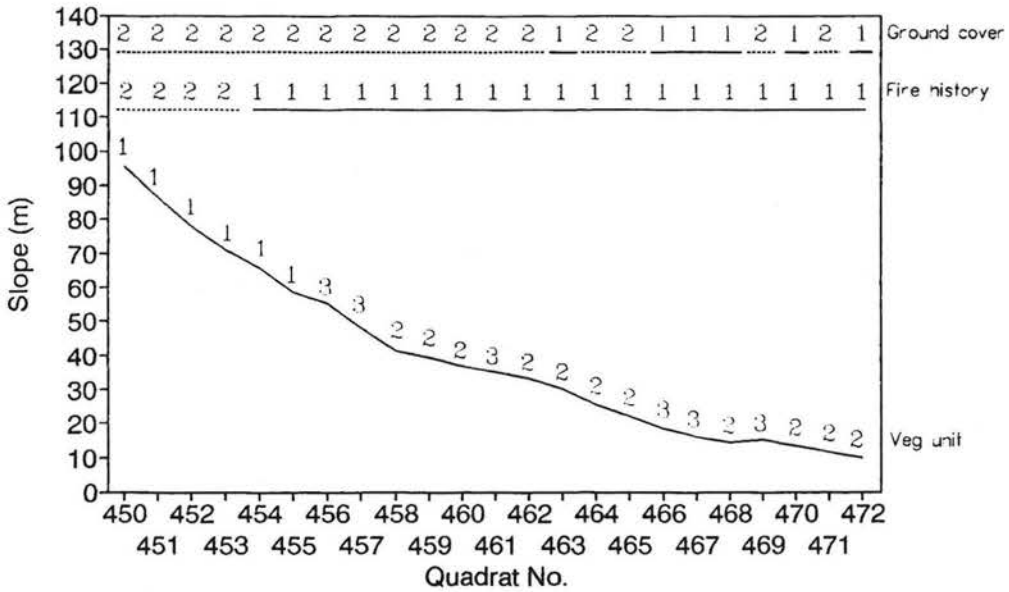

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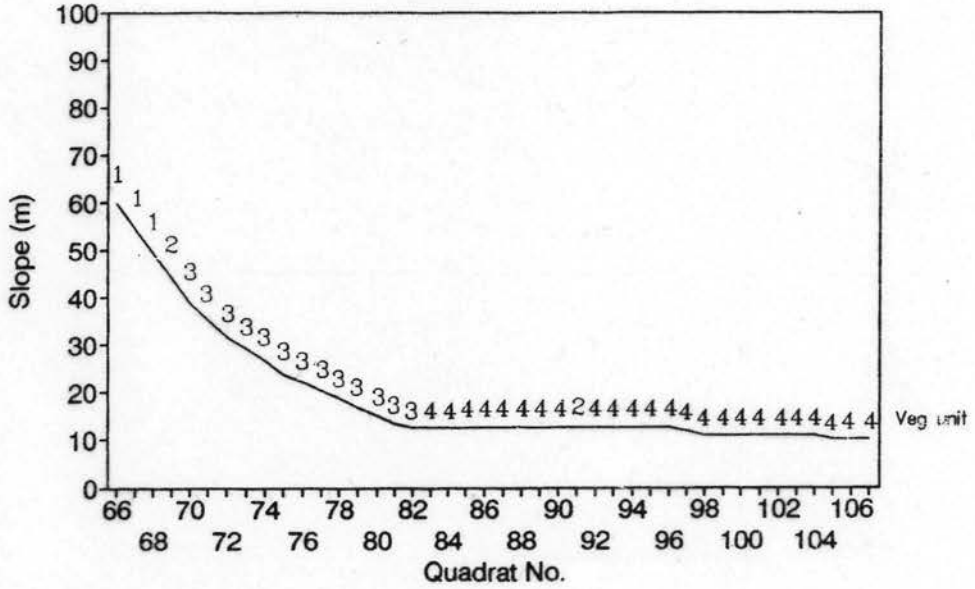

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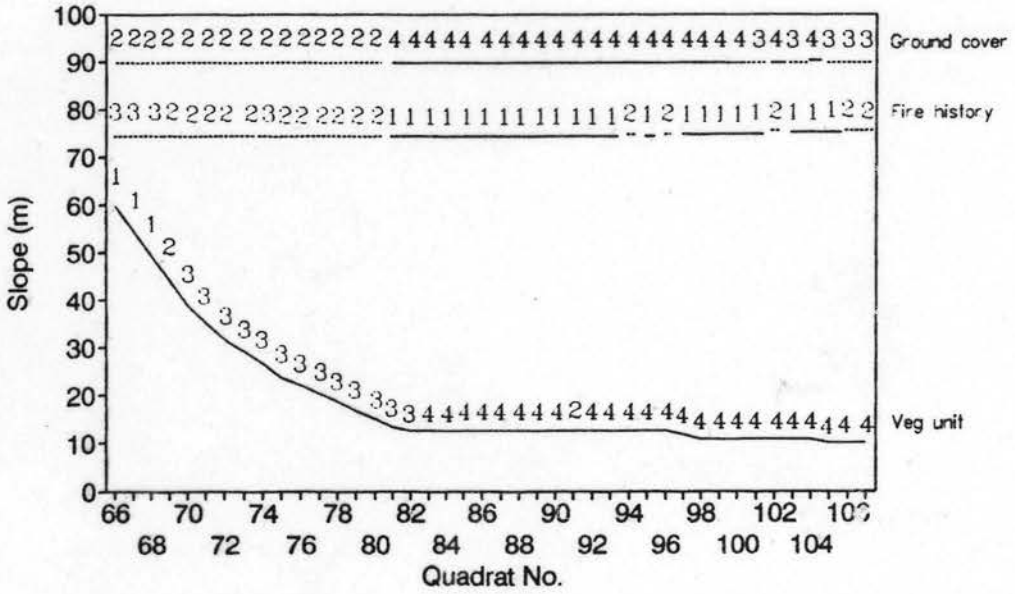
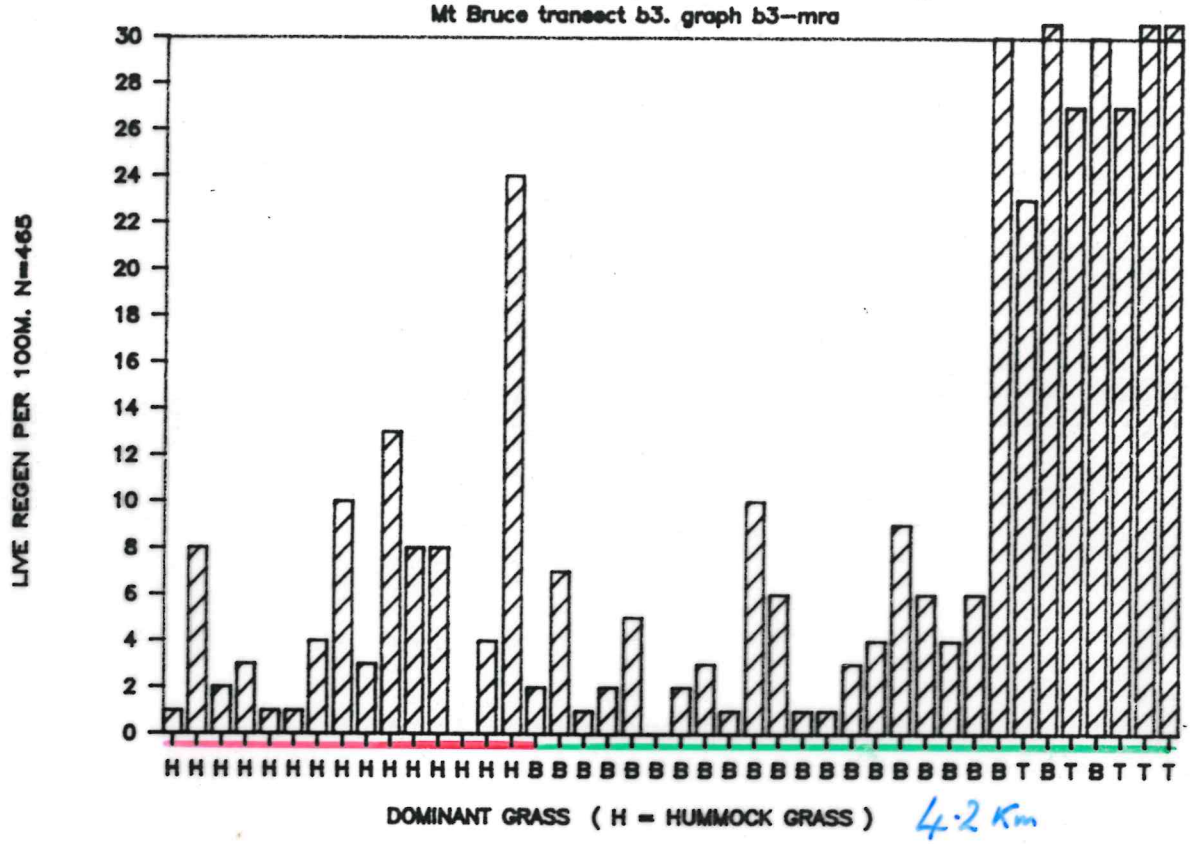


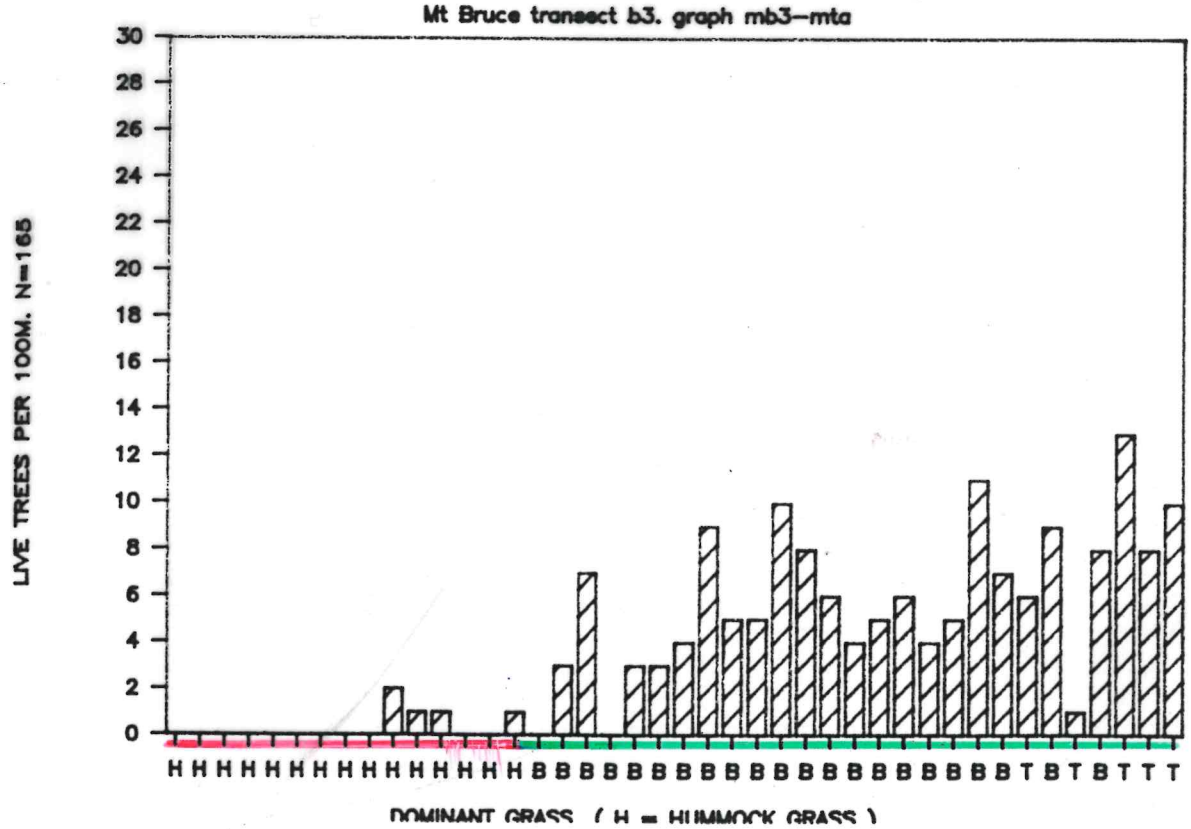
Live Mulga regen / dominant grass

Mt Bruce transect b3. graph b3–mra



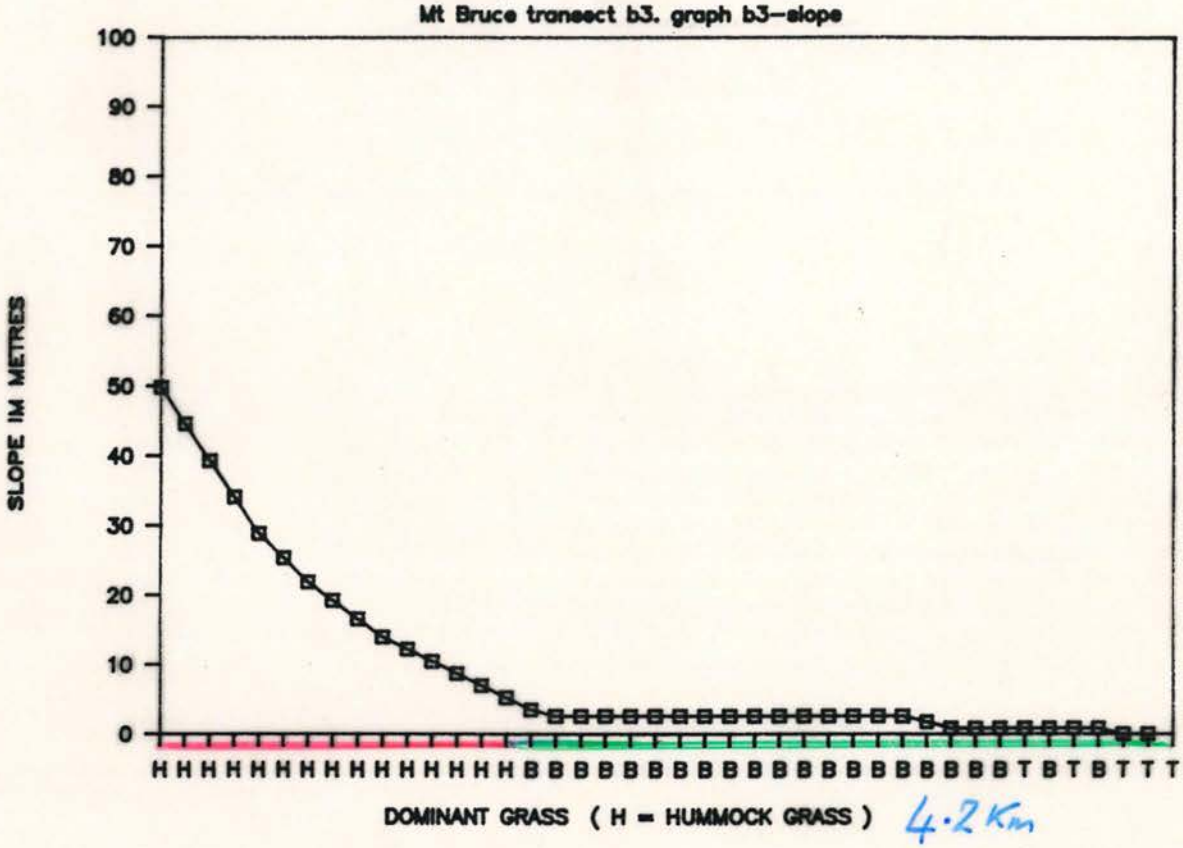
Live Mulga trees / dominant grass

Mt Bruce transect b3. graph mb3–mta



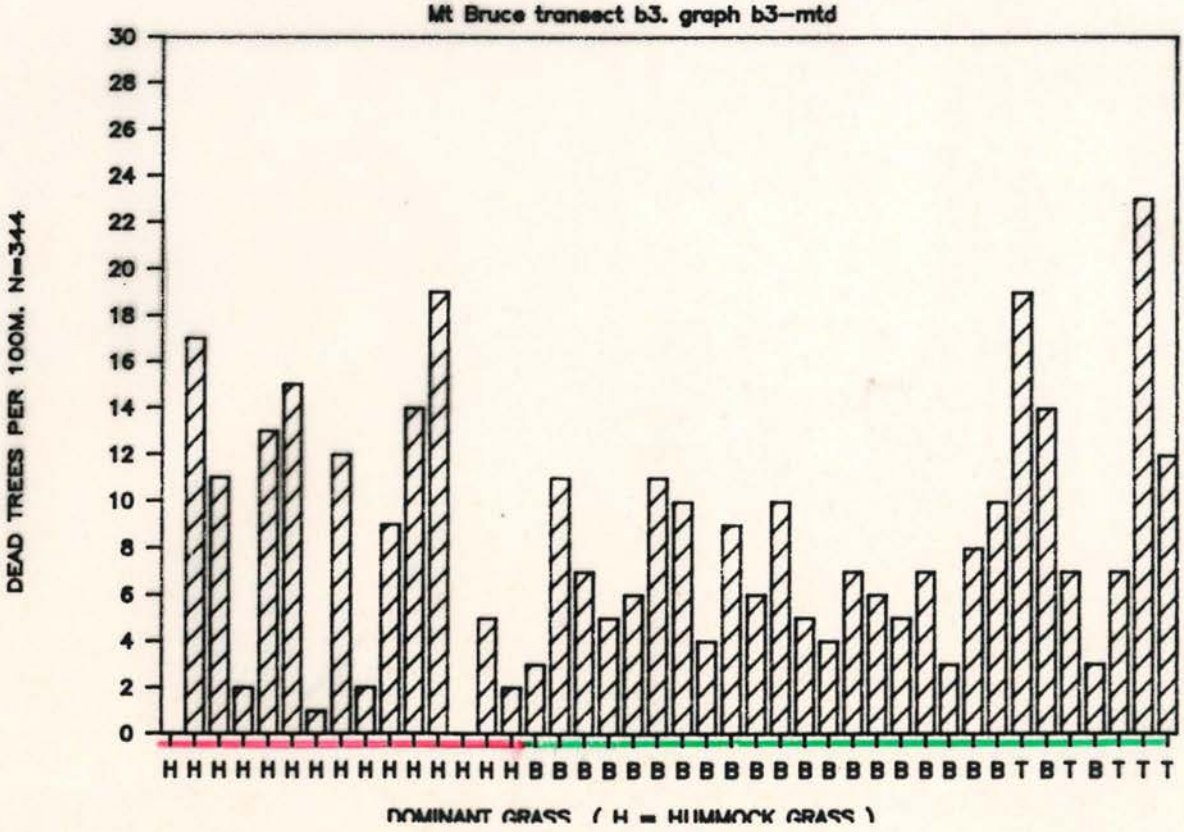
Slope / dominant grass

Mt Bruce transect b3. graph b3–slope



Dead Mulga trees / dominant grass

Mt Bruce transect b3. graph b3–mtd



Mulga and Spinifex in the Hamersley Range - A problem.

Paper presented to the Workshop on Spinifex held at Perth on July 11-13 1990.

By A.N. Start, S. van Leeuwen.

1. ACKNOWLEDGE Phil Fuller and Bob Bromilow.

2. INTRODUCTION

2.1 EARLY CONCERNS. ***overhead WA***
2.2 SIMILAR STORIES FROM ALICE
2.3 CHANCE TO WORK IN THE PILBARA

*

3. OBJECTIVES

3.1 We don't want the biodiversity of HRNP to be diminished by fire. Managers need to know what fire protection prescriptions to apply AND how, when and where to apply them.

3.2 ? Are different Mulga-dominated assemblages recognisable in the HRNP?

? If so which (if any) are vulnerable to long term fire damage?

? What are the components of the vulnerable assemblages? and are they threatened by fire damage?

? How do we manage fire in HRNP

4. METHODS

4.1 SELECTION OF SITES. ***O/H Mt. Bruce flat***
4.2 TRANSECTS
4.3 QUADRATS

5. RESULTS

5.1 TRANSECTS B3, B2, (Spinifex on slopes, Mulga on flats)
5.2 TRANSECTS B5, (as above with creek)
5.3
5.4 SEARCH FOR INTACT SLOPE, MT BRUCE FLAT
5.5 % GONE MT BRUCE FLAT
5.6 SEARCH FOR INTACT SLOPE, ELSEWHERE

6. CONCLUSIONS

* A feature of M. woodlands in this part of the world is the diversity of sites and plant assemblages that are dominated by Mulga. ∴ you get Mulga on screes & Mulga on flats & M ~~domina~~ has an understory of woody shrubs or H. or Themida or oth grasses.

7. FURTHER WORK

Conclusions so far.

1. In terms of fire vulnerability there are distinct differences within Mulga woodlands.

2. There are differences in site characteristics which appear to correlate to the differences in vulnerability

3. There are differences in grass communities on these sites

4. There appear to be differences in other plant species - eg Eremophila cassii Ptilotus etc

5. Alot more work is needed elsewhere to verify these observations quantitatively.

? Animals.

Slides.

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

Form CLM 80A

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.....

Your Ref:
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Enquiries:
Phone:

Subject: Workshop on Nature Conservation Research.
Fire and Mulga in Hamersley Range National Park.

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1 As RM I became concerned at the loss of Mulga by Fire

2. Project is just starting
one recce field trip.

3. Background. – Vegetation

To North Spinifex in N Pilbara (Fortescue Bot Dist.

To South Mulga dominant to south (Ashburton Bot-Dist)

In South Pilbara Mosaic Mulga in valleys / scree slopes in S pilbara
Composition of understory varies widely & ? probably fauna.
HRNP straddles this transition zone
Spinifex – The ideal fuel.
Mulga – Fire sensitive.

Net result patches of Fire sensitive woodland surrounded
by fire prone / highly flammable spinifex
Some sites can support both veg types

4 Background – Fire Aboriginal people – ? patch burn
They've gone ~~[illegible]~~
Present fire (Bushfire or Lightning)
runs into Mulga

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The Problem.

Molga is killed. ~~(if frequency was too enough would it regenerate?)~~

And ~~Anyway~~ today it appears that Spencer moves in - Spencer is perfect fuel etc. Good by Molga.

Questions we want to Ask.

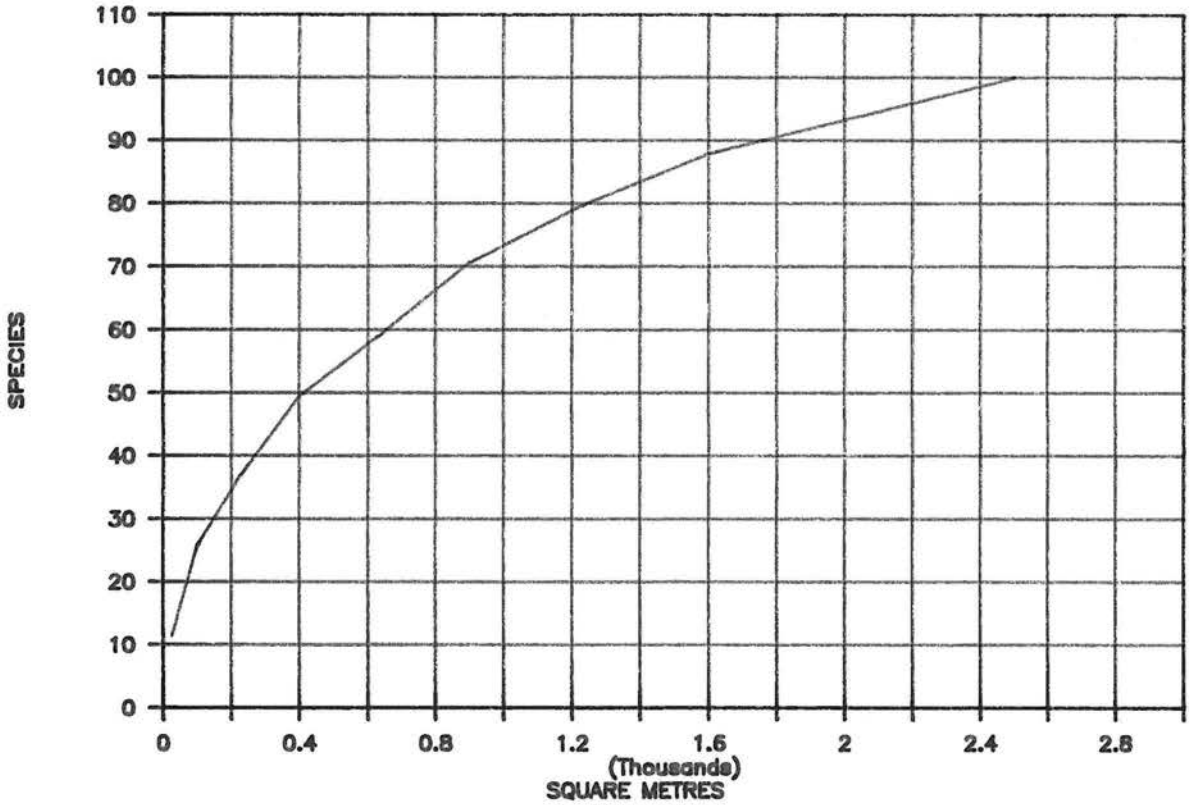
1. Is Molga really being replaced.
2. If so - which communities are affected
3. " - how much of it is affected.
4. What is effect on diversity in the NP.
5. Is it fire driven
6. Is it permanent.

Mt Bruce Map / Slides.
Mille Mille Map Slides.

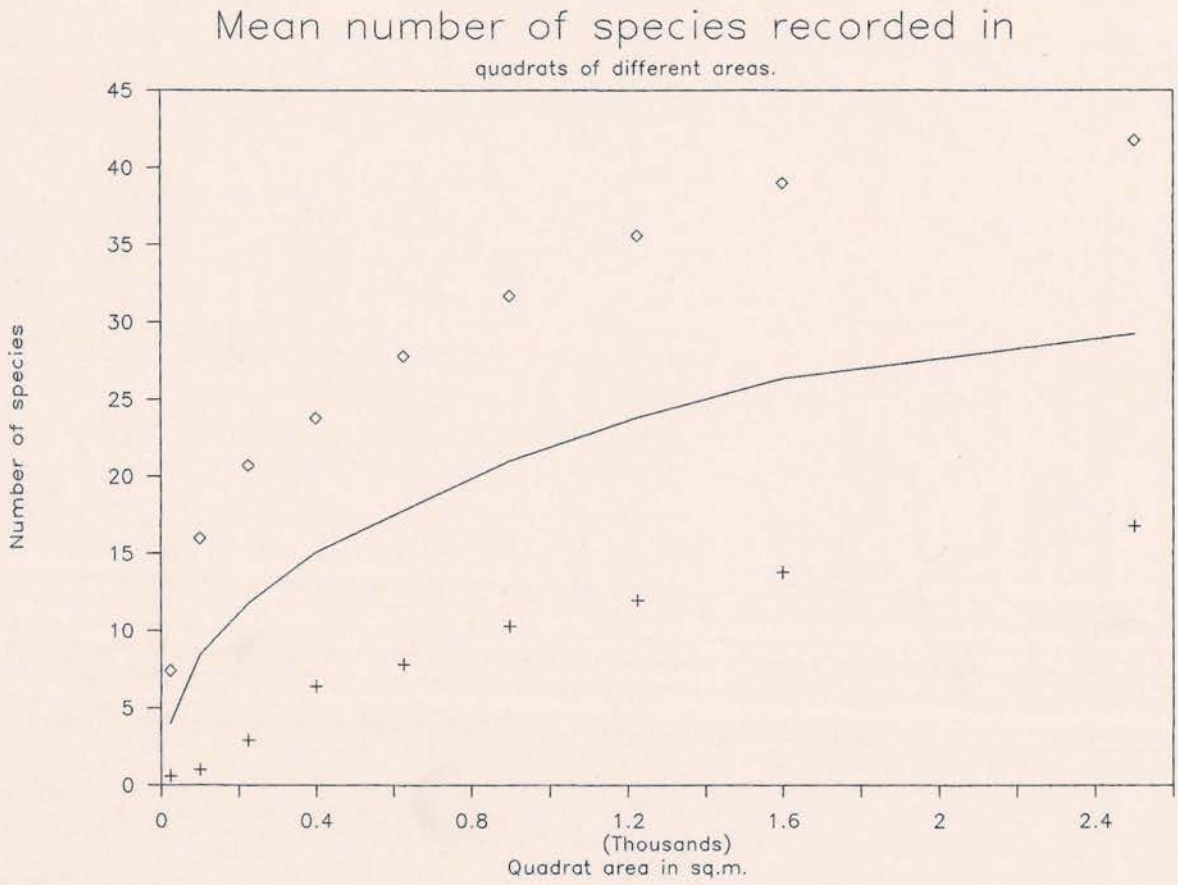
Primary Objective.

Formula RISE = RUN * TAN

angle	run	rise
0.50	100.00	0.87
1.00	100.00	1.74
1.50	100.00	2.62
2.00	100.00	3.49
2.50	100.00	4.36
3.00	100.00	5.24
3.50	100.00	6.12
4.00	100.00	6.99
5		8.75
6		10.51
7		12.28
8		14.05
9		15.84
10		17.63


SPECIES
110
100
90
80
70
60
50
40
30
20
10
0
0
0.4
0.8
1.2
1.6
2
2.4
2.8
(Thousands)
SQUARE METRES

QUADRAT NUMBER	SQ M 25	100	225	400	625	900	1225	1600	2500
227	2	2	3	6	7	8	9	9	10
228	1	3	3	3	3	6	6	7	11
229	1	6	6	12	13	21	22	24	27
230	1	4	8	11	16	17	20	24	25
231	4	5	10	13	16	16	18	18	20
232	2	4	14	19	19	21	29	32	35
233	3	4	4	7	9	13	17	21	30
234	8	18	25	26	31	35	40	42	42
235	11	19	22	26	30	32	36	41	43
236	9	24	29	31	36	42	45	48	52
237	2	4	6	12	16	20	20	24	27
238				21	28	31	35	40	45
239				19	27	30	35	36	37
240				9	11	14	18	20	27
241				11	13	16	23	29	34
242				12	14	17	18	20	27
243				3	5	6	7	13	20
244				6	11	11	11	13	14
245				19	19	20	20	21	22
246				17	17	17	19	23	26
247				18	23	27	29	31	34
SUM	44	93	130	166	196	231	262	290	322
MEAN	4.0	8.5	11.8	15.1	17.8	21.0	23.8	26.4	29.3
SD	3.4	7.5	8.9	8.7	10.0	10.7	11.8	12.6	12.5



"Testquad.pic"