IMPACT OF GRAZING MANAGEMENT ON NATIVE GRASSES OF NON-ARABLE PASTURES IN THE MID-NORTH OF SOUTH AUSTRALIA

MID-NORTH GRASSLANDS WORKING GROUP PROJECT

FINAL REPORT

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CONSULTANCY SERVICES

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EXECUTIVE SUMMARY

A six year project was conducted at the property 'Anama', 15 km north of Clare in the mid-north of South Australia, to determine the effects of various grazing management strategies on animal production and grassland composition and function. The grazing management strategies that were evaluated could be broadly described as:
(1) The regional practice of continuous grazing from April to December followed by a rest from grazing when sheep are removed from grasslands to graze stubbles.
(2) Planning grazing events to avoid the key phenological periods of autumn and/or spring with removal of sheep from December to April.
(3) Planning grazing events based on plant growth rate and designing grazing events such that available grassland forage is removed in 2-4 days. Grazing could be scheduled for any time during the year and is referred to as high density short duration (HDSD).
(4) No grazing from domestic herbivores as generally practiced for grassland conservation reserves in the mid-north of South Australia.

To assess the effects of grazing management on grassland composition and function a number of variables were monitored including, basal cover, frequency of occurrence and biomass production. Animal production was evaluated by reference to animal growth. The 6 year project included a baseline vegetation monitor followed by 5 years of differential grazing management. The results can be broadly interpreted under the following categories.

Basal cover

Bareground increased nearly 10-fold under regional grazing practice, exceeding 40% in the 3-year period, 2002-2004. An additional Spring rest from grazing was more effective than Autumn rest at reducing the extent of bareground. Bareground in paddocks managed with HDSD averaged 5% and only once exceeded 10%. Bareground declined in the nil grazed paddock from 2 to 0%. Estimates of soil surface condition taken from 2003-2005 indicated small improvements in friability associated with grazing due to phenology but large and significant improvements due to HDSD and nil grazing.

Perennial basal cover did not exhibit a consistent trend in paddocks grazed to regional practice or according to plant phenology and averaged 3.7%. Perennial basal cover under HDSD grazing increased 72% reaching a maximum of 9.0% in 2003. In the absence of grazing, perennial basal cover declined by 89%.

Species diversity

The average number of species recorded across all grazing treatments was 20 per transect. After 5 years of differential grazing the paddocks grazed according to regional practice or plant phenology had the highest species diversity.

Number of perennial grass plants

The number of perennial grass plants prior to commencement of grazing practices averaged 53 per transect. After 5 years of grazing the number of perennial grass plants per transect had increased in paddocks grazed according to regional practice or plant phenology but exhibited a small decrease under HDSD or in the absence of grazing. The number of perennial grass plants was considered to be influenced by

recruitment of seedlings and fragmentation of existing tussocks. Data is presented in this report which suggests that fragmentation, in response to environmental stress, was the primary cause for increasing perennial grass number under grazing according to regional practice but not phenology.

Contribution of perennial grasses to biomass production

The contribution of all perennial grasses to total biomass was approximately 23% at the initial measure. Contribution of the 3 perennial indicator species and groups declined with regional practice and an additional Autumn rest. The contribution from the warm-season perennial, *Aristida behriana* increased with Spring rest but a decline for cool-season and year-long green species was observed. Grazing according to HDSD and in the absence of grazing, resulted in an increased contribution of both cool and warm season perennial species. In the latter case, complete cover reduced the contribution of the colonising group *Austrodanthonia* spp.

Animal production

Animal production did not differ between regional practice grazing and additional rest based on plant phenology and over the 5 years of grazing was calculated to average 2.3 DSE/ha. Animal production under HDSD grazing was calculated to average 4.2 DSE/ha.

Conclusion

After 5 years of differential grazing it can be concluded that, in comparison to regional grazing practice, additional Autumn rest provided no functional or compositional advantages. Additional Spring rest further reduced bareground, and made variable but positive changes to the frequency and contribution of perennial grasses. In terms of animal production, there was no difference between the 2 approaches to grazing management. In contrast, HDSD grazing increased animal production by 75%, produced the largest increase to perennial basal cover and was associated with an increased contribution from perennial grasses to total biomass. There was a large (7-fold) increase in the frequency of the undesirable plant, *Gynandriris setifolia*, with HDSD but herbage mass of this species did not exceed 2 kg DM/ha. Removal of grazing by domestic herbivores maintained complete basal cover, but at the expense of perennial grasses, in particular the colonising group, *Austrodanthonia* spp.

In terms of achieving the multiple aims of enhancing grassland function, composition and animal production, no grazing approach (including nil grazing) was without negative influence and grassland composition was observed to experience large changes associated with the variable effects of climate and its interaction with management. On balance, HDSD grazing has enabled considerably higher stocking rates while protecting and gradually enhancing grassland function and this challenges the conventional dogma that increased stocking rate is linked to grassland and landscape deterioration.

INTRODUCTION

The following report details the results from data collected during the period 2000 – 2004 inclusive from the experimental site on "Anama" and the demonstration sites located on 7 commercial farms in the Mid-North of South Australia. Three of the demonstration sites joined the project in 2003 and data has been collected for these 2 years. The period 2000-2002 was supported by the Natural Heritage Trust and 2003-2004 by Land Water and Wool.

PROJECT GOALS

The project goals were established at a meeting of the Mid North Grasslands Working Group (MNGWG) in consultation with members of the Grasslands Ecosystem Technical Advisory group (GETAG) and participating farmers. The meeting was conducted on 20th September 2000 and the goals and objectives of the project were identified at that time as:

- Increase diversity and basal and canopy cover of native flora by grazing management.
- Have farmers consider whole system rather than individual components of grazing management system.
- Achieve 100% ground cover for 100% of year through regenerative farm management with low dollar inputs.
- Understand how hard can country be grazed without being detrimental so pasture can regrow.
- Understand perennials better.
- Identify grazing systems which avoid loss of species, groundcover, overstocking and further increase in salvation Jane, geranium, sage, nutweed, white thistle and cape tulip.
- Identify the nutritive value of pasture components and encourage them.
- Initiate and promote practise in native grasslands management for biodiversity, conservation and production.
- Achieve all of the above and increase profit.

PROJECT OBJECTIVES

- To demonstrate that appropriate grazing management can allow native pastures to be grazed for production and result in improved conservation of native grasslands.
- To establish grazing demonstration sites on seven farms in the Mid-North of South Australia.
- To establish a scientific site on a commercial farm in the Mid-North of South Australia to determine the effects of different grazing strategies on vegetation dynamics in pastures.

Part I

SCIENTIFIC SITE

LOCATION AND SITE HISTORY

The experimental site was established on the property, "Anama", located approximately 15km north of Clare on the Main North Rd. The owners of the property are Ryves and Tom Hawker. The paddock used for the experimental site had a history of summer rest and periodic grazing for the remainder of the year such that annual stocking rate was estimated to be the equivalent of 2.5 ewes per hectare.

METHODS

A total of six treatment paddocks were established on the property "Anama". For the period 2000 – 2005, the six grazing management treatments were:

1. Summer rest from grazing with continuous grazing at all other times (i.e. area practice)
2. Autumn and summer rest from grazing with slow rotational grazing at all other times
3. Spring and summer rest from grazing with slow rotational grazing at all other times
4. Spring, summer and autumn rest from grazing during 2001/02 and spring and summer rest from grazing during 2002/03, 2003/04 and 2004/05 with slow rotational grazing at all other times
5. High density and short duration grazing based on plant growth rate able to be applied for the complete 12 months of each year
6. No grazing for the complete 12 months of each year.

During July 2004, grazing management treatment 4 included a single grazing event with 28 cows and calves for a 5-day period.

Seasons were defined in accordance with plant phenology with season start and end dates of,
Summer: 14 December – 16th April
Autumn: 17th April – 16th June
Winter: 17th June – 24th August
Spring: 25th August – 13th December

The rationale behind the grazing treatments were:

- Summer rest represented the regional practice and was seen as a 'control'.
- Autumn rest would allow for improved germination and survival of cool-season perennial grass species.
- Spring rest would allow for improved seeding of perennial grasses.
- High density and short duration grazing based on plant growth and regardless of season would increase turnover of organic matter and inorganic minerals, reduce repeated defoliation of grass tillers and allow sufficient time for plant regrowth.
- Nil grazing of domestic herbivores which represented the typical management regime philosophy for grassland conservation reserves.

- A short graze event with cattle, at high stock density, timed (ie. July) to coincide with early growth of *Homeria flaccida*, would reduce its abundance.

Paddocks were allocated at random to grazing treatment and the allocations were:

Paddock 1: Summer rest from grazing
Paddock 2: Autumn and summer rest from grazing
Paddock 3: Spring and summer rest from grazing
Paddock 4: Spring, autumn and summer rest in year 1 and spring and summer rest in years 2-5. Grazing with cattle during year 5.
Paddock 5: High density and short duration grazing
Paddock 6: Nil grazing

The area of Paddocks 1-4 was 6.1 ha, 5.0 ha for Paddocks 5 and 3.0 ha for Paddock 6. The stocking rate for treatment 1 was set to achieve an annual stocking rate of 2.5 DSE/ha. To achieve this 23 wethers were stocked in Paddock 1. Stocking rate for treatments 2, 3 and 4 were also set to achieve the same annual stocking rate but grazing management differed. During the relevant season of grazing, treatments 2, 3 and 4 were grazed for 40 days followed by a minimum of 50 days rest from grazing; this allowed for 2 graze events per year (and 1 graze event during year 1 for Paddock 4). To achieve the required annual stocking rate 70 sheep grazed in Paddocks 2 and 3 during the relevant period. Paddock 4 was grazed with 140 sheep during year 1 because the paddock was only grazed on 1 occasion. Actual sheep numbers in Paddocks 1-4 varied during years 4-5 as sheep numbers used to graze paddocks were calculated from a feed budget designed to avoid severe overgrazing. Paddock 4 was subdivided into 4 subpaddocks for the graze event with cattle. Each subpaddock area was 1.5 ha, grazed for 1.25 days by 28 cows and calves to provide a stock density of approximately 280 DSE/ha. Treatment 5 was not restricted to any predetermined stocking rate. In general a flock of 400-500 sheep would graze treatment 5 for a period of 2-4 days. Treatment 5 also involved the subdivision of the treatment paddock to create 2 sub paddocks so that each sub paddock would be grazed for 1-2 days. Typical rest periods from grazing varied from 60 – 180 days.

In each paddock, 5 permanent transects (length 50 m) were established to monitor changes in a number of vegetation parameters over time. Paddocks 1-3 had a portion of their area occupied with grey clay while the rest of the site was composed of sediment-derived soils.

Monitoring of vegetation was undertaken during September 2000, July 2001, November 2001, November 2002, November 2003, November 2004 and November 2005.

BOTANAL

The dry-weight-rank method (known as BOTANAL) gives a measure of the contribution of the dominant plant species to the total dry weight of pasture on offer (*i.e*. also referred to as herbage mass and food on offer). Along each transect the dry-weight-rank was assessed in each of ten 50 x 50 cm quadrats (area of quadrat 0.25 m^2 and total of 50 quadrats per paddock). In each 0.25 m^2 area, dry weight was visually assessed and the species present were ranked in order of their contribution to the dry weight of pasture. Species ranked 1 are estimated to contribute 70% of the weight in

each quadrat, rank 2 is allocated 20% and rank 3 is 10%. More than one species can share ranking but a total of five species cannot be exceeded. Visual assessment of dry weight was well related (r^2 = 0.95) to dry weight. BOTANAL gives little indication of overall species diversity of the pasture. The figures that result from the analysis depend on a number of factors;

i) The growth form of the plant. Small plants, which occur often, will have relatively low scores simply because they have a low weight when dried (e.g. *Vulpia* spp) and similarly large plants which occur in low numbers may score relatively more because of the amount of biomass a single plant produces (e.g. *Lomandra* spp).

ii) The time of the year when measurements are taken. Different plant species have different growth cycles, some grow actively in winter others during late spring to early summer.

iii) The time since the paddocks were grazed. Measurements taken before animals enter a paddock will vary significantly to those taken after animals have grazed a paddock. Unpalatable plants that the animals have avoided grazing will dominate measurements taken after a period of grazing. Livestock graze selectively and the most palatable plants in the pasture will experience the greatest grazing pressure (i.e. defoliation).

SPECIES PRESENCE/ABSENCE

At 4.5 m intervals along each transect the presence or absence of plant species was recorded in 50 x 50 cm quadrats (total of 10 quadrats per transect and 50 quadrats per paddock). The presence or absence of plant species gives a measure of the relative abundance of a species (i.e. frequency) and the overall species richness or diversity within the pasture. This variable accounts for the very small plants so important to the functioning of grassland ecosystems but which contribute little in the way of feed for livestock. Presence/absence data is expressed as the percentage frequency of occurrence of each species in the total number of quadrats measured. Measurements repeated over time will enable determination of changes in the diversity and abundance of each species.

NUMBER OF SPECIES RECORDED PER QUADRAT AND PER TRANSECT

From the presence/absence data it was possible to calculate the average number of species which occurred within each of the 50 x 50 cm quadrats in each transect and also the number of species which occurred within each transect area (i.e. 2.5m^2). These data give an indication of the distribution of plant species across the area and the diversity of species present on a small scale, the quadrat, and on a relatively larger scale, the transect; the latter being the experimental unit used in statistical analysis. In many cases, the measure of the number of species recorded along the transect would reflect the majority of species present in the paddock.

NUMBER OF NATIVE PERENNIAL GRASS PLANTS PER QUADRAT

The number of native perennial grasses per quadrat and per transect area was measured by counting the number of individual native perennial grass plants present in each of ten 50 x 50 cm square quadrats along two transects per paddock for the experimental site. Native perennial grasses provide stability to grassland production

systems and this measure gives a good indication of the condition of the pasture and the sustainability of the grazing management regime in current use.

PLANT BASAL COVER

The 100 point quadrat method was used to determine plant basal cover. A $1m^2$ quadrat with points located 10cm apart was used. Three replicates were measured in each treatment paddock with the 100 point quadrat being located 5m from the end (and outside the transect) of three transects. The 100 point method gives a measure of the percentage ground area (i.e. basal cover) occupied by living plants. It also gives an indication of basal cover composition and percentage bare ground, litter, rock and lichen.

GROUND COVER

Ground cover was estimated visually within each 50cm x 50cm quadrat along all transects. Estimates were recorded from Nov 2003 – Nov 2005. Ground cover was defined as consisting of any material (ie. live and dead plant material, rock greater than 25mm in diameter, cryptogam and dung) which prevented a raindrop from directly hitting the soil surface.

SOIL SURFACE CONDITION

The condition of the soil surface was estimated by visual and tactile inspection in 3 locations within each 50cm x 50cm quadrat along all transects. Estimates were recorded from Nov 2004 – Nov 2005. Soil surface was estimated on a 5-point scale and are described below:

1. Values of 1 or less represented a soil surface which had no litter and was immovable to tactile pressure applied with the index finger.
2. Values of 1-2 represented a soil surface which had some litter and was slightly movable to tactile pressure applied with the index finger. Such pressure could only move the top 5 mm of soil.
3. Values of 2-3 represented a soil surface which had decomposing litter and was readily movable to tactile pressure applied with the index finger. Such pressure could move the top 10 mm of soil.
4. Values of 3-4 represented a soil surface which had a considerable amount of decomposing litter, intermingling the boundary between the litter layer and the soil surface, and was readily movable to tactile pressure applied with the index finger. Such pressure could move the top 15 mm of soil.
5. Values of 4-5 represented a soil surface which had a considerable amount of decomposing litter, intermingling the boundary between the litter layer and the soil surface, and was readily movable to tactile pressure applied with the index finger. Such pressure could move the top 20 mm of soil.

SOIL BIOLOGY

Triplicate samples of 20 soil cores (0-10 cm) were collected from each paddock during July, September and December 2004 for analysis of soil biological activity (Soil Food Web Laboratory, Lismore NSW). A range of soil microbial indicators were examined including; active (fluorosene acetate) and total bacteria, active (fluorosene acetate) and total fungi, total biomass (bacteria and fungi), total protozoa

numbers (ie. the sum of flagellates, amoebae and ciliates), nematode numbers and mycorrhizal colonisation.

STATISTICAL ANALYSIS

Data collected from the experimental site were subjected to analysis of variance, analysis of covariance or repeated measures analysis of variance depending on the measured variable using the statistical software SAS (SAS Institute, Cary, New York, 1992). Least squares means ± standard error (se) are presented for untransformed data and ± 68% confidence interval for backtransformed data. Presence and absence data and ground cover estimates were converted to percentage frequency for analysis of grazing treatment effects. Prior to analysis, percentage frequency data was normalised by applying an arcsine transformation. Back transformed least squares means are presented later in this report. Assumptions of normality of raw data and residuals were tested for all other variables and transformations were made were required.

RESULTS

BOTANAL

The percentage contribution of herbaceous species to total dry weight (also referred to as herbage mass), and species dry weight (kg DM/ha), over the period September 2000 – October 2005, for the 6 grazing treatments is detailed in Appendix 1. All *Austrostipa* and *Austrodanthonia* species were collectively grouped by genus allowing a more meaningful understanding of the respective contribution to dry weight. The individual species which constituted each group are listed in the section on species presence/absence.

Total herbage mass (Fig 1) was estimated at each sampling event and probably represents the maximum or near maximum level of herbage throughout the year. There were no differences among paddocks at the initial measure, but by the next measure (Jul 2001) differences ($P<0.05$) had emerged among treatment paddocks. These differences continued throughout the 5-year measurement period, with the exception of 2004 when herbage mass of all paddocks converged to a similar value. In general, Paddock 5 had a level of herbage mass greater ($P<0.05$) than Paddocks 1, 2, 3 and 4 (exception of Jul 2001 and Nov 2001 for Pdk 4) and equal in all but 1 year (ie. except 2002) with the nil graze Paddock 6. In 2002, the nil graze Paddock 6 had a herbage mass greater ($P<0.01$) than all other paddocks.

When averaged over the entire 5-year measurement period (Fig 1), herbage mass of Paddock 1^{a} (1810±127.5 kg DM/ha) did not differ significantly from Paddocks 2^{a} or 4^{ab} (1819±127.5 kg DM/ha and 2147 ±127.5 kg DM/ha respectively; phenology based) but did differ from Paddock 3^{bc} (2194±127.5 kg DM/ha; $P<0.05$; phenology), Paddock 5^{cd} (2515±127.5 kg DM/ha; $P<0.001$; HDSD) and Paddock 6^{d} (2841±127.5 kg DM/ha; $P<0.001$; nil graze). The 5-year mean herbage mass of Paddocks 5 and 6 did not differ significantly.

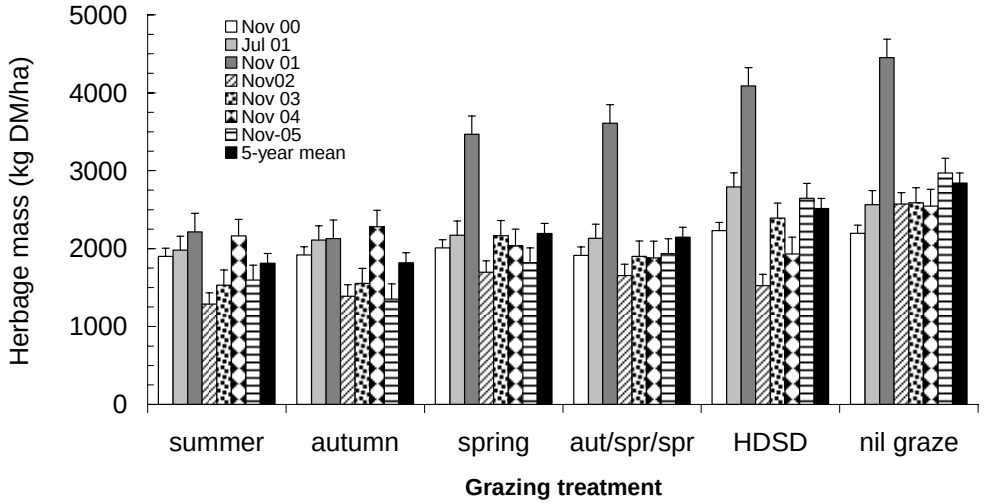

Figure 1. Herbage mass (± se) over the period September 2000 – November 2005 within grazing treatments on "Anama". Grazing treatment refers to season of rest from grazing.

Differences in (i) percentage contribution of herbaceous species to total dry weight and (ii) species dry weight, among grazing treatments were tested using a number of species or functional species groups as indicators. The species and species groups that were subjected to analysis included (A) native perennial grasses - *Austrostipa* spp group, *Austrodanthonia* spp group, *Aristida behriana*, summer active species group (*Themeda australis* and *Dicanthium sericeum*); (B) annual grasses – *Brachypodium distachyon, Avena barbata*, *Bromus* spp group, *Vulpia* spp group, total annual grasses and; (C) dicot weeds – *Homeria flaccida* and *Scabiosa atropurpurea*.

Percentage contribution to dry weight

(1) *Percentage contribution of Austrostipa spp group declined over time in Paddocks 1-3 but remained constant for Paddocks 4, 5 and 6. When compared to the summer rest control (Pdk 1), grazing management based on High Density and Short Duration (HDSD – Pdk 5) but not seasonal phenology (Pdks 2-4) was most successful at maintaining the percentage contribution of Austrostipa spp group.*

No significant differences existed among treatment paddocks in the initial estimate of percentage contribution to dry weight for the *Austrostipa* spp group. Over time, differences among grazing treatments developed with the contrast of summer rest vs high density and short duration grazing being statistically significant ($P<0.05$) during 2003 and 2004. Paddocks 1 and 4 tended to have the lowest contribution of *Austrostipa* spp to dry weight during 2003 and Paddocks 1-4 the lowest ($P<0.05$) during 2004. Paddock 6 had the greatest ($P<0.05$) contribution during 2004 and 2005 with Paddock 5 being intermediate and not differing from other treatments (Fig 2). *Austrostipa* spp herbage mass at the initial estimate (lsmean ± se) in 2001 did not differ ($P=0.13$) among treatment paddocks and averaged 336 ± 127.4 kg DM/ha. At the 2005 measure, *Austrostipa* spp herbage mass was greatest ($P<0.05$) in Paddock 6, least in Paddocks 1-4 and intermediate in Paddock 5. Least squares means (±se) at 2005 were 107^{a} ± 134.6 kg DM/ha for Paddocks 1-4, 385^{ab} ± 134.6 for Paddock 5 and 665^{b} ± 134.6 for Paddock 6.

(2) *Percentage contribution of Aristida behriana was variable over time in all paddocks with the exception of Paddocks 4 and 6, in which the contribution increased. Grazing based on an initial autumn and spring rest followed by spring rest in subsequent years (with cattle grazing in 2004 – Pdk 4) was successful at increasing the percentage contribution of A. behriana.*

Significant differences (lsmean ± 68% ci; $P<0.01$) existed in the initial estimate of percentage contribution to dry weight for *A. behriana* with Paddocks 1 (16.1 ± 4.21%) and 4 (10.2 ± 3.54%) having the greatest percentage contribution and Paddock 5 (0.7 ± 1.23 %) the least. Over time, differences among grazing treatments remained, but the ranking varied such that at the last two measures (Nov 2004 & 2005) *A. behriana*, in Paddock 4, made the greatest ($P<0.01$) contribution to dry weight (Fig 3). Mean (lsmean ± se) *A. behriana* herbage mass differed among treatment paddocks at the initial estimate in 2001 ($P<0.05$) being greatest in Paddocks 1 and 4 (332±56.3 and 206±56.3 kg DM/ha respectively) and least in Paddock 5 (21±56.3 kg DM/ha). *A. behriana* herbage mass remained greatest in Paddock 4 at 2004 ($P<0.01$; 661±90.1 kg DM/ha) and 2005 ($P<0.01$; 488±74.3 kg DM/ha).

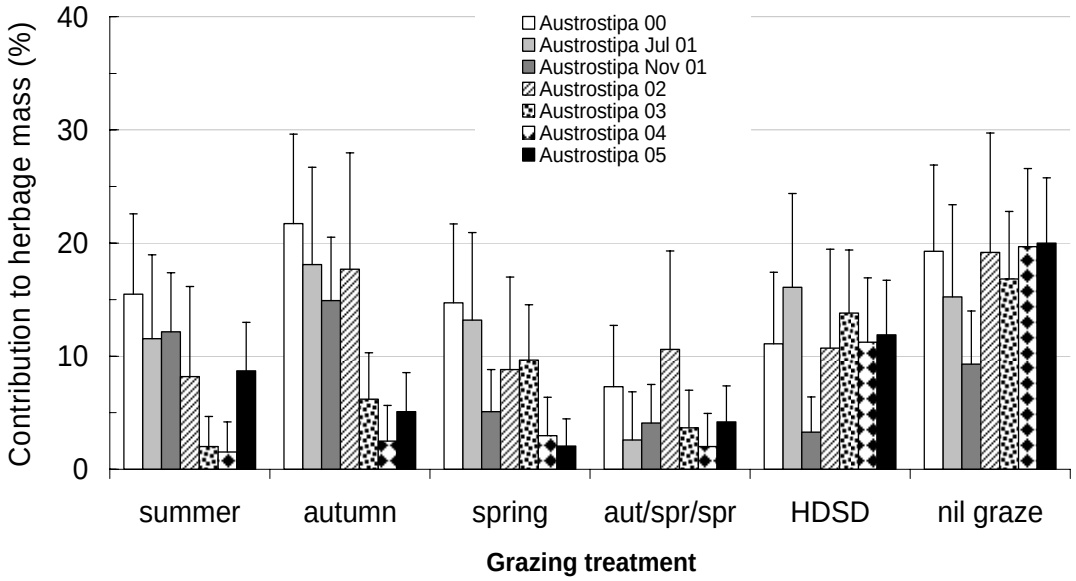

Figure 2. Percentage contribution to dry weight (± 68% c.i.) of *Austrostipa spp* group over the period September 2000 – November 2005 within grazing treatments on "Anama". Grazing treatment refers to season of rest from grazing.

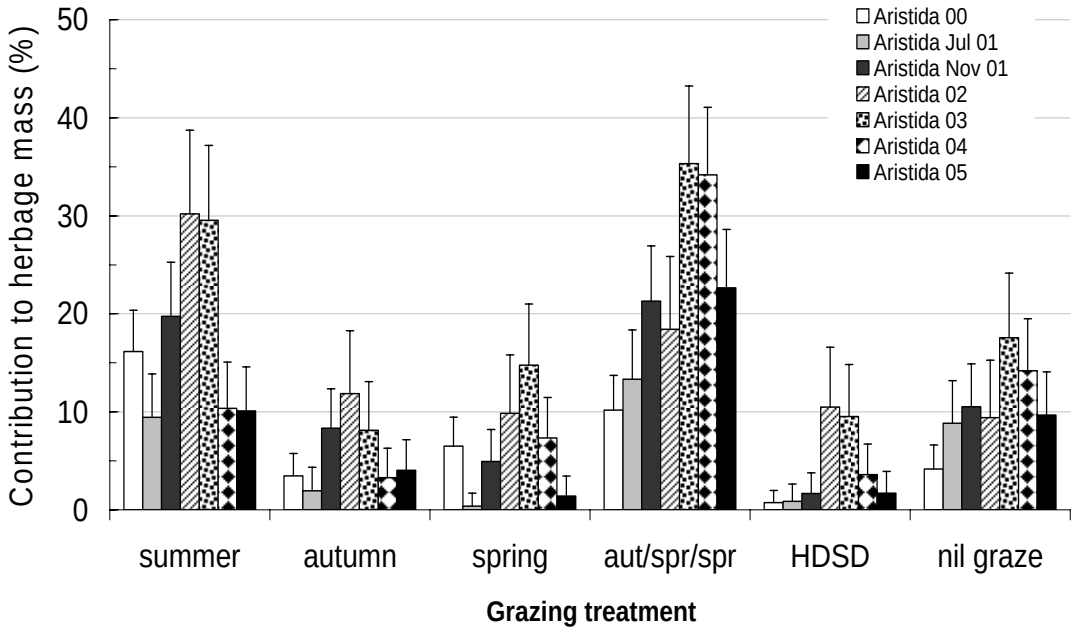

Figure 3. Percentage contribution to dry weight (±68% c.i.) of *Aristida behriana* over the period September 2000 – November 2005 within grazing treatments on "Anama". Grazing treatment refers to season of rest from grazing.

(3) *Percentage contribution of Austrodanthonia spp group was variable over time but was greatest in the summer rest control paddock. A decline in the percentage contribution of Austrodanthonia spp group over time was observed only in the summer rest control Paddock 1 (- 52%; P<0.10 and in the additional autumn rest Paddock 2 (-176%; P<0.05)).*

Percentage contribution of *Austrodanthonia* spp group varied considerably among paddocks with numerous zero estimates. The consequence of this distribution was to lower the usefulness of this species group as a indicator of change due to grazing management. Significant differences (lsmean ± 68% ci) existed in the initial estimate for *Austrodanthonia* spp group with Paddock 1 (5.5 ± 2.11%) having a greater (P<0.01) contribution than all other paddocks (mean of Pdks 2-6; 0.2 ± 0.44%). Over time, differences among grazing treatments disappeared (Fig 4). Mean (lsmean ± se) *Austrodanthonia* spp group herbage mass differed (P<0.05) among treatment paddocks at the initial estimate in 2001 (P<0.05) being greatest in Paddock 1 (113±26.5 kg DM/ha), intermediate in Paddock 2 (57±26.5 kg DM/ha) and least in all other paddocks (4±26.5 kg DM/ha; mean of Paddocks 2-6). At the final measure in 2005, *Austrodanthonia* spp group herbage mass did not differ among treatments and was 26±9.5; 0±9.5; 27±9.5; 3±9.5; 2±9.5; 12±9.5 kg DM/ha for Paddocks 1-6 respectively.

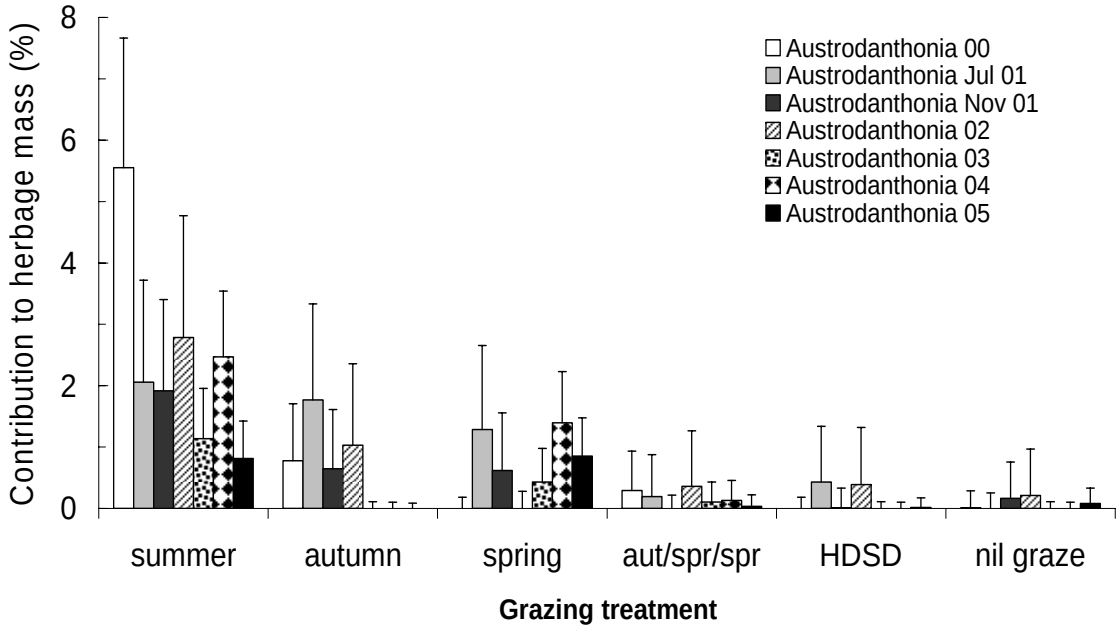

Figure 4. Percentage contribution to dry weight (±68% c.i.) of *Austrodanthonia spp* group over the period September 2000 – November 2005 within grazing treatments on "Anama". Grazing treatment refers to season of rest from grazing.

(4) The *summer active species, Themeda australis and Dicanthium sericeum, had a patchy distribution through the treatment paddocks and as such were a poor indicator of grazing treatment effects. At the first measure, summer active species accounted for 0.9^{a}, 0.1 ^{a}, 13.3 ^{b}, 3.0 ^{a}, 0 ^{a}, 2.0 ^{a} % of herbage mass in Paddocks 1-6 respectively. At the final measure, summer active species contributed less than 0.1% in Paddocks 1 ^{a}, 2 ^{a}, 5 ^{a} and 6 ^{a} and 5.3 and 1.9 % in Paddocks 3^{b} and 4^{ab}. Means and paddocks, within measurement period, with different superscripts differed significantly (P<0.01 & P<0.05 for first and last measure respectively).*

(5) *Percentage contribution of total annual grass group declined over time until 2004 when a large increase was recorded in all grazed paddocks. Major differences in annual contribution developed in the contrast between grazed paddocks and the ungrazed Paddock 6. During 2004 and 2005 contribution was greatest (P<0.01) in grazed paddocks.*

Total annual grass group made the greatest percentage contribution to dry weight and averaged 39% (range 11-64%) over all paddocks and sampling times. No significant differences existed in the initial estimate of percentage contribution to dry weight for total annual grass group. Over time, differences among grazing treatments developed with the contrast of grazed vs nil grazed being statistically significant (P<0.01) at 2004 and 2005. There was however, a suggestion from the data, that grazing treatment effects on annual contribution could be broadly described as to fit into either of 3 groups. The first group with greatest contribution and an increasing trend with time included Paddocks 1, 2 and 5; the second group with intermediate contribution and a decreasing trend with time included Paddocks 3 and 4, and the third group with least contribution and decreasing trend with time included Paddock 6 (Fig 5). Mean (lsmean ± se) total annual grass group herbage mass did not differ at the first measure, but in Nov 2001 was 1319 ± 300.4 kg DM/ha for Paddocks 1-5, which all differed significantly (P<0.01) from Paddock 6 (2545 ± 300.4 kg DM/ha). By Nov 2005, total annual grass group herbage mass was 1254 ± 112 kg DM/ha in Paddock 5 which was greater (P<0.01) than average (658 ± 112 kg DM/ha) recorded for all other paddocks.

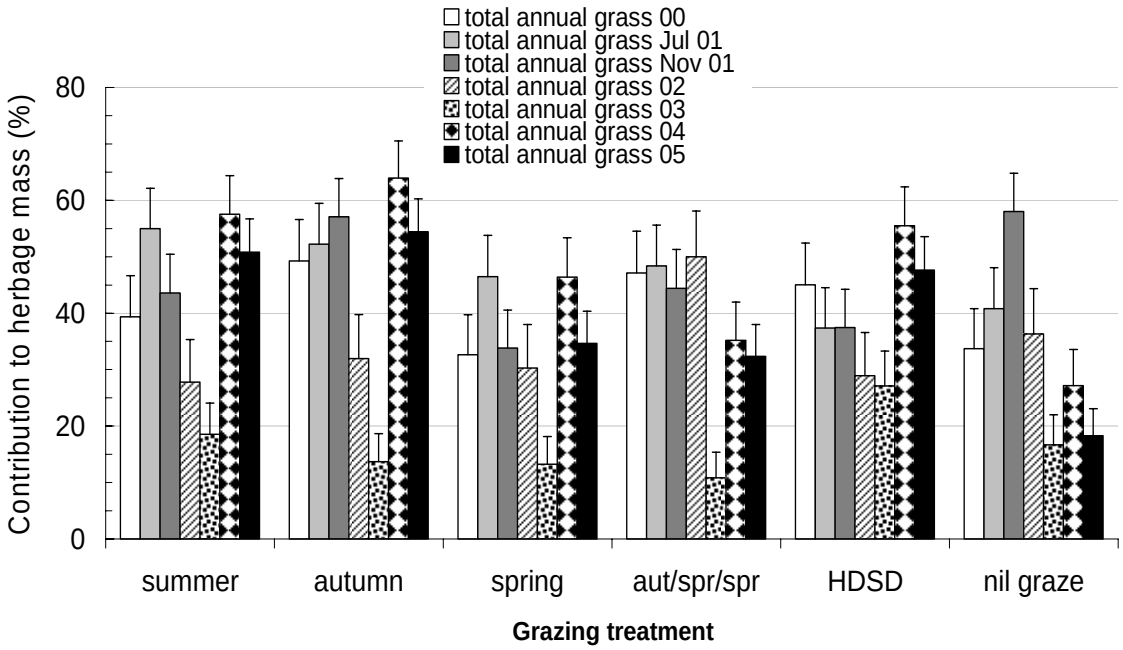

Figure 5. Percentage contribution to dry weight (±68% c.i.) of total annual grasses over the period September 2000 – November 2005 within grazing treatments on "Anama". Grazing treatment refers to season of rest from grazing.

(6) *Percentage contribution of Homeria flaccida increased steadily over time in the summer rest control paddock but in contrast was variable in all other treatments.*

Significant differences (P<0.05) existed in the initial estimate of percentage contribution (lsmean ± 68% ci) of *Homeria flaccida* to dry weight, with the contribution in Paddock 6 (29 ± 8.6%) and Paddock 4 (16 ± 7.2%) being greater than in other paddocks (mean of Pdks 1-3 & 5; 7±5.0%); which did not differ among themselves. By Nov 2002, percentage contribution of *H. flaccida* in the summer rest control (Paddock 1) was greater (P<0.05) than in the HDSD, Paddock 5 and the nil grazed Paddock 6. This continued in 2003. By Nov 2004, statistically significant differences among grazing treatments in the percentage contribution of *H. flaccida* had disappeared and this remained in 2005 (Fig 6). Mean (lsmean ± se) *H. flaccida* herbage mass differed among treatment paddocks at the initial estimate (P<0.05) in 2001 but not in Nov 2004 or 2005. Mean *H. flaccida* herbage mass was (pooled se = 127.6; *means with common superscripts do not differ significantly P>0.05*) 70^{a}, 125^{a}, 251^{a}, 403^{ab}, 290^{a} and 696^{ab} kg DM/ha for Paddocks 1-6 respectively in 2001, (pooled se = 60.9) 184, 87, 218, 160, 72 and 287 kg DM/ha for Paddocks 1-6 respectively in 2004 and (pooled se = 91.1) 170, 267, 266, 200, 310 and 309 kg DM/ha for Paddocks 1-6 respectively in 2005.

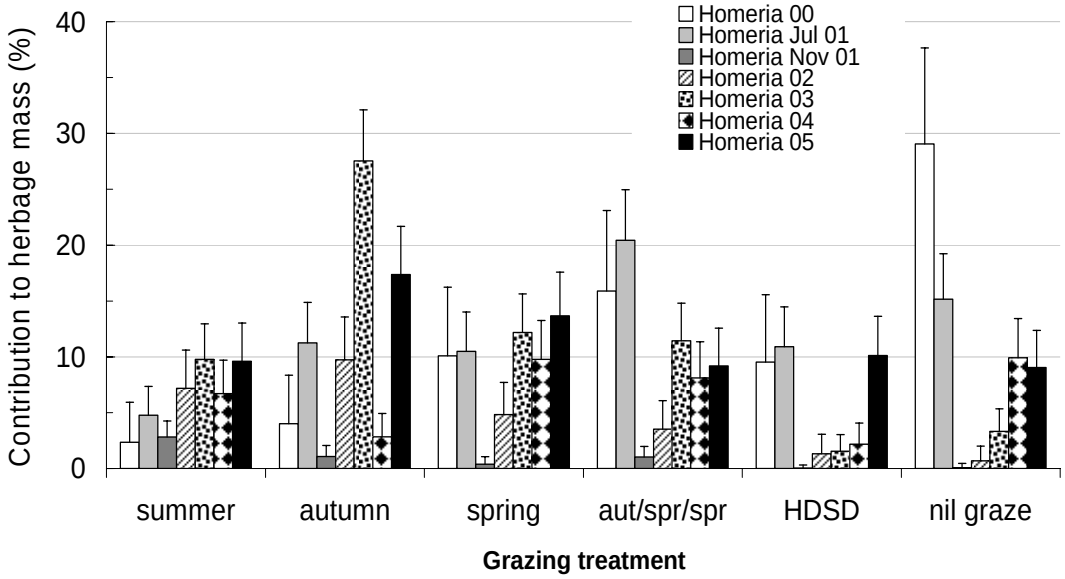

Figure 6. Percentage contribution to dry weight (±68% c.i.) of *Homeria flaccida* over the period September 2000 – November 2005 within grazing treatments on "Anama". Grazing treatment refers to season of rest from grazing.

(7) *Percentage contribution of Scabiosa atropurpurea was constant or declined over time in all paddocks with the exception of the nil grazed Paddock 6. In the absence of grazing the percentage contribution of S. atropurpurea increased eight-fold from 2000-2005.*

Significant differences (P<0.05) existed in the initial estimate of percentage contribution (lsmean ± 68% ci) of *S. atropurpurea* to dry weight, with the contribution in Paddocks 1, 3 and 6 (3^{ab}±1.9%, 6^{a} ±2.8% and 1^{ab} ± 1.4%) being greater than in Paddocks 2, 4 and 5 (0.3^{a} ±0.82%, 0.3^{a} ±0.79% and 0.1^{a} ±0.57%). *Means with different superscripts differ significantly (P<0.05).* Over time, differences among grazing treatments remained with the contrast of grazed vs nil grazed being statistically significant (P<0.001 in 2000, 2001, 2003, 2004 and 2005; P<0.05 in 2002). By Nov 2002, percentage contribution of *S. atropurpurea* in Paddock 6 (10 ± 5.2%) was greater (P<0.05) than in all other paddocks (mean 2±2.5%). Differences in contribution of *S. atropurpurea* increased further (P<0.001) to 10±4.2% for Paddock 6 and 0.9±1.34% as a mean of all grazed paddocks (ie. Pdks 1-5) (Fig 7). Mean (lsmean ± se) *S. atropurpurea* herbage mass differed among treatment paddocks at the initial estimate (P<0.05) in 2001 with Paddock 3 having the greatest *S. atropurpurea* herbage mass (151±33.2 for Paddock 3 vs 38±33.2 kg DM/ha mean of Pdks 1,2,4-6). However, by Jul 2001 differences (P<0.01) existed between the nil grazed Paddock 6 and the mean of all grazed paddocks (Pdks 1-5). Mean *S. atropurpurea* herbage mass in grazed and nil grazed paddocks was 36 and 212±39.3 in Jul 2001, 105 and 423±106.3 in Nov 2001 (P<0.10), 59 and 296±63.7 in Nov 2002 (P<0.05), 27 and 332±53.7 in Nov 2003 (P<0.001), 22 and 352±46.8 kg DM/ha in Nov 2004 (P<0.001) and 32 and 375±53.7 kg DM/ha in Nov 2005 (P<0.001) respectively.

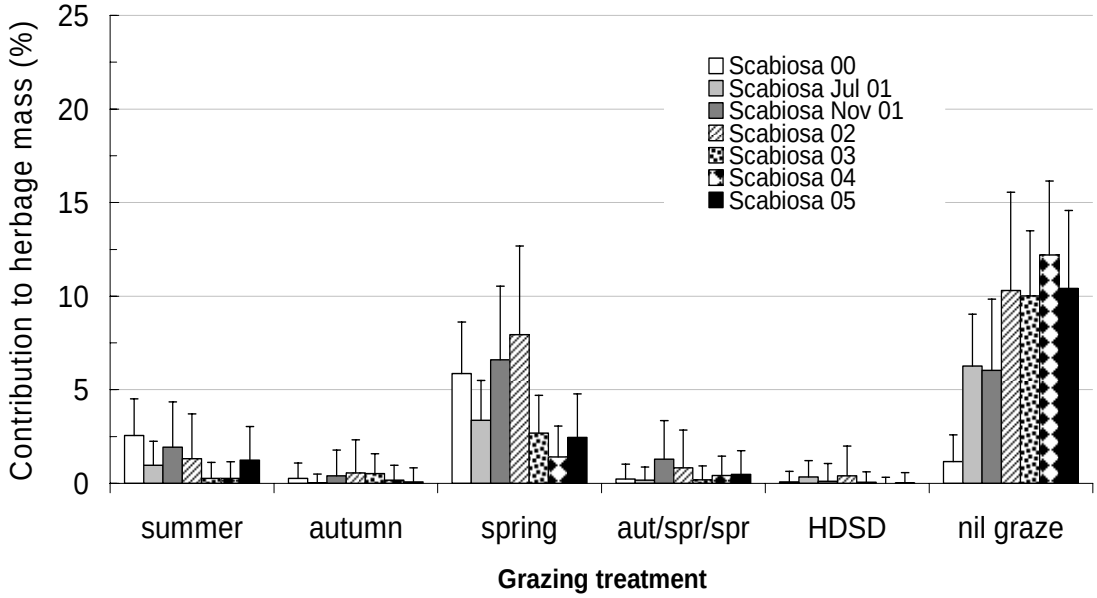

Figure 7. Percentage contribution to dry weight (±68% c.i.) of *Scabiosa atropurpurea* over the period September 2000 – November 2005 within grazing treatments on "Anama". Grazing treatment refers to season of rest from grazing.

PERCENTAGE FREQUENCY

The percentage frequency of herbaceous species over the period September 2000 – November 2005 for the 6 grazing treatments is detailed in Appendix 2 (Tables A2.1 – 2.6. A total of 92 species were recorded across the six grazing treatments. Of the total number of species, four species were present in more than 40% of quadrats in all paddocks at all sampling times. The species were *Avena barbata, Brachypodium distachyon, Aristida behriana and Homeria flaccida.*

Of these species, *Avena* (92% frequency) and *Brachypodium* (84%) are introduced annual species and *Homeria* (85%) is an introduced bulb-forming lily. *Aristida behriana* is a native species and was the most frequent perennial grass (average frequency of 72%). Within the native perennial grasses, the next most frequent species *Austrostipa blackii* (56%) and *Austrodanthonia* tenuior (9%). The native perennial grass, *Themeda australis* was recorded in all paddocks except HDSD at an average frequency of 8%. Note that this species was present in HDSD but was not represented along the transects. Other frequently occurring species were *Trifolium angustifolium* (76%), *Lolium multiflorum* (40%), *Romulae minutiflora* (36%) and *Scabiosa atropurpurea* (32%).

Presence and absence data were converted to percentage frequency for analysis of grazing treatment effects. Prior to analysis, percentage frequency data was normalised by applying an arcsine transformation. Back transformed means and 68% confidence intervals for a number of informative indicator species are presented. Differences (P value) among grazing treatments for percentage frequency data are detailed in Table 1.

At the initial measurement in 2000, the frequency of *Aristida behriana* was lowest ($P<0.05$) in HDSD (statistical difference as compared to treatment Paddocks 1, 4 and 6) and this situation continued over time (Fig 7a). After adjusting for the initial differences in the frequency of *A. behriana* (ie. analysis of covariance) grazing treatment did not affect significantly the frequency of *A. behriana* at later measurements.

The frequency of *Austrodanthonia eriantha* was initially greatest ($P<0.001$) in the summer rest control, Paddock 1. After adjusting for the initial differences in the frequency of *A. eriantha* (ie. analysis of covariance) grazing treatment did not affect significantly the frequency of *A. eriantha* until Nov 2004. At Nov 2004 and 2005, the frequency of *A. eriantha* was greatest ($P<0.05$) in Paddocks 1 and 3 and lowest in Paddocks 2, 4, 5 and 6 (Fig 7b).

The frequency of *Austrostipa blackii* did not initially differ among paddocks. No differences among treatments emerged over time (Fig 7c).

The frequency of *Themeda australis* was initially considerably greatest ($P<0.05$) in the additional spring rest Paddock 3. After adjusting for the initial differences in the frequency of *T. australis* (ie. analysis of covariance), frequency remained greatest in Paddock 3 at Nov 2001 ($P<0.05$), Nov 2003 ($P<0.05$ with the exception of Paddock 4) and Nov 2005 (Fig 7d). This suggests that grazing management did not materially affect the frequency of *T. australis*.

The frequency (lsmean ± 68% ci) of *Gynandriris setifolia* did not initially differ among grazing treatments. By Nov 2002 frequency was greater ($P<0.01$) in HDSD (44±10.5%) than all other treatment paddocks (mean 6±5.2%). Significant differences were not apparent among treatment paddocks in 2003 but were again evident in 2004 by which stage frequency in HDSD was 35±11.6% which was greater ($P<0.01$) than all paddocks except Paddock 6. By Nov 2005, frequency was greatest in Paddocks 2, 4 and 5 (Fig 7e).

The initial frequency of *Homeria flaccida* differed ($P<0.01$) among paddocks and could be described by 2 groupings. Frequency (lsmean ± 68% ci) was greatest in Paddocks 3, 4 and 6 (99±0.7, 89±6.5 and 99±1.3% respectively) and least in Paddocks 1, 2 and 5 (64±11.5, 70±10.9 and 56±12.3%). After adjustment for these initial differences, the frequency of *H. flaccida* did not differ among grazing treatments until Nov 2004, at which stage frequency in Paddock 1 was 99±0.1% and greater ($P<0.05$) than in Paddocks 2 (79±8.6%) and 5 (81±8.3%). At the final measurement in Nov 2005, frequency in Paddock 1 remained greatest ($P<0.05$) at 100% and lowest in Paddock 5 (Fig 7f). Over time, *H. flaccida* frequency in grazed paddocks increased by 39%.

Table 1: Probability of statistically significant differences in percentage species frequency among grazing treatments over the period September 2000 – November 2005.

Species	Sept '00	Nov '01	Nov '02	Nov '03	Nov '04	Nov '05	Treat x time	Average over time
Aristida behriana	0.03	0.01	0.18	0.37	0.02	0.15	0.02	0.05
Austrodanthonia eriantha	0.001	0.14	0.04	0.05	0.001	0.001	0.29	0.001
Austrodanthonia tenuior	0.34	0.01	0.23	0.01	0.24	0.03	0.03	0.06
Austrostipa blackii	0.68	0.38	0.58	0.77	0.87	0.79	0.83	0.69
Themeda australis	0.01	0.001	0.03	0.001	0.001	0.001	0.21	0.001
Avena barbata	0.25	0.35	0.01	0.12	0.49	0.73	0.03	0.38
Brachypodium distachyon	0.04	0.14	0.49	0.14	0.52	0.03	0.57	0.11
Bromus molliformis	0.23	0.01	0.16	0.01	0.001	0.001	0.01	0.01
Vulpia spp	0.02	0.001	0.01	0.001	0.001	0.001	0.001	0.001
Gynandriris setifolia	0.31	0.38	0.01	0.25	0.01	0.01	0.01	0.02
Homeria flaccida	0.01	0.01	0.40	0.08	0.02	0.02	0.001	0.03
Scabiosa atropurpurea	0.37	0.41	0.11	0.28	0.20	0.03	0.01	0.18
Trifolium angustifolium	0.77	0.43	0.08	0.21	0.001	0.11	0.001	0.19

Note P value < 0.05 considered statistically significant, P < 0.10 considered significant in this report. P values < 0.10 imply a 90% confidence in treatment differences. Treat x time indicates if the trend over time differed among the grazing treatments. Average over time indicates if the average value for all times differs.

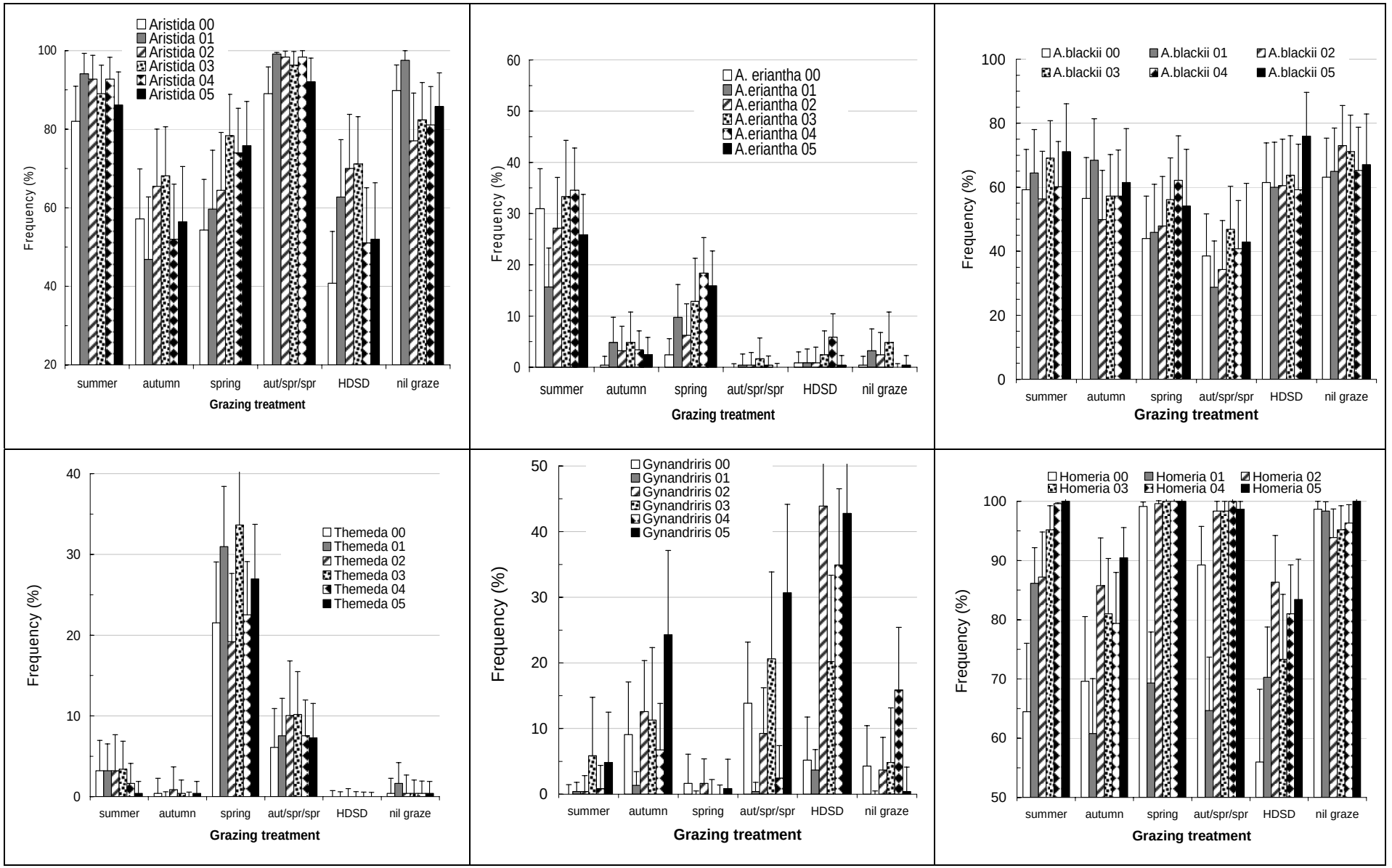

Figure 7a-f. Percentage frequency (± 68% ci) of occurrence of indicator species, *Aristida behriana* (a); *Austrodanthonia eriantha* (b); *Austrostipa blackii* (c); *Themeda australis* (d); *Gynandriris setifolia* (e); *Homeria flaccida* (f), over the period September 2000 – November 2005.

NUMBER OF SPECIES RECORDED

The average number of species per transect (2.5m^2) is detailed in Figure 8. The average number (lsmean ± se) of species per transect did not differ significantly among grazing treatments at the initial measurement and was 20.7±1.26. By November 2001 the number of species per transect was greatest (P<0.01) in Paddocks 1 (21.4±1.02) and 5 (22.2±1.02) because species number had declined in the other treatment paddocks. Differences among grazing treatments remained with Paddock 6 having the lowest number of species per transect from Nov 2003 until the final measure. At the final measurement in Nov 2005, the number of species per transect in Paddock 6 (16.4±1.13) was less (P<0.01) than for all other grazed paddocks (mean 23.2±1.13).

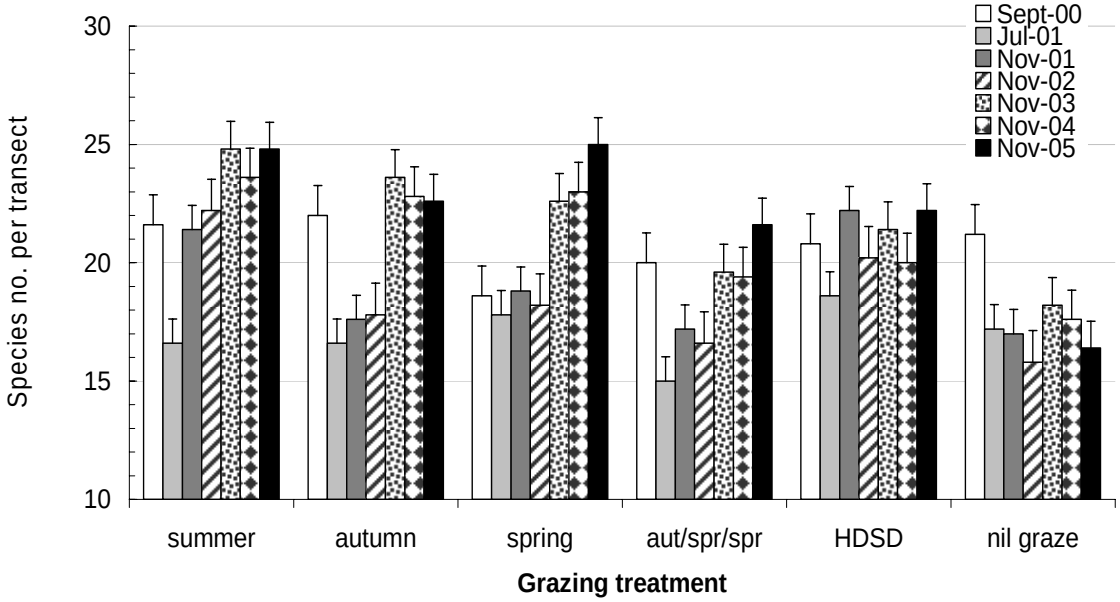

Figure 8. Mean (± SE) number of species recorded per 2.5m^2 transect over the period September 2000 – November 2005 within grazing treatments on "Anama".

NUMBER OF NATIVE PERENNIAL GRASS PLANTS

The mean number of native perennial grasses per transect (2.5m^2) did not differ significantly among grazing treatments at the initial measurement (Fig 9) and averaged 52.7±11.42 plants per 2.5m^2. By November 2003 the number of native perennial grasses per transect was described by 2 groupings (P=0.01) namely, Paddocks 1, 2 and 4 (116, 107 and 132±11.3 respectively) and Paddocks 3, 5 and 6 (59, 62 and 47±11.3 respectively). By November 2004 these groupings had remained largely unchanged (P<0.05) with the exception that the number of native perennial grass plants had increased in Paddock 3. The 2 groupings were Paddocks 1-4 (88, 121, 75 and 121±13.3 respectively) and Paddocks 5 and 6 (52 and 49 ±13.3 respectively). By the final measure these groupings remained but the variability between transects within paddocks had increased resulting in larger standard errors and no statistical differences among grazing treatments. In general, areas with increased numbers of perennial grasses had a very low dry weight of pasture and poor soil surface structure. The individual perennial grasses in these areas were typically very small reflecting the difficult environment.

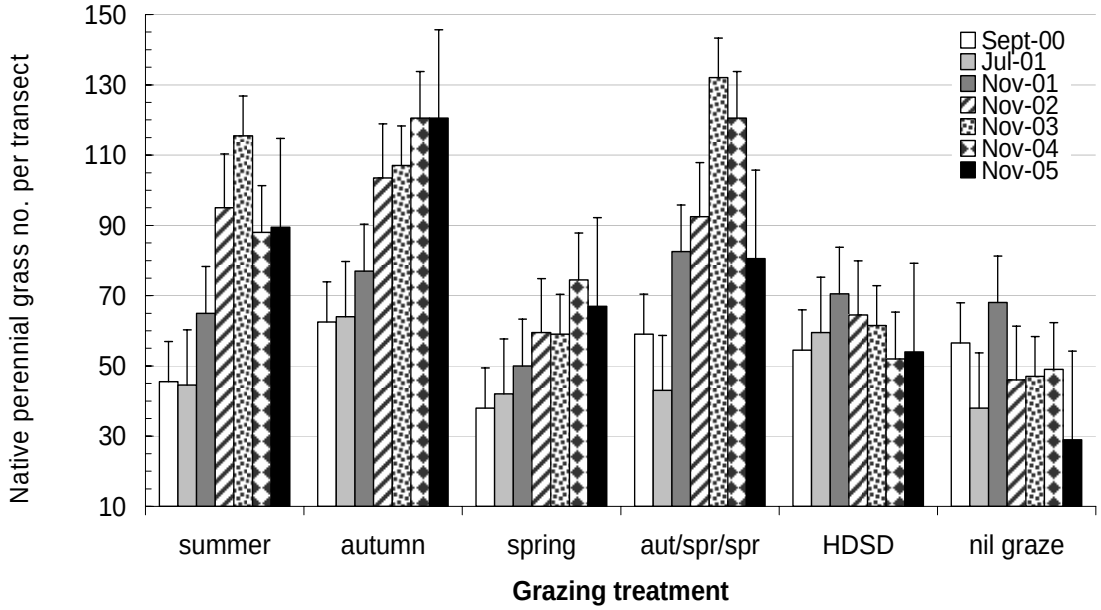

Figure 9. Mean (± se) number of native perennial grass plants recorded per 2.5m^2 transect over the period September 2000 – November 2005 within grazing treatments on "Anama".

PLANT BASAL COVER

Plant basal cover (combination of all herbaceous species) did not differ significantly among grazing treatments at the first measurement and averaged (lsmean ± se) 14.8±1.44%. By Jul 2001 (2nd measure) total plant basal cover was greatest (P<0.01) in HDSD (20.7±0.99%) and least in Paddocks 1 (11.7±0.99%) and 4 (13.0±0.99%). Total basal cover declined greatly after the dry year of 2002 to average 5.7±0.86% at which time HDSD retained a significantly (P=0.01) greater total plant basal cover (9.0±0.86%) than all other paddocks except Paddock 3. By November 2004, plant basal cover continued to differ (P<0.05) significantly among treatment paddocks and was described by 2 groupings. Paddocks 3, 4, 5 and 6 had the greatest cover and Paddocks 1 and 2 the least cover. At the final measure in 2005, differences among treatments were not apparent but remained numerically highest in Paddock 5 at 21.6±2.26% (Fig 10).

Annual grass basal cover did not differ significantly among grazing treatments at the first measurement and averaged 8.1±1.34% (ie. 55% of total plant cover) (Fig 11). Differences (P<0.05) among grazing treatments were only apparent at Nov 2004 when annual grass basal cover was greatest in Paddocks 3 and 6. In general however, annual cover was least in Paddock 1 over the 5-year period.

Perennial grass basal cover did not differ significantly among grazing treatments at the first measurement and averaged 3.9±0.97% (ie. 26% of total plant cover) (Fig 12). Perennial grass basal cover differed among grazing treatments at Nov 2003 (P<0.05), Nov 2004 (P<0.05) and Nov 2005 (P<0.05). At 2003, perennial basal cover was greatest in HDSD (9.0±1.28% vs 3.1 ±1.28% mean for all other paddocks). At 2004, perennial cover in Paddocks 4 (6.7±0.85%) and 5 (6.0±0.85%) was greater than in all other paddocks (mean 3.0±0.85%). At 2005,

perennial cover was greatest in Paddocks 1 and 5. Perennial cover was numerically least in the nil graze Paddock 6 at the final 3 measures.

Bare ground did not differ initially among grazing treatments and at the first measurement averaged 3.4±2.26% (Fig 13). By November 2001 Paddock 1 had the greatest (P<0.01) bareground at 16.0 ±2.40% with Paddocks 3, 4, 5 and 6 (mean 2.6±2.40%) the least. This trend continued until Nov 2003 when Paddocks 1 and 2 had the greatest bareground estimate (50.7±6.13 and 33.0±6.13% respectively); and this was repeated in 2004. By 2005, differences among grazing treatments were not apparent because a larger variability between transects within paddocks resulted in larger standard errors. In should be noted that after the initial measure, bareground in the nil graze Paddock 6 was always zero or less than 1%.

Basal cover of cryptogams did not differ among grazing treatments and averaged (lsmean±se) 12.4±7.70% (min = 1%; max = 23%) across all treatment paddocks and times. The lowest cover of cryptogams followed the dry year of 2002 when a cover of 5.2±3.60% was recorded. At the final measure in 2005, cryptogam cover was numerically least in Paddock 5 at 2.7±9.20%.

Litter cover did not differ initially among grazing treatments and at the first measurement averaged 65±9.57% (Fig 14). By November 2002, Paddock 1 had the least (P<0.01) litter cover at 42.3 ±5.75%. By Nov 2003, Paddocks 1 and 2 had the least (P<0.01) litter cover (27.3±6.40 and 36.3±6.40% respectively). By Nov 2004, litter cover was still numerically least in Paddocks 1 and 2 but these estimates were only significantly different (P<0.05) from Paddocks 5 and 6. In contrast, litter cover in the nil graze Paddock 6 was greater (P<0.05) during 2003 than all other paddocks. During 2004, greatest (P<0.05) litter cover was recorded in Paddocks 5 (HDSD) and 6. By Nov 2005, greatest (P<0.05) litter cover was recorded in Paddock 1 with no differences among grazing treatments.

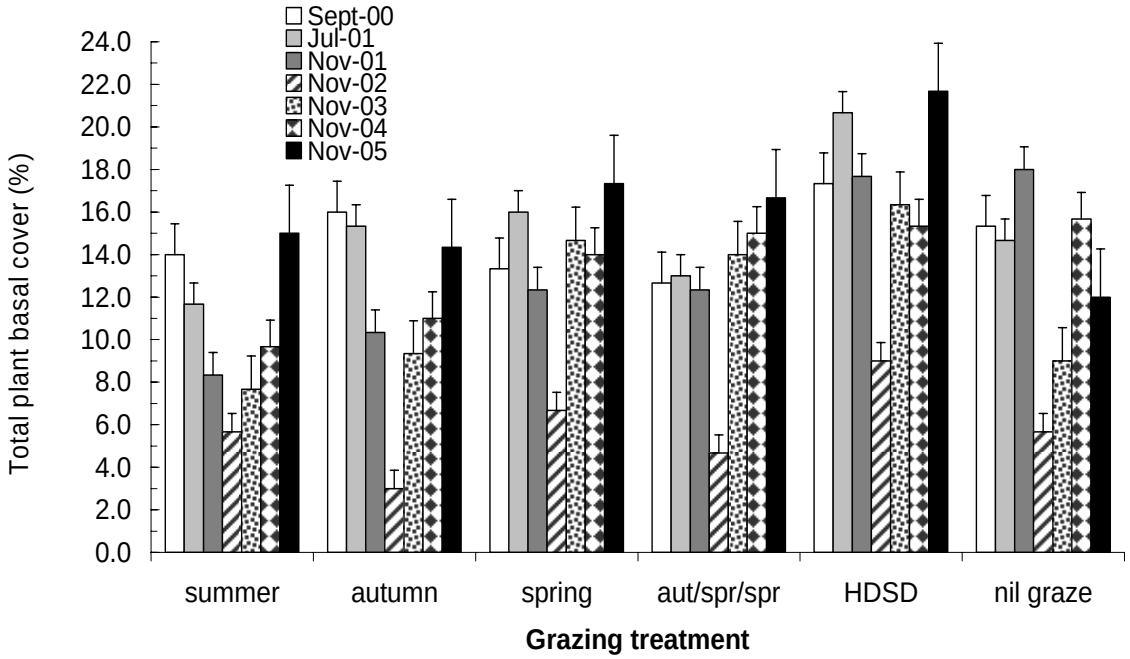

Figure 10. Mean (± se) percentage plant basal cover over the period September 2000 – November 2005 within grazing treatments on "Anama".

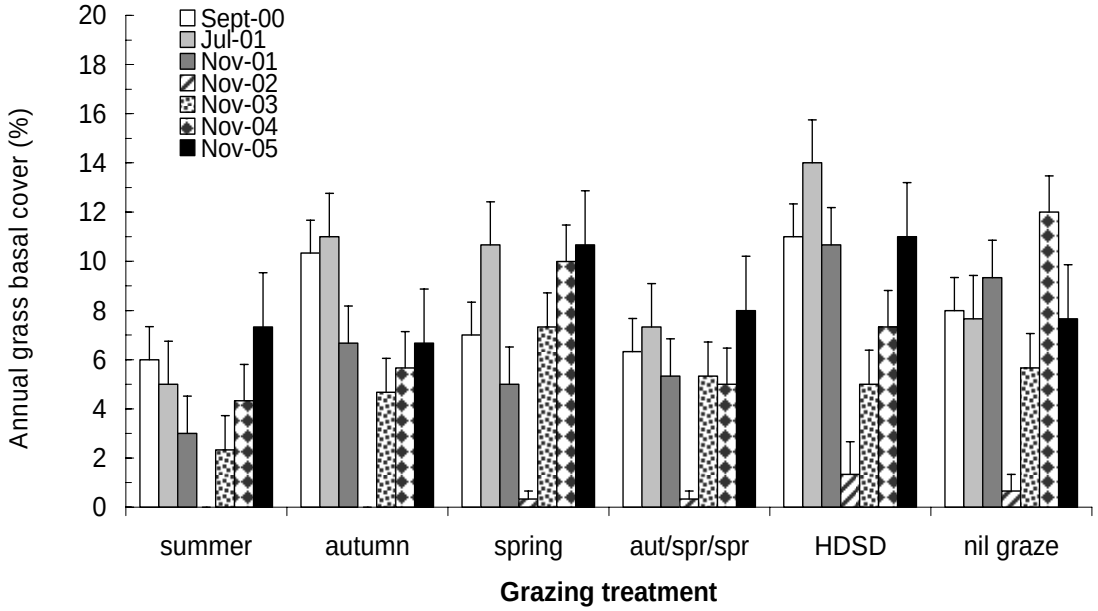

Figure 11. Mean (± se) percentage annual grass basal cover over the period September 2000 – November 2005 within grazing treatments on "Anama".

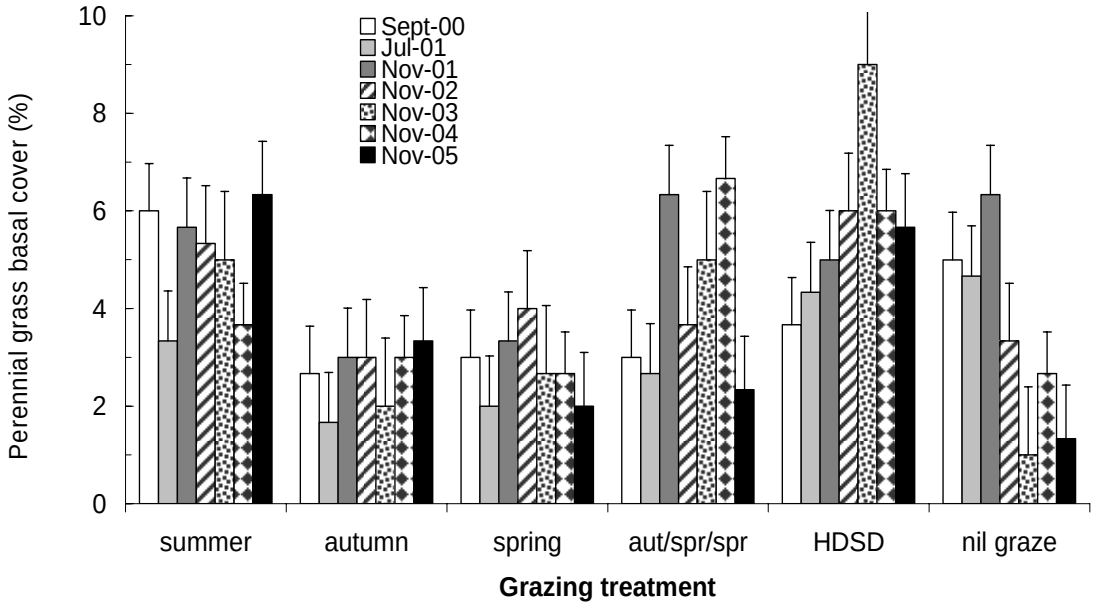

Figure 12. Mean (± se) percentage perennial basal cover over the period September 2000 – November 2005 within grazing treatments on "Anama".

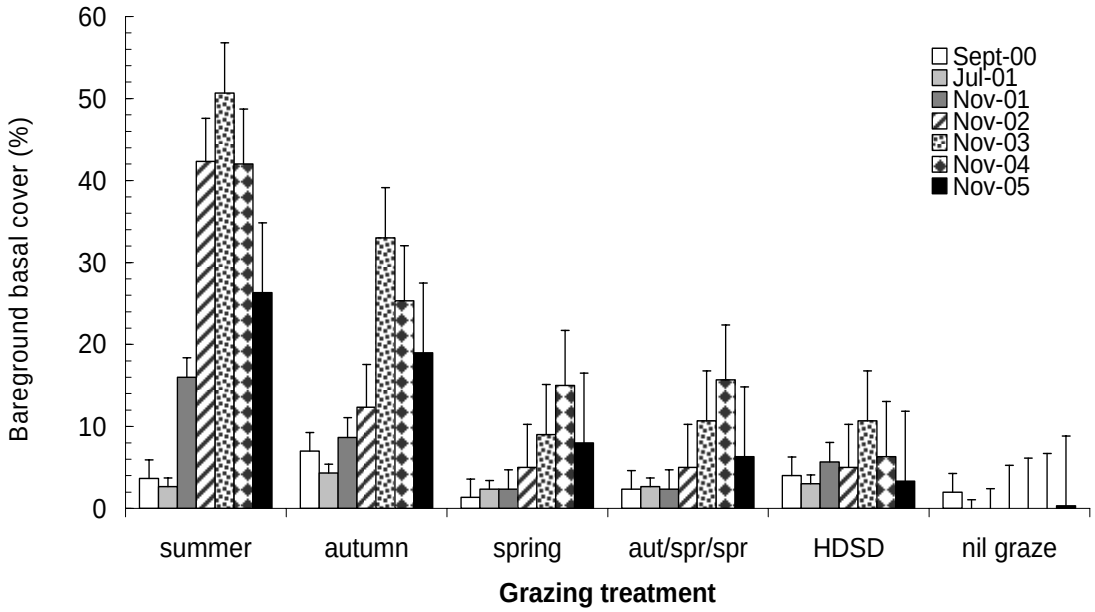

Figure 13. Mean (± se) percentage bare ground over the period September 2000 – November 2005 within grazing treatments on "Anama".

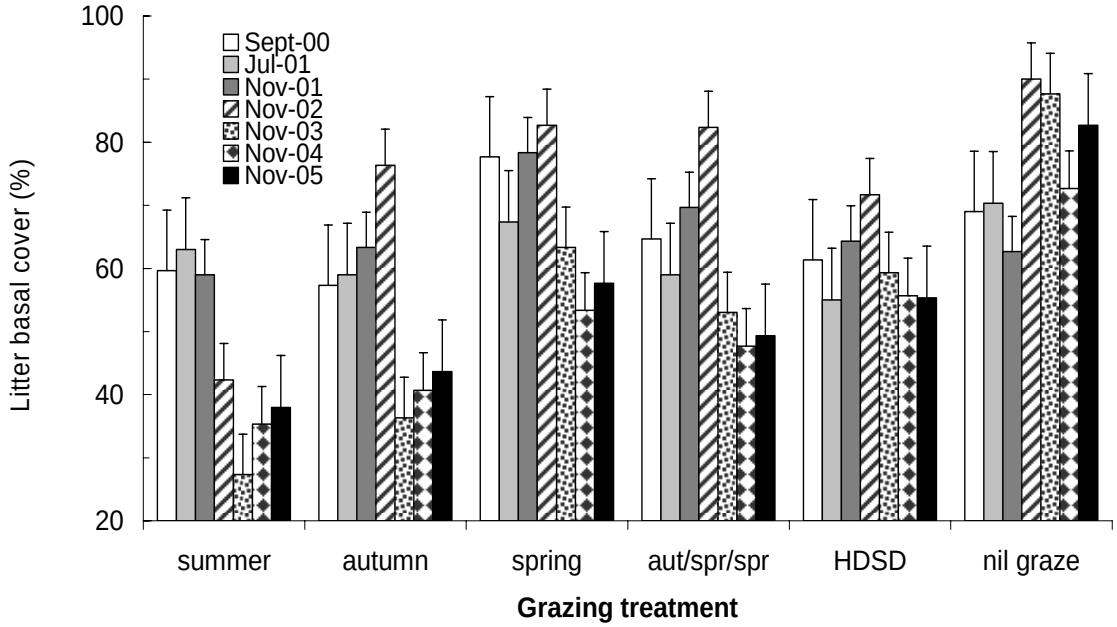

Figure 14. Mean (± se) percentage litter cover over the period September 2000 – November 2005 within grazing treatments on "Anama".

GROUND COVER

Visual estimates of ground cover were introduced later in the trial and recorded from Nov 2004, so it was not possible to determine if any differences existed among treatment paddocks prior to grazing treatments being imposed. However, given that herbage mass did not differ significantly at the first measure it is unlikely that initial differences in ground cover existed among paddocks. At Nov 2004, ground cover differed ($P<0.001$) among grazing treatments and was least in Paddocks 1^{ab}, 2^{a} and 4^{ab}, intermediate in Paddock 3^{cb} and greatest in Paddocks 5^{cd} and 6^{d}. At Nov 2005, ground cover remained least ($P<0.05$) in Paddocks 1^{ab} and 2^{a}, intermediate in Paddock 3^{abc} and greatest in Paddocks 4^{bc}, 5^{bc} and 6^{c} (Fig 15).

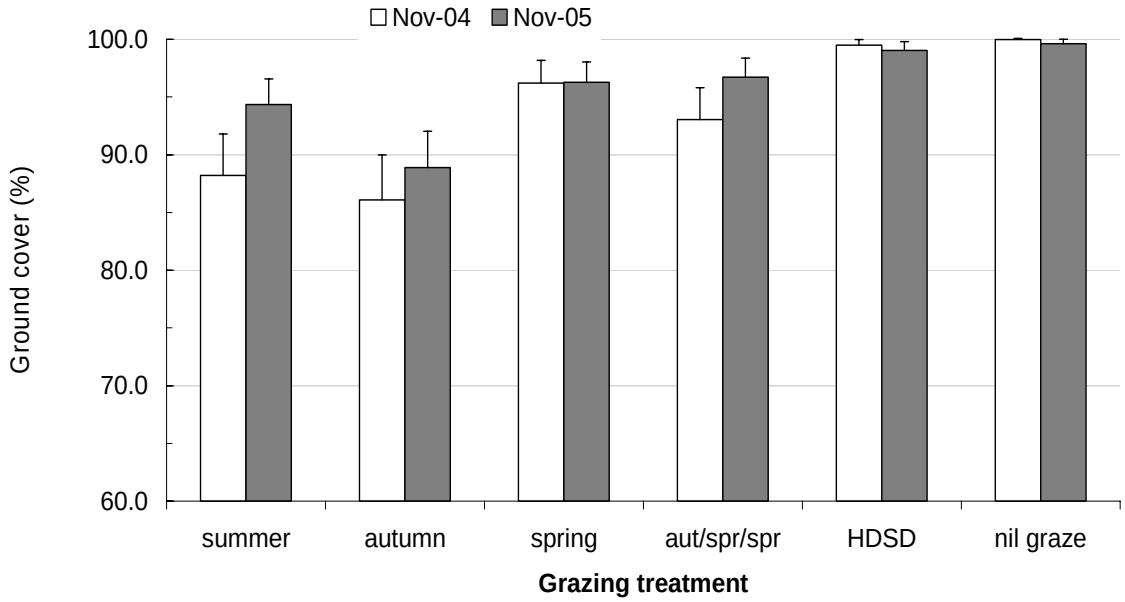

Figure 15. Mean (± 68% c.i.) ground cover over the period November 2004 – November 2005 within grazing treatments on "Anama".

SOIL SURFACE

Estimates of the condition of the soil surface were introduced later in the trial and recorded from Nov 2003, so it was not possible to determine if any differences existed among treatment paddocks prior to grazing treatments being imposed. At Nov 2003, soil surface condition differed ($P<0.01$) among grazing treatments and was least in Paddocks 1^{a}, 2^{a} and 4^{ab} and greatest in Paddocks 5^{bc} and 6^{c}. Differences among grazing treatments increased over time ($P<0.001$) and soil surface condition remained greatest in Paddocks 5 and 6 at the final measure (Fig 16). Over the 3 years of estimates, soil surface condition declined (-37%; $r^2=0.82$) only in Paddock 1. The greatest numerical improvement occurred in Paddock 5 (72%; $r^2=0.88$).

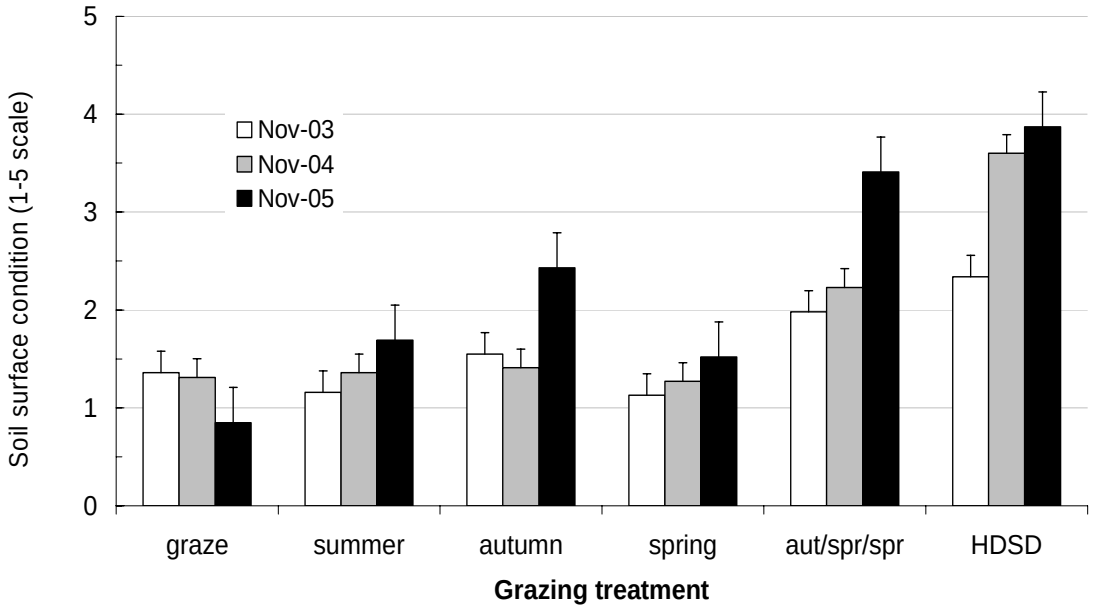

Figure 16. Mean (± se) soil surface condition over the period November 2003 – November 2005 within grazing treatments on "Anama".

SOIL BIOLOGY

Soil dry matter did not vary among grazing treatments at any of the 3 measures taken in 2004. Soil dry matter was numerically lowest (ie. greatest moisture content) at the first sample in July and was (lsmean ±se) 80.3±0.12%. Averaged across all paddocks and sampling periods, soil dry matter was 84.0 ±0.11%.

Neither active bacterial or active fungal concentration (ppm) in soil (0-10 cm) varied among grazing treatments. When averaged (lsmean±68% c.i.) across all paddocks and sampling periods, active bacterial and fungal concentration was 10.9±3.93 ppm and 6.4±4.18 ppm respectively. Similarly, active microbial biomass (ie. sum of active bacteria and active fungi) did not differ among grazing treatments. When averaged (lsmean±68% c.i.) across all paddocks and sampling periods, active microbial biomass concentration was 18.0±7.10 ppm.

Total bacterial concentration in soil differed among grazing treatments during July ($P<0.001$) and September ($P<0.01$) but not at December 2004. (Fig 17). At July 2004, total bacterial concentration was lowest in Paddocks 5 and 6, with no differences among the other paddocks. At September 2004, the situation had changed with total bacterial concentration being lowest in Paddocks 1 and 2, with no differences among the other paddocks. Interestingly, total bacterial concentration was least stable in Paddocks 1 and 2, due to the large decrease in total bacteria at September.

Total fungal concentration in soil differed among grazing treatments during July 2004 ($P<0.05$) but not thereafter (Figure 18). At July 2004, total fungal concentration was greatest in Paddock 4^{b}, intermediate in Paddocks 2^{ac}, 3^{ac}, 5^{ac} and 6^{bc} and lowest in Paddock 1^{a}. Fungal concentration declined sharply in all paddocks at the September sample but recovered at December with the exception of the nil grazed Paddock 6.

Total microbial biomass differed among grazing treatments at July (P=0.06) and September (P<0.05) but not at December 2004 (Figure 19). At July 2004, microbial biomass was greatest in Paddocks 4^{b} and 6^{ab} with no differences among the other grazing treatments[a]. At September 2004, microbial biomass was least in Paddock 2^{a} with no differences among the other grazing treatments (Paddocks 1^{ab}, 3^{b}, 4^{b}, 5^{ab}, 6^{b}). Assuming a bulk density of the top 10cm of soil of 1000 kg/m^3, it can be calculated that the units of ppm equate to kg/ha in the top 10 cm. Averaged across all samples and treatment paddocks, total microbial biomass was estimated to be 358±59.5 kg/ha with a minimum value of 149 (Paddock 2, Sept 2004) and a maximum value of 647 kg/ha (Paddock 4, July 2004).

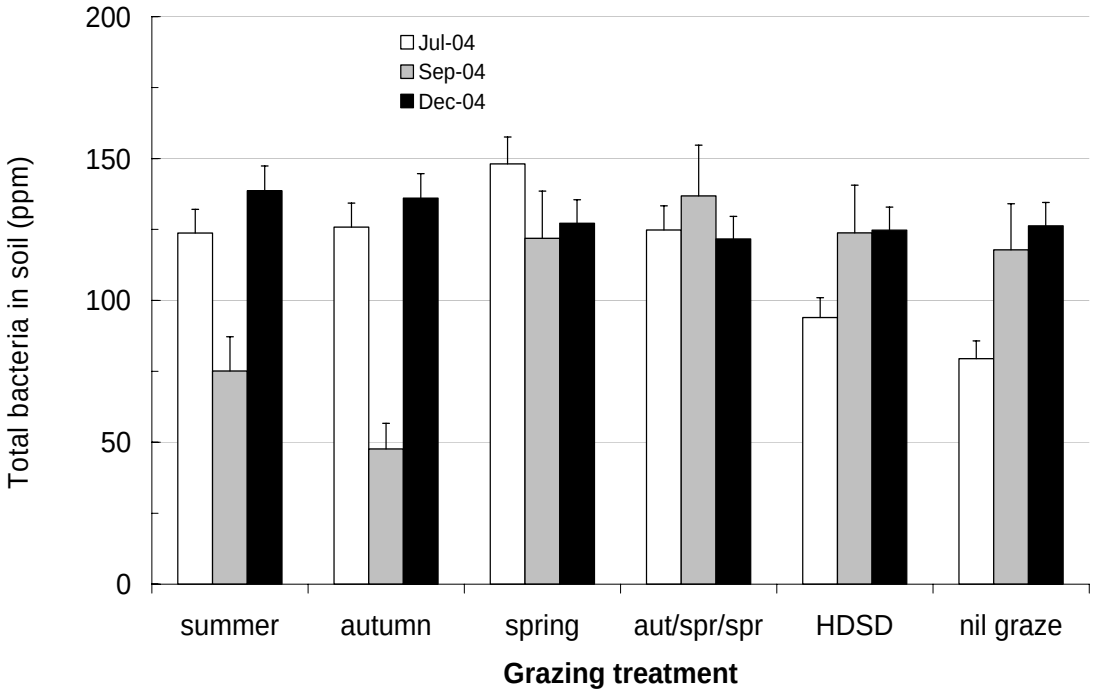

Figure 17. Mean (± 68% c.i.) total bacterial concentration in soil (0-10cm) within grazing treatments on "Anama".

Protozoa number (per gram of soil; 0-10 cm) differed among grazing treatments, but only at the first measure in July 2004 (P<0.01) when numbers (lsmeans±68% c.i.) were greatest in Paddocks 3^{b}, 5^{b} and 6^{ab} at 42,519±21,106, 42,164±20,996 and 12,933±10,196 per gram respectively. Numbers of protozoa were least in Paddocks 1^{a}, 2^{a} and 4^{a} at 945±2,318, 2,778±4,164 and 843±2,184 per gram respectively.

No differences existed among grazing treatments for nematode number (per gram of soil; 0-10 cm) or percentage root colonisation by mycorrhiza. The average number (lsmean±68% c.i.) of nematodes and percentage mycorrhizal colonisation across all sampling periods and paddocks was 3.2±0.76 per gram of soil and 0.5±0.14%.

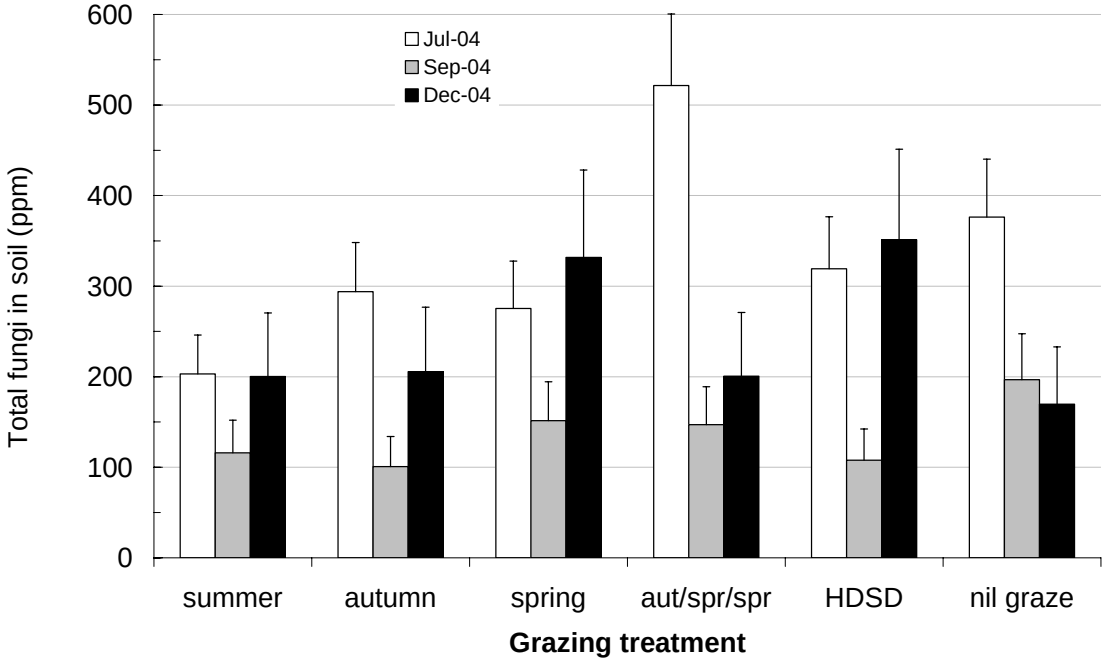

Figure 18. Mean (± 68% c.i.) total fungal concentration in soil (0-10cm) within grazing treatments on "Anama".

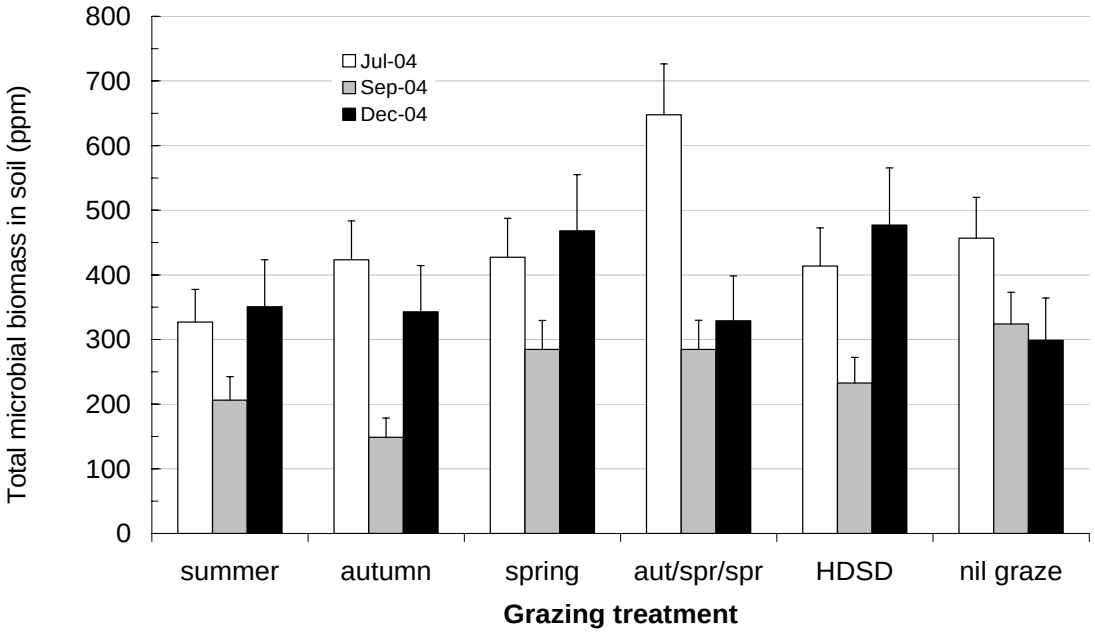

Figure 19. Mean (± 68% c.i.) total microbial biomass in soil (0-10cm) within grazing treatments on "Anama".

STOCKING RATE

Stocking rate was calculated for Paddocks 1-4 by reference to live weight changes obtained from weighing animals into paddocks and then out of paddocks at the end of the grazing period. Animals in the summer rest control (Paddock 1) were weighed at the same time and returned to the paddock. Because graze periods in HDSD were of a few days in duration this prevented the use of live weight change data to calculate stocking rates. Therefore, a dry sheep equivalent (DSE) was estimated for these periods based on herbage mass, estimated herbage quality and live weight changes in other paddocks around the same time. Drought conditions during 2002 required a change to the number of sheep grazing in grazing treatments based on the calculation of feed budgets. Reduced stock numbers continued for 2003 and 2004. Stocking rate for the 4 years is detailed in Table 2. Data are expressed in terms of DSE equivalent. Averaged over the four years the stocking rate of HDSD was 4.2 DSE/ha as compared to a mean of 2.3 DSE/ha for all other grazing treatments. The variation in stocking rate was assessed by reference to the co-efficient of variation which was 8, 25, 38, 38 and 25% for Paddocks 1-5 respectively. Variation was least in Paddock 1 and greatest in Paddocks 3 and 4.

Table 2. Stocking rate (dry sheep equivalents) for the grazing treatments at 'Anama' during 2001-2005.

Grazing treatment	Paddock	2001	2002	2003	2004	2005	Mean
Srest	1	2.7	2.4	2.3	2.3	2.2	2.4
SArest	2	3.0	1.8	1.9	1.7	2.2	2.1
SSrest	3	3.7	1.7	1.8	1.7	2.3	2.3
SASSrest	4	4.0	1.3	2.3	2.3	2.6	2.5
HDSD	5	5.6	3.0	3.5	4.5	4.7	4.2
Nil graze	6	0	0	0	0	0	0

Calculation of DSE is affected by sheep live weight change and this, plus a change to sheep numbers because of drought, accounts for why the planned stocking rate of 2.5 DSE/ha was not achieved in Paddocks 1-4. Live weight change of sheep varied during the year with live weight loss generally experienced from grazing periods that occurred between April – August. Mean annual live weight change and sheep numbers are detailed in Table 3.

Table 3. Mean annual live weight change during relevant grazing periods and sheep numbers for the grazing treatments at 'Anama' during 2001-2005.

Grazing treatment	Paddock	Mean live weight change (g/day)					Mean sheep numbers				
		2001	2002	2003	2004	2005	2001	2002	2003	2004	2005
Srest	1	18	34	0	29	-17	23	18	22	19	21
SArest	2	32	15	10	94	-67	70	55	53	45	70
SSrest	3	91	-63	8	-10	-14	70	68	53	52	70
SASSrest	4	79	-124	40	58	13	160	69	53	53	70
HDSD	5	NA	NA	NA	NA	NA	465	590	472	302	420
Nil graze	6	NA	NA	NA	NA	NA	0	0	0	0	0

DISCUSSION

VEGETATION

It is a difficult task to succinctly describe effects of grazing management on vegetation composition in a field experiment. That task is made difficult because of the large influence that the growing season conditions, such as rainfall volume and timing and ambient temperature and timing of first and last frosts, has on vegetation. The approach that has been used in this report is to assess the effects of grazing treatments on indicator species and functional plant groups. The monitoring has allowed effects of grazing to be assessed at a number of levels that investigate grassland function and production including;

Productivity

1. Contribution to dry weight (herbage mass) – allows examination of the relative contribution of a indicator species or functional group to dry weight independent of total dry weight of pasture.
2. Species dry weight – measures the absolute dry weight of herbage (also referred to as herbage mass), for a given species or group, present at sampling and does not adjust for effects of grazing on total pasture production.
3. Stocking rate – measures the productive capacity and rate of utilisation of the pasture. Stocking rate is achieved through the product of pasture growth rate and utilisation rate.

Distribution

4. Species frequency – estimates the spatial distribution of indicator species or groups without reference to dry weight. Changes in species frequency may precede changes to dry weight.

Diversity

5. Number of species per transect – records the species diversity at the level of a non-contiguous area of $2.5m^2$.

Perenniality

6. Number of perennial grass plants per transect – indicates both positive and negative processes. Increasing number may be associated with seedling recruitment (positive) but also from fragmentation of existing large perennial grass tussocks into smaller tussocks.

Cover

7. Basal cover – measures the components of cover at ground level and as such, plant basal cover is a more stable measure than ground (ie. canopy) cover.
8. Ground cover – measures the extent to which the soil surface is covered and protected from the forces associated with raindrops. Increasing ground cover is associated with reduced rainfall run-off.
9. Soil surface condition – estimates the friability of the surface of the soil. It is assumed that increasing soil surface condition is associated with reduced rainfall run-off and a more favourable environment for recruitment of seedlings.

A summary of the changes in the 20 vegetation indicators is provided in Table 4. The data presented in this report indicate that the regional practice of the summer rest control (Paddock 1) produced the least herbage mass and resulted in a reduction in the contribution of native perennial grasses to herbage mass and an increased contribution from *H. flaccida*. In contrast, both the frequency and number of native perennial grasses increased which, when considered with the productivity data, suggests that this management led to a greater number of perennial grass plants accompanied by a reduction in biotic potential (ie. more numerous but less productive plants): frequency of *G. setifolia* increased 10.7 fold. The increased number of perennial grasses could have arisen from 2 processes, the first being recruitment of new plants and the second from fragmentation of existing tussocks. Fragmentation occurs as the central tillers on existing single tussocks (generally *Austrodanthonia* spp) die and lateral tillers eventually separate forming 'separate' plants. Field observation was that the latter of these processes was most influential and occurred mostly with *Austrodanthonia* spp plants in capped (ie. low soil surface condition which was on average 1.3, 1.4 and 0.9 in Paddock 1 during 2003-2005 respectively) areas. As such this is a stress response and is not considered a desirable change. Total species diversity increased supporting the observation of positive effects on native grass frequency and niches for germination created by low ground cover. A small increase in annual and perennial grass basal cover was recorded but these changes were overshadowed by a large and significant reduction in litter cover and a resultant increase (9.8 fold) in bareground which averaged 26% over the 5-year period. A 5-year mean stocking rate of 2.4 DSE/ha approximates the regional average (Survey, 2004).

When compared with regional practice, an additional Autumn rest (SArest; Paddock 2) did not produce more herbage or change the contribution of native perennial grasses or *H. flaccida* to herbage mass. Unlike the control, there was a no increase in the frequency of *A. blackii* but the frequency of the *Austrodanthonia* spp group increased 2.9 fold. The increased frequency of *Austrodanthonia* spp group may be associated with being generally prolific seeders, new seedlings germinating in response to Autumn rainfall, and being a species which colonisers bareground (Lodge and Whalley, 1989). Providing rest from grazing during the Autumn period may have facilitated a greater recruitment of *Austrodanthonia* spp. The increased number of native perennial grass plants and greater total species diversity matched that of the control. It is also possible that the increased frequency arose from the process of fragmentation. Field observation indicated that fragmentation and seedling recruitment were both operating. Total plant basal cover fell by 16.5% relative to the control but this was associated with lower annual grass but greater perennial grass basal cover. Nevertheless, litter cover was reduced by a similar extent as in the control resulting in a 3-fold increase in bareground which averaged 16%; which was a considerably smaller increase than that observed in the control Paddock 1. The 5-year mean stocking rate of 2.1 DSE/ha was below that of the control mostly because wethers typically experienced weight loss during the first graze event after Autumn had ceased (graze event started mid June). Weight loss occurred at this time presumably because the nutritional value of the standing dead and dry material from the previous growing season had fallen to a very low value and yet there was very little green herbage from the current season.

When compared with regional practice, an additional Spring rest (SSrest & SASSrest; Paddocks 2 and 3) produced more herbage (20% increase) but this effect was largely accrued from significant effects on herbage mass in the years 2001 and 2002. Similar negative changes to the control were recorded for the contribution of *A. blackii* to herbage mass but Spring rest resulted in an increase to the contribution from *A. behriana*. Unlike that recorded for the control and SArest paddocks, the contribution of *H. flaccida* did not increase over time. In

relation to the control, Spring rest led to an increase in the frequency of *A. blackii*, *A. behriana* and *Austrodanthonia* spp group. The differential effects of Spring rest on production and distribution of the 3 indicator native perennial grasses may arise from differences in phenology. *A. behriana* is a warm-season perennial grass and the majority of its green-leaf production and seedling emergence occurs in response to Spring rainfall; seed is produced from late Spring to early summer. *A. blackii* is a cool-season perennial grass and *Austrodanthonia* spp group a year-long green. Both phenological groups produce green leaf in response to winter and Spring rainfall but seedlings emerge following Autumn rain; seed is produced during late Spring..

Providing a rest from grazing during Spring would prevent defoliation of *A. behriana* by sheep and provide a window of opportunity for seedling emergence which together may result in a greater contribution to herbage mass and increased recruitment and hence frequency. In contrast, Spring rest would have a lesser effect on restricting defoliation of green leaf from *A. blackii* and *Austrodanthonia* spp group, which begins green leaf production during late winter. However, Spring rest may result in a greater contribution to soil seed reserves, by removing grazing of reproductive tillers, and although these paddocks were grazed during the germination window of the subsequent Autumn, the larger seed contribution may have been sufficient to produce the increased frequency.

The increased number of native perennial grass plants and greater total species diversity were similar to that of the control. Total plant basal cover increased by approximately 25% relative to the control but basal cover of annual and perennial grasses varied between SSrest and SASSrest. The initial additional Autumn rest and the cattle grazing during 2004 that occurred in SASSrest, separated the management of these paddocks yet SASSrest, but not SArest. recorded a large increase (ie. 21%) in basal cover of perennial grasses. Litter cover suffered a smaller reduction than in the control but bareground increased by 6-fold across both paddocks. Importantly, the average level of bareground was 6% which was considerably lower than that observed in the control Paddock 1. The 5-year mean stocking rate of 2.4 DSE/ha was identical to that of the control.

HDSD grazing produced significantly more herbage than Paddock 1 and resulted in positive effects on the species contribution to herbage mass. For example, a small increase for *A. blackii* and a large increase for *A. behriana* was recorded which contrasts with the reductions in the control Paddock 1. In addition, the contribution of *H. flaccida* declined 2.7-fold which was numerically greater than in the control paddock. Changes in the frequency of *A. blackii* and *A. behriana* were similar to that of the control paddock but frequency of *Austrodanthonia* spp group increased 2.4 fold. The latter change, possibly reflecting that the initial grazing event for each year occurred well after the Autumn rain and adequate periods of rest from grazing during Spring. There was a large and significant increase in the frequency of *G. setifolia* (7-fold) but total herbage mass of this species was 0 kg DM/ha on 6 occasions and 2 kg DM/ha on a single occasion. Total plant species diversity increased to a smaller extent than in the control and the number of native perennial grasses declined, in contrast to the large increase in Paddocks 1-4. A small reduction in perennial grass number in conjunction with an increase in contribution to herbage mass indicates fewer but more productive plants and that fragmentation, and hence stress, was not occurring to the extent as in Paddocks 1 and 2. Total plant basal cover matched that of the control but importantly the basal cover of perennial grasses increased 72%, which was larger than any other treatment. Basal cover of litter declined to a small extent (10%) and bareground increased slightly. The average level of

bareground was 5% which was considerably lower than that observed in the control Paddock 1. The 5-year mean stocking rate of 4.2 DSE/ha was 75% greater than in the control.

Table 4: A summary of the changes in grassland function and production affected by grazing management

	Treatment paddock					
	1 Srest	2 SArest	3 SSrest	4 SASSrest	5 HDSD	6 Nil graze
(A) Herbage mass	least	least	inter	inter	most	most
(B) Percentage contribution to herbage mass of:						
Austrostipa blackii	***-67***	***-88***	***-75***	-35	14	25
Aristida behriana	-21	-3	16	***185***	375	162
Austrodanthonia spp group	-51	***-175***	**	-56	**	-103
Total annual grasses	13	1	-6	-47	20	-79
Homeria flaccida	294	271	56	-34	-17	-40
Scabiosa atropurpurea	-58	-32	-73	-34	-276	***767***
(C) Species frequency						
Austrostipa blackii	15	0	***35***	26	17	4
Aristida behriana	3	4	***44***	2	10	10
Austrodanthonia spp group	16	286	***590***	-55	242	-231
Gynandriris setifolia	***1074***	142	-51	103	***718***	97
Homeria flaccida	***51***	***32***	14	24	***41***	0
Plant species	***26***	21	***39***	18	6	-12
Native perennial grass plants	***118***	***106***	***88***	89	-13	-35
(E) Basal cover						
Total plant cover	4.1	-12.3	21.8	34.6	5.5	-21.9
Annual plant cover	17.6	-41.0	48.9	9.4	-29.8	14.8
Perennial plant cover	2.7	27.5	-22.1	21.1	71.8	***-89.2***
Bareground	***978***	305	832	423	***42***	***-47***
Litter	***-53***	-42	***-30***	-31	-10	21
(F) Stocking rate	2.4	2.1	2.3	2.5	4.2	0

Note: Values which are bold and italicised have a statistically significant (P<0.10) regression co-efficient indicating change. ** denotes not possible to calculate change because of a zero initial value.

Removal of domestic herbivores (nil grazing) was associated with a level of herbage mass greater than all other paddocks except HDSD. A small increase in contribution to herbage mass from *A. blackii* and a large increase from *A. behriana* were recorded but contribution from *Austrodanthonia* spp group declined to a larger extent than in the control. There was a decline in contribution from *H. flaccida* but an undesirably large and significant increase (7.7-fold) in the contribution of the woody weed *S. atropurpurea*. Small improvements in the frequency of *A. blackii* and *A. behriana* were similar to that recorded in the control but the frequency of *Austrodanthonia* declined sharply (2.3-fold). Total species diversity declined (this did not occur in any other treatment paddock) as did the number of native perennial grasses. Total plant basal cover declined because of the significant drop (-89%) in basal cover of perennial grasses. Increasing litter was only recorded in Paddock 6 and the net effects of these changes was a reduction in bareground. The average level of bareground was 0.3%, with 5/7 measurements recorded with zero bareground. It is likely that the high litter cover (mean of 76% vs 46% in Paddock 1) and complete ground cover was responsible for the decline in the number of perennial grass plants and the frequency and productivity of *Austrodanthonia* spp group. As discussed previously, this group plays a colonising role and individual plants have a shorter-life span than the other perennial grass species discussed in this report. Almost complete cover would reduce the opportunity for germination events because of competition for light and the replacement rate would be less than the death rate of individual plants. The 5-year mean stocking rate was 0 DSE/ha.

The processes of recruitment and fragmentation may be teased apart further to better understand treatment effects on the number of native perennial grasses and conclude more accurately the effects of grazing. Frequency was calculated from the recording of presence and absence data, such that 100% frequency indicates that a species or species group was identified in every quadrat along each transect. The number of native perennial grasses was determined by counting apparently individual plants within each quadrat along transects. Hence, number of grass perennial plants records change at the same sites and frequency records change in distribution and is more likely to be informative of true recruitment. Therefore, a comparison of change in frequency with change in the number of perennial grasses may indicate which of the 2 processes (ie. recruitment and fragmentation) was most apparent. In the control Paddock 1, frequency of perennial grasses changed little (mean 11% across all 3 indicator groups) but number of perennial grasses more than doubled. In contrast, frequency of perennial grasses (mostly *Austrodanthonia* spp group) increased substantially with Autumn and Spring rest as did the number of perennial grasses. This suggests that increasing number of perennial grasses in Paddock 1, but not Paddocks 2-4, was mostly due to the process of fragmentation.

No grazing treatment has been without desirable or undesirable outcomes. However, the variables reported in this report have different weightings on grassland function and sustainability. For example, grazing treatments of summer rest (Paddock 1) and the additional autumn rest (SArest; Paddock 2) have, on average, reduced litter cover by 47% and increased bareground from, on average, 5% – 23%; with a maximum value of 51% in 2003. This change is unsustainable and overshadow the few other positive effects. In terms of extension, the additional autumn rest provided few productive or functional benefits and is unlikely to be adopted by graziers. Of the seasonal rests, Spring rest resulted in the most positive effects on grassland function and an improvement above that of summer rest. However, modest improvements in herbage production and no improvement in stocking rate limit the value of this approach for graziers.

HDSD was able to maintain bareground at generally low levels, with the only exception being after the drought year of 2002 when bareground reached 10.7%, at which time it was 51% in Paddock 1. There was also evidence of recruitment of perennial grasses and increased productivity of perennial grasses and the pasture sward in general. In terms of extension and attractiveness to graziers and land managers in general, the stocking rate in HDSD was 75% greater than in the summer rest control. Recent data (reported separately by Cliff Hignett, Soil Water Solutions) also indicates that HDSD results in lower bulk density, greater macroporosity and increased water infiltration (Fig. 20) when compared with Paddock 1. That HDSD improved grassland function and landscape condition while increasing stocking rates challenges the conventional dogma that increased stocking rate is linked to grassland and landscape deterioration.

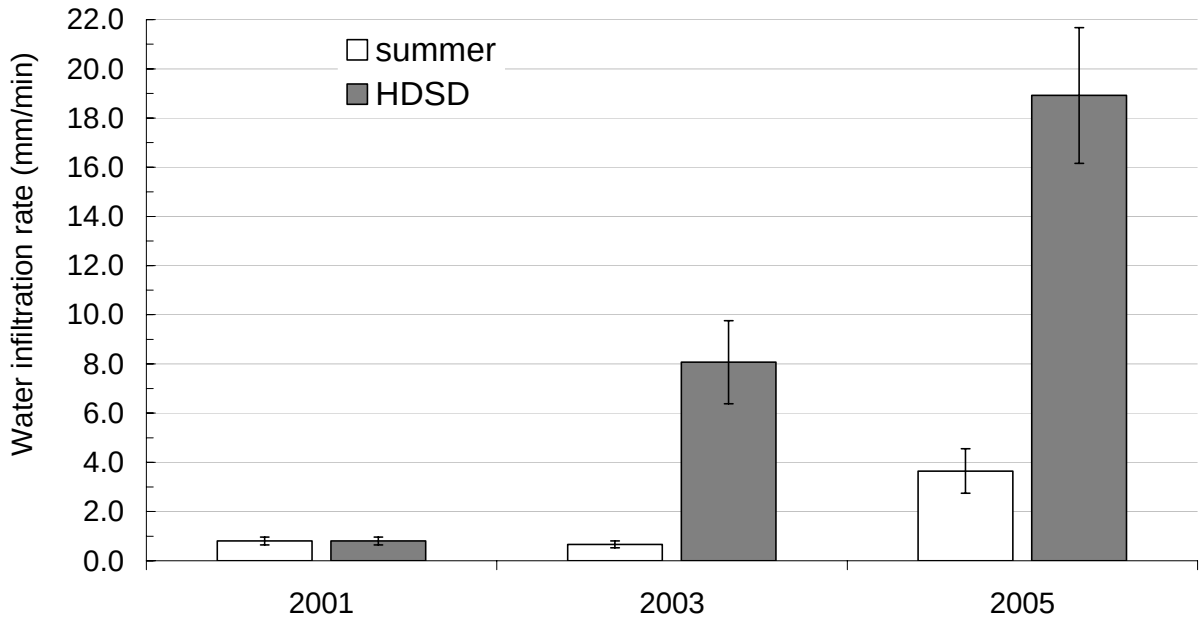

Figure 20. Water infiltration (mean±se) in soil within grazing treatments on "Anama".

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Lodge, G.M. and Whaley, R.D.B. (1989). *Native and natural pastures on the Northern Slopes and Tablelands of New South Wales*. Technical Bulletin 35. (Ed. Matthew Stevens) NSW Agriculture & Fisheries, Sydney.

APPENDIX 1

Botanal raw data expressed as percent of herbage mass (Table A1.1-A1.6) and species herbage mass (kg DM/ha) (Table A1.7-A1.12).

Table A1.1: Mean percentage contribution to herbage mass (kg DM/ha) at each time of measurement in Paddock 1 (Srest) on 'Anama'.

	Botanical name	Common name	Oct '00	Jul '01	Nov '01	Nov '02	Nov '03	Nov '04	Nov '05
*	*Brachypodium distachyon*	False brome	22.1	26.5	31.5	21.9	14.7	44.2	4.3
	Aristida behriana	Brush wiregrass	18.1	12.3	21.0	30.8	29.9	11.6	11.4
*	*Avena barbata*	Wild oats	16.1	28.4	9.8	4.9	3.5	4.3	26.5
	Austrostipa spp.	Speargrass	16.2	13.0	13.6	10.8	3.4	2.2	8.9
*	*Homeria flaccida*	Cape tulip	3.6	5.32	4.4	9.4	11.2	7.5	10.4
*	*Trifolium angustifolium*	Narrow leaf clover	0.1	1.7	2.2	1.2	16.2	10.3	3.3
*	*Vulpia myuros*	Silver grass	0.3	0	1.3	1.5	0.6	8.5	18.2
	Austrodanthonia spp.	Wallaby grass	6.2	3.5	3	4.7	2	3.3	1.7
*	*Carthamus lanatus*	Saffron thistle	0	0	0.4	3.7	13.7	1.4	0.1
*	*Scabiosa atropurpurea*	Pin cushion	4.5	1.6	3.3	2.7	0.7	0.6	3.1
*	*Briza maxima*	Quaking grass	3.6	0	0.8	1.2	1.0	1.8	4.0
	Themeda australis	Kangaroo grass	2.3	2.6	1.9	2.7	1.8	0.6	0.1
*	*Trifolium campestre*	Hop clover	0.4	0	2.0	0	0.5	0.9	4.5
*	*Bromus molliformis*	Soft brome	1.2	0	1.14	1.7	0	0.2	1.9
	Carex pumila	Sedge	2.0	1.1	1.0	0.2	0.9	0	0
*	*Plantago lanceolata*	Lamb's tongue	2.7	0.1	0.8	0.5	0	0	0.9
*	*Romuleae minutiflora*	Onion grass	0	3.1	0	0.5	0	0	0
*	*Lolium multiflorum*	Ryegrass	0	0	1.5	0	0	1.4	0.3
	Dicanthium sericeum	Qld blue grass	0	0.3	0	1.3	0	0	0
*	*Aira elegantissima*	Silver hair grass	0.3	0	0	0	0	1.1	0.3
	Walwhalleya proluta	Homophilis	0.3	0.4	0.3	0.6	0	0	0
	Oxalis perennans	Wood sorrel	0	0	0.2	0	0	0.1	0
*	*Erodium brachycarpum*	Geranium	0	0.2	0	0	0	0	0
	Acaena echinata	Sheep's burr	0.1	0	0	0	0	0	0
*	*Arctotheca calendula*	Cape weed	0.1	0	0	0	0	0	0
*	*Trifolium arvense*	Hare's foot clover	0	0	0	0	0	0	0.1
	Herbage mass (kg DM/ha)		1901	1979	2216	1286	1531	2161	1597
	Percentage Green		51		72	13	4	32	79

* denotes introduced plant species. Native species have a corresponding empty cell.

Table A1.2: Mean percentage contribution to herbage mass (kg DM/ha) at each time of measurement in Paddock 2 (SArest) on ‘Anama’.

	Botanical name	Common name	Oct '00	Jul '01	Nov '01	Nov '02	Nov '03	Nov '04	Nov ‘05
*	*Brachypodium distachyon*	False brome	22.2	33.4	15.7	10.2	10.5	31.4	3.5
	Austrostipa spp.	Speargrass	22.7	23.0	15.5	22.5	7.6	4.7	7.3
*	*Avena barbata*	Wild oats	18.5	18.3	20.2	6.8	3.8	8.7	13.4
*	*Homeria flaccida*	Cape tulip	6.7	12.5	1.5	11.6	27.9	4.3	17.9
*	*Bromus molliformis*	Soft brome	6.5	0	21.1	12.9	2.5	15.1	14.4
	Aristida behriana	Brush wiregrass	4.7	3.0	11.6	17.3	12.1	6.0	7.2
*	*Trifolium angustifolium*	Narrow leaf clover	0.7	0.3	2.2	3	21.9	9.1	5.3
*	*Vulpia myuros*	Silver grass	1.9	0.3	0	3.6	0	8.2	22.8
	Austrodanthonia spp.	Wallaby grass	3.7	4.5	3.1	3.4	0	2.9	0
*	*Lolium multiflorum*	Ryegrass	1.2	0.8	2.2	0	2.8	2.9	4.9
*	*Carthamus lanatus*	Saffron thistle	1.6	0	0	0	8.0	2.5	0.1
*	*Briza maxima*	Quaking grass	4.2	0	1.5	0.2	1.4	0.9	1.6
	Walwhalleya proluta	Homophilis	2.8	0.6	1.8	2	0.1	0	0
*	*Scabiosa atropurpurea*	Pin cushion	0.7	0.2	0.7	1.2	1.0	0.8	0.4
*	*Gynandriris setifolia*	Thread Iris	0	2.3	0.3	0.2	0	0	0
*	*Phalaris aquatica*	Phalaris	0	0.1	0.3	1.5	0	0.9	0
*	*Trifolium campestre*	Hop clover	0	0.1	0.8	0	0.3	0.3	1.0
*	*Plantago lanceolata*	Lamb's tongue	1.5	0	0.7	0	0	0	0
	Dicanthium sericeum	Qld blue grass	0.2	0	0.8	0.9	0	0	0
	Themeda australis	Kangaroo grass	0.2	0	0	1.4	0	0	0
	Convulvulus erubescens	Bindweed	0	0	0	1.3	0	0	0
	Oxalis perennans	Wood sorrel	0	0	0	0.1	0	0.9	0.2
*	*Romuleae minutiflora*	Onion grass	0	0.8	0	0	0	0.1	0
*	*Trifolium arvense*	Hares foot clover	0	0	0	0	0	0.3	0
*	*Sonchus oleraceus*	Milk thistle	0	0	0	0	0.2	0	0
*	*Bromus diandrus*	Great brome	0.2	0	0	0	0	0	0
	Herbage mass (kg DM/ha)		1919	2111	2129	1390	1552	2279	1354
	Percentage Green		51		74	5	3	23	83

Table A1.3: Mean percentage contribution to herbage mass (kg DM/ha) at each time of measurement in Paddock 3 (SSrest) on ‘Anama’.

	Botanical name	Common name	Oct '00	Jul '01	Nov '01	Nov '02	Nov '03	Nov '04	Nov ‘05
*	*Brachypodium distachyon*	False brome	20.5	43.0	20.6	16.9	11.0	42.1	6.7
	Themeda australis	Kangaroo grass	17.1	15.8	16.1	10.1	10.1	4.2	7.7
*	*Homeria flaccida*	Cape tulip	12.1	11.7	0.7	6.2	13.3	10.7	14.1
	Austrostipa spp.	Speargrass	15.3	14.1	6.5	11.3	10.9	4.3	3.5
*	*Avena barbata*	Wild oats	9.6	2.9	8.0	7.2	3.5	2.8	23.9
	Aristida behriana	Brush wiregrass	7.3	1.1	5.7	12.6	17.7	9.2	2.0
*	*Lolium multiflorum*	Ryegrass	2.9	0.2	6.6	5.3	3.3	12.3	12.5
*	*Scabiosa atropurpurea*	Pin cushion	7.6	4.4	8.5	11.0	3.6	2.0	4.2
*	*Trifolium angustifolium*	Narrow leaf clover	0.1	0.4	5.9	2.4	16.5	3.4	6.0
*	*Briza maxima*	Quaking grass	0.3	0.8	8.8	8.8	4.4	3.2	4.8
*	*Bromus molliformis*	Soft brome	2.0	0.5	5.3	6.6	0	0.3	1.9
*	*Plantago lanceolata*	Lamb's tongue	1.7	0.5	3.3	1.5	0.2	0	3.8
	Austrodanthonia spp.	Wallaby grass	0	1.6	1.6	0	2.1	2.3	1.4
	Acaena echinata	Sheep's burr	1.9	1.1	1.2	0.2	1.4	0.7	0.1
*	*Vulpia myuros*	Silver grass	0	0.1	0	0	0	1.2	2.6
*	*Trifolium campestre*	Hop clover	0	0	0.9	0	0.9	0.2	1.2
*	*Carthamus lanatus*	Saffron thistle	0	0	0	0	1.2	0.7	0
	Carex pumila	Sedge	0	0	0	0	0	0.3	1.0
*	*Bromus diandrus*	Great brome	1.3	0	0.1	0	0	0	0
	Dicanthium sericeum	Queensland blue grass	0	0.9	0	0	0	0	0
*	*Hordeum leporinum*	Barley grass	0	0	0	0	0	0	0.8
*	*Briza minor*	Small quaking grass	0	0	0	0	0	0	0.8
	Poa crassicaudex	Poa tussock	0	0.7	0	0	0	0	0
	Walwhalleya proluta	Homophilis	0	0	0	0	0	0	0.6
*	*Hypochaeris radicata*	Flatweed	0.2	0	0.1	0	0	0	0
	Dichopogon strictus	Chocolate lily	0.1	0.1	0	0	0	0	0
*	*Trifolium arvense*	Hare's foot clover	0	0	0	0	0	0	0.2
	Herbage mass (kg DM/ha)		2007	2172	3468	1696	2165	2033	1817
	Percentage Green		51		74	9	5	16	91

Table A1.4: Mean percentage contribution to herbage mass (kg DM/ha) at each time of measurement in Paddock 4 (SASrest) on ‘Anama’.

	Botanical name	Common name	Oct '00	Jul '01	Nov '01	Nov '02	Nov '03	Nov '04	Nov ‘05
*	*Brachypodium distachyon*	False brome	29.8	37.0	30.6	29.2	7.4	22.0	8.2
	Aristida behriana	Brush wiregrass	11.0	15.8	21.6	19.7	35.5	34.6	24.9
*	*Avena barbata*	Wild oats	13.9	11.4	11.8	19.1	4.6	7.8	14.4
*	*Homeria flaccida*	Cape tulip	20.3	20.8	1.7	3.7	11.6	8.4	9.8
*	*Trifolium angustifolium*	Narrow leaf clover	1.2	0.5	8.9	2.2	29.3	4.2	6.7
	Austrostipa spp.	Speargrass	10.0	4.4	6.1	14.5	4.2	3.3	5.1
	Themeda australis	Kangaroo grass	5.9	7.4	7.5	4.7	2.6	3.7	4.7
*	*Vulpia myuros*	Silver grass	1.4	0	0.4	0	0.2	5.6	6.9
*	*Scabiosa atropurpurea*	Pin cushion	1.1	0.8	3.9	2.7	0.9	2.0	2.3
*	*Lolium multiflorum*	Ryegrass	0	0	2.1	0	0.3	3.8	5.0
*	*Briza maxima*	Quaking grass	0.9	0	1.5	0.3	1.6	3.3	2.6
*	*Bromus molliformis*	Soft brome	1.9	0	1.3	2	0	0.3	3.2
*	*Trifolium campestre*	Hop clover	0.3	0	0.4	0	0.6	0	5.0
	Austrodanthonia spp.	Wallaby grass	0.7	0.6	0	1.1	0.3	0.6	0.2
*	*Plantago lanceolata*	Lamb's tongue	0.2	0	0.4	0.8	0.2	0	0
	Walwhalleya proluta	Homophilis	0	0.6	0.4	0	0	0	0
*	*Aira elegantissima*	Silver hair grass	0.1	0	0	0	0.1	0	0.8
*	*Onopordum acaulon*	Stemless thistle	0	0	0.8	0	0	0	0
*	*Hypochaeris radicata*	Flatweed	0	0.1	0	0	0.4	0	0
*	*Romuleae minutiflora*	Onion grass	0	0.5	0	0	0	0	0
	Oxalis perennans	Wood sorrel	0.2	0	0.1	0	0.2	0	0
*	*Bromus diandrus*	Great brome	0	0	0.4	0	0	0	0
	Dichopogon strictus	Chocolate lily	0.4	0	0	0	0	0	0
	Acaena echinata	Sheep's burr	0.3	0	0	0	0	0	0
	Maireana spp.	Bluebush	0	0	0	0	0	0	0.3
*	*Sonchus oleraceus*	Milk thistle	0.2	0	0	0	0	0	0
*	*Carthamus lanatus*	Saffron thistle	0	0	0	0	0.1	0	0
	Herbage mass (kg DM/ha)		1915	2131	3611	1653	1902	1880	1934
	Percentage Green		51		72	6	5	16	80

Table A1.5: Mean percentage contribution to herbage mass (kg DM/ha) at each time of measurement in Paddock 5 (HDSD) on ‘Anama’.

	Botanical name	Common name	Oct '00	Jul '01	Nov '01	Nov '02	Nov '03	Nov '04	Nov ‘05
*	*Avena barbata*	Wild oats	20.7	31.1	23.0	9.5	9.1	9.2	1.9
	Austrostipa spp.	Speargrass	14.8	18.8	5.8	17.0	16.1	14.3	13.9
*	*Hordeum leporinum*	Barley grass	15.6	8.4	6.6	22.8	13.5	16.7	16.7
*	*Vulpia myuros*	Silver grass	12.8	4.6	1.8	4.1	12.4	21.7	31.4
*	*Lolium multiflorum*	Ryegrass	4.0	11.9	32.0	8.9	6.4	3.3	2.9
*	*Brachypodium distachyon*	False brome	8.4	2.6	3.0	2.7	4.5	21.5	13.4
*	*Homeria flaccida*	Cape tulip	13.0	11.7	0.2	2.2	2.1	3.4	11.6
	Aristida behriana	Brush wiregrass	0.9	1.9	2.9	12.7	12.5	4.5	2.3
*	*Bromus molliformis*	Soft brome	1.8	0	10.0	12.4	0.9	2.7	1.0
*	*Trifolium angustifolium*	Narrow leaf clover	0.3	0.3	6.4	2.0	11.9	0.3	2.0
*	*Poa bulbosa*	Bulbous poa	0.2	0.2	0	0.2	6.8	1.2	0.7
*	*Echium plantagineum*	Salvaltion Jane	2.1	3.3	1.7	0.2	0	0.1	0.5
*	*Trifolium campestre*	Hop clover	0.3	0	3.0	0	1.0	0.1	0.8
*	*Scabiosa atropurpurea*	Pin cushion	0.4	1.6	0.5	1.9	0.3	0	0.1
*	*Hypochaeris radicata*	Flatweed	0.5	0.5	2.5	1	0.1	0	0.1
*	*Bromus diandrus*	Great brome	1.5	0	0	0.6	0.7	0	0
	Austrodanthonia spp.	Wallaby grass	0	1.1	0.1	1.1	0	0	0.1
*	*Onopordum acaulon*	Stemless thistle	0.7	0	0	0	0.2	1.0	0.5
*	*Arctotheca calendula*	Cape weed	1.1	0.6	0	0	0	0.1	0
*	*Briza maxima*	Quaking grass	0.1	0	0.4	0.5	0.4	0	0
*	*Erodium brachycarpum*	Geranium	0.3	0.9	0	0	0.3	0	0
	Themeda australis	Kangaroo grass	0	0	0	0	0.7	0	0
*	*Trifolium arvense*	Hair's foot clover	0.1	0	0.3	0	0	0	0.2
	Acaena echinata	Sheep's burr	0.2	0.3	0	0	0	0	0.1
*	*Romuleae minutiflora*	Onion grass	0	0.3	0	0	0	0	0
	Poa crassicaudeaux	Poa tussock	0.2	0	0	0	0	0	0
	Convulvulus erubescens	Bindweed	0.1	0.1	0	0	0	0	0
*	*Gynandriris setifolia*	Thread iris	0	0	0	0.1	0	0	0
	Herbage mass (kg DM/ha)		2331	2792	4087	1524	2391	1931	2647
	Percentage Green		51		86	5	4	28	88

Table A1.6: Mean percentage contribution to herbage mass (kg DM/ha) at each time of measurement in Paddock 6 (NIL graze) on ‘Anama’.

	Botanical name	Common name	Oct '00	Jul '01	Nov '01	Nov '02	Nov '03	Nov '04	Nov ‘05
	Austrostipa spp.	Speargrass	22.7	19.6	11.8	23.1	19.7	21.9	21.4
*	*Brachypodium distachyon*	False brome	21.3	20.7	37.9	14.9	8.3	10.1	11.0
*	*Avena barbata*	Wild oats	12.3	20.2	18.1	21.8	9.3	18.0	8.1
	Aristida behriana	Brush wiregrass	4.6	9.8	11.9	10.7	18.1	16.1	10.3
*	*Scabiosa atropurpurea*	Pin cushion	2.2	8.5	10.0	14.2	13.4	15.6	13.1
*	*Homeria flaccida*	Cape tulip	29.9	16.0	0.4	1.3	3.9	11.2	10.4
	Litter		0	0	0	0	19.9	0	12.2
*	*Plantago lanceolata*	Lamb's tongue	1.7	2.9	3.7	5.4	1.4	1.0	1.8
	Acaena echinata	Sheep's burr	1.3	0.5	1.1	2.1	2.3	2.0	4.0
*	*Haloragis actangula*		0	1.4	2	3.4	0	1.6	3.5
*	*Trifolium angustifolium*	Narrow leaf clover	0.9	0.1	0.5	0.1	0.8	1.1	0.5
	Themeda australis	Kangaroo grass	1.0	0.4	1.8	0	0	0	0.5
*	*Lolium multiflorum*	Ryegrass	0.2	0	0.2	0.8	0.1	0.2	1.6
*	*Echium plantagineum*	Salvation Jane	0	0	0	0	3.0	0	0
	Lomandra spp.	Matrush	0	0	0	1.4	0	0.6	0
	Austrodanthonia spp.	Wallaby grass	0.1	0	0.4	0.6	0	0	0.4
*	*Briza maxima*	Quaking grass	0	0	0	0.2	0	0.5	0.7
*	*Aira elegantissima*	Silver hair grass	0.6	0	0	0	0	0	0
*	*Vulpia myuros*	Silver grass	0.6	0	0	0	0	0	0
*	*Trifolium campestre*	Hop clover	0.1	0	0.1	0	0	0.1	0.2
*	*Bromus diandrus*	Great brome	0	0	0	0	0	0	0.2
*	*Hypochaeris radicata*	Flatweed	0	0	0	0	0	0	0.1
*	*Oxalis perennans*	Wood sorrel	0	0	0	0	0	0	0.1
*	*Romuleae minutiflora*	Onion grass	0.1	0.1	0	0	0	0	0
*	*Bromus molliformis*	Soft brome	0	0	0	0.1	0	0	0
	Convulvulus erubescens	Bindweed	0.1	0	0	0	0	0	0
	Plantago spp.	Plantain	0	0	0.1	0	0	0	0
	Herbage mass (kg DM/ha)		2197	2131	4451	2573	2587	2545	2970
	Percentage Green		51		68	8	4	9	61

Table A1.7: Mean herbage mass (kg DM/ha) at each time of measurement in Paddock 1 (Srest) on ‘Anama’.

	Botanical name	Common name	Oct '00	Jul '01	Nov '01	Nov '02	Nov '03	Nov '04	Nov ‘05
*	*Brachypodium distachyon*	False brome	420	524	698	282	225	955	69
	Aristida behriana	Brush wiregrass	344	243	465	396	458	251	182
*	*Avena barbata*	Wild oats	306	562	217	63	54	93	423
	Austrostipa spp.	Speargrass	308	257	301	139	52	48	142
*	*Homeria flaccida*	Cape tulip	68	105	98	121	171	162	166
*	*Trifolium angustifolium*	Narrow leaf clover	2	34	49	15	248	223	53
*	*Vulpia myuros*	Silver grass	6	0	29	19	9	184	291
	Austrodanthonia spp.	Wallaby grass	118	69	66	60	31	71	27
*	*Carthamus lanatus*	Saffron thistle	0	0	9	48	210	30	2
*	*Scabiosa atropurpurea*	Pin cushion	86	32	73	35	11	13	50
*	*Briza maxima*	Quaking grass	68	0	18	15	15	39	64
	Themeda australis	Kangaroo grass	44	51	42	35	28	13	2
*	*Trifolium campestre*	Hop clover	8	0	44	0	8	19	72
*	*Bromus molliformis*	Soft brome	23	0	25	22	0	4	30
	Carex pumila	Sedge	38	22	22	3	14	0	0
*	*Plantago lanceolata*	Lamb's tongue	51	2	18	6	0	0	14
*	*Romuleae minutiflora*	Onion grass	0	61	0	6	0	0	0
*	*Lolium multiflorum*	Ryegrass	0	0	33	0	0	30	5
	Dicanthium sericeum	Qld blue grass	0	6	0	17	0	0	0
*	*Aira elegantissima*	Silver hair grass	6	0	0	0	0	24	5
	Walwhalleya proluta	Homophilis	6	8	7	8	0	0	0
	Oxalis perennans	Wood sorrel	0	0	4	0	0	2	0
*	*Erodium brachycarpum*	Geranium	0	4	0	0	0	0	0
	Acaena echinata	Sheep's burr	2	0	0	0	0	0	0
*	*Arctotheca calendula*	Cape weed	2	0	0	0	0	0	0
*	*Trifolium arvense*	Hare's foot clover	0	0	0	0	0	0	2
	Herbage mass (kg DM/ha)		1901	1979	2216	1286	1531	2161	1597
	Percentage Green		51		72	13	4	32	79

Table A1.8: Mean herbage mass (kg DM/ha) at each time of measurement in Paddock 2 (SArest) on ‘Anama’.

	Botanical name	Common name	Oct '00	Jul '01	Nov '01	Nov '02	Nov '03	Nov '04	Nov ‘05
*	*Brachypodium distachyon*	False brome	426	705	334	142	163	716	47
	Austrostipa spp.	Speargrass	436	486	330	313	118	107	99
*	*Avena barbata*	Wild oats	355	386	430	95	59	198	181
*	*Homeria flaccida*	Cape tulip	129	264	32	161	433	98	242
*	*Bromus molliformis*	Soft brome	125	0	449	179	39	344	195
	Aristida behriana	Brush wiregrass	90	63	247	240	188	137	97
*	*Trifolium angustifolium*	Narrow leaf clover	13	6	47	42	340	207	72
*	*Vulpia myuros*	Silver grass	36	6	0	50	0	187	309
	Austrodanthonia spp.	Wallaby grass	71	95	66	47	0	66	0
*	*Lolium multiflorum*	Ryegrass	23	17	47	0	43	66	66
*	*Carthamus lanatus*	Saffron thistle	31	0	0	0	124	57	1
*	*Briza maxima*	Quaking grass	81	0	32	3	22	21	22
	Walwhalleya proluta	Homophilis	54	13	38	28	2	0	0
*	*Scabiosa atropurpurea*	Pin cushion	13	4	15	17	16	18	5
*	*Gynandriris setifolia*	Thread Iris	0	49	6	3	0	0	0
*	*Phalaris aquatica*	Phalaris	0	2	6	21	0	21	0
*	*Trifolium campestre*	Hop clover	0	2	17	0	5	7	14
*	*Plantago lanceolata*	Lamb's tongue	29	0	15	0	0	0	0
	Dicanthium sericeum	Qld blue grass	4	0	17	13	0	0	0
	Themeda australis	Kangaroo grass	4	0	0	19	0	0	0
	Convulvulus erubescens	Bindweed	0	0	0	18	0	0	0
	Oxalis perennans	Wood sorrel	0	0	0	1	0	21	3
*	*Romuleae minutiflora*	Onion grass	0	17	0	0	0	2	0
*	*Trifolium arvense*	Hares foot clover	0	0	0	0	0	7	0
*	*Sonchus oleraceus*	Milk thistle	0	0	0	0	3	0	0
*	*Bromus diandrus*	Great brome	4	0	0	0	0	0	0
	Herbage mass (kg DM/ha)		1919	2111	2129	1390	1552	2279	1354
	Percentage Green		51		74	5	3	23	83

Table A1.9: Mean herbage mass (kg DM/ha) at each time of measurement in Paddock 3 (SSrest) on ‘Anama’.

	Botanical name	Common name	Oct '00	Jul '01	Nov '01	Nov '02	Nov '03	Nov '04	Nov ‘05
*	*Brachypodium distachyon*	False brome	411	934	714	287	238	856	122
	Themeda australis	Kangaroo grass	343	343	558	171	219	85	140
*	*Homeria flaccida*	Cape tulip	243	254	24	105	288	218	256
	Austrostipa spp.	Speargrass	307	306	225	192	236	87	64
*	*Avena barbata*	Wild oats	193	63	277	122	76	57	434
	Aristida behriana	Brush wiregrass	147	24	198	214	383	187	36
*	*Lolium multiflorum*	Ryegrass	58	4	229	90	71	250	227
*	*Scabiosa atropurpurea*	Pin cushion	153	96	295	187	78	41	76
*	*Trifolium angustifolium*	Narrow leaf clover	2	9	205	41	357	69	109
*	*Briza maxima*	Quaking grass	6	17	305	149	95	65	87
*	*Bromus molliformis*	Soft brome	40	11	184	112	0	6	35
*	*Plantago lanceolata*	Lamb's tongue	34	11	114	25	4	0	69
	Austrodanthonia spp.	Wallaby grass	0	35	55	0	45	47	25
	Acaena echinata	Sheep's burr	38	24	42	3	30	14	2
*	*Vulpia myuros*	Silver grass	0	2	0	0	0	24	47
*	*Trifolium campestre*	Hop clover	0	0	31	0	19	4	22
*	*Carthamus lanatus*	Saffron thistle	0	0	0	0	26	14	0
	Carex pumila	Sedge	0	0	0	0	0	6	18
*	*Bromus diandrus*	Great brome	26	0	3	0	0	0	0
	Dicanthium sericeum	Qld blue grass	0	20	0	0	0	0	0
*	*Hordeum leporinum*	Barley grass	0	0	0	0	0	0	15
*	*Briza minor*	Small quaking grass	0	0	0	0	0	0	15
	Poa crassicaudex	Poa tussock	0	15	0	0	0	0	0
	Walwhalleya proluta	Homophilis	0	0	0	0	0	0	11
*	*Hypochaeris radicata*	Flatweed	4	0	3	0	0	0	0
	Dichopogon strictus	Chocolate lily	2	2	0	0	0	0	0
*	*Trifolium arvense*	Hare's foot clover	0	0	0	0	0	0	4
	Herbage mass (kg DM/ha)		2007	2172	3468	1696	2165	2033	1817
	Percentage Green		51		74	9	5	16	91

Table A1.10: Mean herbage mass (kg DM/ha) at each time of measurement in Paddock 4 (SASrest) on ‘Anama’.

	Botanical name	Common name	Oct '00	Jul '01	Nov '01	Nov '02	Nov '03	Nov '04	Nov ‘05
*	*Brachypodium distachyon*	False brome	571	788	1105	483	141	414	159
	Aristida behriana	Brush wiregrass	211	337	780	326	675	650	482
*	*Avena barbata*	Wild oats	266	243	426	316	87	147	278
*	*Homeria flaccida*	Cape tulip	389	443	61	61	221	158	190
*	*Trifolium angustifolium*	Narrow leaf clover	23	11	321	36	557	79	130
	Austrostipa spp.	Speargrass	192	94	220	240	80	62	99
	Themeda australis	Kangaroo grass	113	158	271	78	49	70	91
*	*Vulpia myuros*	Silver grass	27	0	14	0	4	105	133
*	*Scabiosa atropurpurea*	Pin cushion	21	17	141	45	17	38	44
*	*Lolium multiflorum*	Ryegrass	0	0	76	0	6	71	97
*	*Briza maxima*	Quaking grass	17	0	54	5	30	62	50
*	*Bromus molliformis*	Soft brome	36	0	47	33	0	6	62
*	*Trifolium campestre*	Hop clover	6	0	14	0	11	0	97
	Austrodanthonia spp.	Wallaby grass	13	13	0	18	6	11	4
*	*Plantago lanceolata*	Lamb's tongue	4	0	14	13	4	0	0
	Walwhalleya proluta	Homophilis	0	13	14	0	0	0	0
*	*Aira elegantissima*	Silver hair grass	2	0	0	0	2	0	15
*	*Onopordum acaulon*	Stemless thistle	0	0	29	0	0	0	0
*	*Hypochaeris radicata*	Flatweed	0	2	0	0	8	0	0
*	*Romuleae minutiflora*	Onion grass	0	11	0	0	0	0	0
	Oxalis perennans	Wood sorrel	4	0	4	0	4	0	0
*	*Bromus diandrus*	Great brome	0	0	14	0	0	0	0
	Dichopogon strictus	Chocolate lily	8	0	0	0	0	0	0
	Acaena echinata	Sheep's burr	6	0	0	0	0	0	0
	Maireana spp.	Bluebush	0	0	0	0	0	0	6
*	*Sonchus oleraceus*	Milk thistle	4	0	0	0	0	0	0
*	*Carthamus lanatus*	Saffron thistle	0	0	0	0	2	0	0
	Herbage mass (kg DM/ha)		1915	2131	3611	1653	1902	1880	1934
	Percentage Green		51		72	6	5	16	80

Table A1.11: Mean herbage mass (kg DM/ha) at each time of measurement in Paddock 5 (HDSD) on ‘Anama’.

	Botanical name	Common name	Oct '00	Jul '01	Nov '01	Nov '02	Nov '03	Nov '04	Nov ‘05
*	*Avena barbata*	Wild oats	483	868	940	145	218	178	50
	Austrostipa spp.	Speargrass	345	525	237	259	385	276	368
*	*Hordeum leporinum*	Barley grass	364	235	270	347	323	322	442
*	*Vulpia myuros*	Silver grass	298	128	74	62	296	419	831
*	*Lolium multiflorum*	Ryegrass	93	332	1308	136	153	64	77
*	*Brachypodium distachyon*	False brome	196	73	123	41	108	415	355
*	*Homeria flaccida*	Cape tulip	303	327	8	34	50	66	307
	Aristida behriana	Brush wiregrass	21	53	119	194	299	87	61
*	*Bromus molliformis*	Soft brome	42	0	409	189	22	52	26
*	*Trifolium angustifolium*	Narrow leaf clover	7	8	262	30	285	6	53
*	*Poa bulbosa*	Bulbous poa	5	6	0	3	163	23	19
*	*Echium plantagineum*	Salvaltion Jane	49	92	69	3	0	2	13
*	*Trifolium campestre*	Hop clover	7	0	123	0	24	2	21
*	*Scabiosa atropurpurea*	Pin cushion	9	45	20	29	7	0	3
*	*Hypochaeris radicata*	Flatweed	12	14	102	15	2	0	3
*	*Bromus diandrus*	Great brome	35	0	0	9	17	0	0
	Austrodanthonia spp.	Wallaby grass	0	31	4	17	0	0	3
*	*Onopordum acaulon*	Stemless thistle	16	0	0	0	5	19	13
*	*Arctotheca calendula*	Cape weed	26	17	0	0	0	2	0
*	*Briza maxima*	Quaking grass	2	0	16	8	10	0	0
*	*Erodium brachycarpum*	Geranium	7	25	0	0	7	0	0
	Themeda australis	Kangaroo grass	0	0	0	0	17	0	0
*	*Trifolium arvense*	Hair's foot clover	2	0	12	0	0	0	5
	Acaena echinata	Sheep's burr	5	8	0	0	0	0	3
*	*Romuleae minutiflora*	Onion grass	0	8	0	0	0	0	0
	Poa crassicaudeaux	Poa tussock	5	0	0	0	0	0	0
	Convulvulus erubescens	Bindweed	2	3	0	0	0	0	0
*	*Gynandriris setifolia*	Thread iris	0	0	0	2	0	0	0
	Herbage mass (kg DM/ha)		2331	2792	4087	1524	2391	1931	2647
	Percentage Green		51		86	5	4	28	88

Table A1.12: Mean herbage mass (kg DM/ha) at each time of measurement in Paddock 6 (Nil graze) on ‘Anama’.

	Botanical name	Common name	Oct '00	Jul '01	Nov '01	Nov '02	Nov '03	Nov '04	Nov ‘05
	Austrostipa spp.	Speargrass	499	418	525	594	510	557	636
*	*Brachypodium distachyon*	False brome	468	441	1687	383	215	257	327
*	*Avena barbata*	Wild oats	270	430	806	561	241	458	241
	Aristida behriana	Brush wiregrass	101	209	530	275	468	410	306
*	*Scabiosa atropurpurea*	Pin cushion	48	181	445	365	347	397	389
*	*Homeria flaccida*	Cape tulip	657	341	18	33	101	285	309
	Litter		0	0	0	0	515	0	362
*	*Plantago lanceolata*	Lamb's tongue	37	62	165	139	36	25	53
	Acaena echinata	Sheep's burr	29	11	49	54	60	51	119
*	*Haloragis actangula*		0	30	89	87	0	41	104
*	*Trifolium angustifolium*	Narrow leaf clover	20	2	22	3	21	28	15
	Themeda australis	Kangaroo grass	22	9	80	0	0	0	15
*	*Lolium multiflorum*	Ryegrass	4	0	9	21	3	5	48
*	*Echium plantagineum*	Salvation Jane	0	0	0	0	78	0	0
	Lomandra spp.	Matrush	0	0	0	36	0	15	0
	Austrodanthonia spp.	Wallaby grass	2	0	18	15	0	0	12
*	*Briza maxima*	Quaking grass	0	0	0	5	0	13	21
*	*Aira elegantissima*	Silver hair grass	13	0	0	0	0	0	0
*	*Vulpia myuros*	Silver grass	13	0	0	0	0	0	0
*	*Trifolium campestre*	Hop clover	2	0	4	0	0	3	6
*	*Bromus diandrus*	Great brome	0	0	0	0	0	0	6
*	*Hypochaeris radicata*	Flatweed	0	0	0	0	0	0	3
*	*Oxalis perennans*	Wood sorrel	0	0	0	0	0	0	3
*	*Romuleae minutiflora*	Onion grass	2	2	0	0	0	0	0
*	*Bromus molliformis*	Soft brome	0	0	0	3	0	0	0
	Convulvulus erubescens	Bindweed	2	0	0	0	0	0	0
	Plantago spp.	Plantain	0	0	4	0	0	0	0
	Herbage mass (kg DM/ha)		2197	2131	4451	2573	2587	2545	2970
	Percentage Green		51		68	8	4	9	61

APPENDIX 2

Presence and absence data expressed as percentage frequency (Table A2.1-A2.6).

Table A2.1: Percentage species frequency at each time of measurement in Paddock 1 (Srest) on 'Anama'

	Botanical Name	Common Name	Oct '00	Jul '01	Nov '01	Nov '02	Nov '03	Nov '04	Nov '05
*	*Brachypodium distachyon*	False brome	92	96	100	78	98	94	94
*	*Avena barbata*	Wild oats	84	84	98	96	92	94	92
*	*Homeria flaccida*	Cape tulip	64	88	82	84	92	98	100
*	*Trifolium angustifolium*	Narrow leaf clover	78	72	72	84	98	100	96
	Aristida behriana	Brush wiregrass	78	72	90	88	86	88	82
	Cryptogams	Lichen & mosses	54	76	78	78	86	86	86
*	*Trifolium campestre*	Hop clover	62	30	62	42	94	92	92
	Austrostipa blackii	Crested speargrass	58	56	64	56	68	60	70
*	*Aira elegantissima*	Silver hair grass	54	0	28	20	52	78	82
*	*Scabiosa atropurpurea*	Pincushion	36	42	44	42	40	38	38
*	*Vulpia myuros*	Silver grass	12	8	10	18	52	80	82
*	*Romulae minutiflora*	Onion grass	24	30	22	32	46	54	44
	Austrodanthonia eriantha	Hill wallaby grass	32	20	16	28	34	36	26
*	*Carthamus lanatus*	Saffron thistle	18	2	2	32	54	38	32
*	*Briza maxima*	Quaking grass	26	2	26	22	30	32	32
	Austrodanthonia tenuior	Wallaby grass	12	10	30	26	32	26	30
*	*Bromus molliformis*	Soft brome	10	14	14	24	16	20	28
*	*Anagalis arvensis*	Blue pimpernel	20	10	16	6	24	12	34
*	*Lolium multiflorum*	Rye grass	6	4	18	14	24	26	26
*	*Plantago lanceolata*	Lambs tongue	14	12	18	16	24	14	20
*	*Oxalis perennans*	Wood sorrel	12	10	16	14	10	12	10
*	*Erodium brachycarpum*	Geranium / Heronsbill	16	10	2	10	0	12	26
	Carex pumila	Sedge	14	8	10	8	12	0	6
*	*Trifolium arvense*	Hares foot clover	2	14	8	0	0	8	22
	Austrostipa gibbosa	Swollen speargrass	2	0	2	4	12	10	18
	Themeda australis	Kangaroo grass	8	8	8	8	8	4	2
*	*Sonchus oleraceus*	Sow thistle	0	0	4	2	20	0	12
*	*Trifolium glomeratum*	Ball clover	0	0	0	4	8	12	14
	Stackhousia monogyna	Creamy candles	6	6	6	6	4	0	0
*	*Gyandriris setifolia*	Thread iris	0	0	2	2	10	4	8
*	*Hypochaeris radicata*	Cat's ear	0	2	0	0	0	0	22
	Walwhalleya proluta	Homophilus	2	2	2	6	6	4	0
	Acaena echinata	Sheep's burr	2	2	2	2	2	4	4
*	*Hedypnois rhagadioloides*	Cretan weed	0	0	4	2	2	2	8
*	*Spergularia rubra*	Red sandspurry	2	0	2	6	4	2	0
	Chamaesyce drummondii	Caustic weed	4	0	2	0	4	2	0
	Dichanthium sericeum	Queensland blue grass	0	2	6	2	2	0	0
	Maireana villosa	Hairy bluebush	2	0	0	4	2	2	2
*	*Arctotheca calendula*	Cape weed	0	0	0	0	4	4	2
*	*Briza minor*	Lesser quaking grass	4	0	0	0	0	2	4
*	*Petrorhagia velutina*	Proliferous pink	6	0	2	0	0	0	0
	Austrostipa trichophylla	Corkscrew grass	0	0	0	0	4	2	2
*	*Galium murale*	Small bedstraw	0	0	0	0	0	0	6
*	*Bromus rubens*	Red brome	0	0	4	0	0	0	0
*	*Bromus diandrus*	Great brome	0	0	2	0	0	0	0

Table A2.1 continued

	Botanical Name	Common Name	Oct '00	Jul '01	Nov '01	Nov '02	Nov '03	Nov '04	Nov '05
	Convulvulus erubescens	Bindweed	0	0	0	0	0	2	0
	Crassula sieberiana	Australian stonecrop	0	0	0	0	0	0	2
	Austrodanthonia caespitosa	Wallaby grass	0	0	2	0	0	0	0
	Dichopogon strictus	Chocolate lily	2	0	0	0	0	0	0
*	*Echium plantagineum*	Salvation Jane	0	0	0	0	0	2	0
	Glycine clandestrina	Twining glycine	0	0	0	0	2	0	0
	Maireana spp.	Bluebush	0	0	0	2	0	0	0
*	*Neatostema apulum*	Hairy sheepweed	0	0	0	0	2	0	0
	Sida spp.	Sida	0	0	0	2	0	0	0
	Austrostipa nodosa	Tall speargrass	0	0	0	0	2	0	0
-	Unknown Forb		0	0	8	0	8	12	16
	Unknown Asteraceae		4	0	0	0	2	4	2
	Total number of species recorded		36	29	40	37	42	40	40
	Mean number of species per transect		21.2	16.4	21.4	22.0	24.8	24.2	25.2

Table A2.2: Percentage species frequency at each time of measurement in Paddock 2 (SArest) on ‘Anama’

	Botanical Name	Common Name	Oct '00	Jul '01	Nov '01	Nov '02	Nov '03	Nov '04	Nov ‘05
*	*Avena barbata*	Wild oats	96	90	96	78	96	88	88
*	*Trifolium angustifolium*	Narrow leaf clover	70	64	66	90	98	96	96
*	*Brachypodium distachyon*	False brome	62	74	78	64	86	90	80
*	*Homeria flaccida*	Cape tulip	64	72	60	78	76	74	84
	Cryptogams	Lichen & mosses	40	76	60	60	68	64	74
*	*Trifolium campestre*	Hop clover	68	30	50	26	74	68	66
	Austrostipa blackii	Crested speargrass	56	48	62	50	56	52	56
	Aristida behriana	Brush wiregrass	56	44	48	60	62	52	56
*	*Bromus molliformis*	Soft brome	52	20	62	48	56	68	62
*	*Lolium multiflorum*	Rye grass	30	24	40	4	42	52	48
*	*Romulae minutiflora*	Onion grass	20	18	22	30	50	54	36
*	*Vulpia myuros*	Silver grass	12	16	22	20	44	48	48
*	*Scabiosa atropurpurea*	Pincushion	16	22	24	26	34	32	26
*	*Carthamus lanatus*	Saffron thistle	28	4	0	16	40	38	28
*	*Erodium brachycarpum*	Geranium / Heronsbill	28	22	12	14	12	20	20
*	*Gyandriris setifolia*	Thread iris	16	12	6	20	22	16	30
	Austrodanthonia tenuior	Wallaby grass	14	12	10	20	14	10	10
	Walwhalleya proluta	Homophilus	18	12	16	10	20	4	4
*	*Aira elegantissima*	Silver hair grass	14	0	0	0	18	28	18
*	*Briza maxima*	Quaking grass	12	0	12	16	12	12	14
*	*Trifolium glomeratum*	Ball clover	8	0	0	0	20	18	26
*	*Sonchus oleraceus*	Sow thistle	4	2	2	2	12	22	24
*	*Trifolium arvense*	Hares foot clover	4	0	0	0	22	20	16
	Austrodanthonia eriantha	Hill wallaby grass	2	4	12	8	12	8	10
	Austrostipa trichophylla	Corkscrew grass	20	14	6	6	4	0	2
*	*Oxalis perennans*	Wood sorrel	6	6	6	6	6	6	4
*	*Hypochaeris glabra*	Smooth cat's ear	6	8	6	2	4	4	6
*	*Anagalis arvensis*	Blue pimpernel	12	0	2	0	4	8	6
*	*Bromus diandrus*	Great brome	4	0	4	0	4	18	0
*	*Plantago lanceolata*	Lambs tongue	4	6	4	6	2	6	2
*	*Bromus rubens*	Red brome	4	0	10	4	0	8	0
	Austrostipa gibbosa	Swollen speargrass	0	6	4	4	4	4	4
*	*Arctotheca calendula*	Cape weed	2	2	0	0	4	4	12
*	*Spergularia rubra*	Red sandspurry	2	0	0	0	6	12	0
	Convulvulus erubescens	Bindweed	4	2	2	2	0	2	2
	Maireana villosa	Hairy bluebush	2	0	0	4	2	4	2
*	*Trifolium scabrum*	Rough clover	0	0	0	0	4	4	6
	Chamaesyce drummondii	Caustic weed	0	0	0	0	8	4	0
*	*Hypochaeris radicata*	Cat's ear	0	0	0	0	0	0	12
*	*Phalaris aquatica*	Phalaris	0	2	2	2	2	2	0
	Themeda australis	Kangaroo grass	2	0	0	4	2	0	2
	Dichanthium sericeum	Queensland blue grass	2	0	2	2	2	0	0
*	*Carduus tenuiflorus*	Slender thistle	0	0	0	0	4	2	0
*	*Hedypnois rhagadioloides*	Cretan weed	0	0	2	0	2	2	0
*	*Rapistrum rugosum*	Turnip	0	0	0	0	6	0	0
	Schoenus apogon	Bog rush	0	4	0	0	0	0	2
*	*Briza minor*	Lesser quaking grass	0	0	0	0	0	2	2
*	*Bromus alopecurus*	Curly brome	0	0	0	0	0	4	0
*	*Cirsium vulgare*	Spearthistle	0	0	0	0	4	0	0
	Dichopogon strictus	Chocolate lily	2	2	0	0	0	0	0
	Sida spp.	Sida	0	0	0	2	2	0	0

Table A2.2 continued

	Botanical Name	Common Name	Oct '00	Jul '01	Nov '01	Nov '02	Nov '03	Nov '04	Nov '05
	Sida corrugata	Sida	2	0	0	0	2	0	0
*	*Trifolium hirtum*	Rose clover	4	0	0	0	0	0	0
	Asperula conferta	Common woodruff	2	0	0	0	0	0	0
	Crassula sieberiana	Australian stonecrop	2	0	0	0	0	0	0
	Elymus scaber	Wheatgrass	0	0	0	0	2	0	0
*	*Galium murale*	Small bedstraw	0	0	0	0	0	0	2
*	*Onopordum acaulon*	Stemless thistle	2	0	0	0	0	0	0
*	*Paronychia brasiliana*	Chilean whitlow	0	0	0	0	0	0	2
*	*Poa bulbosa*	Bulbous poa	0	0	0	0	0	0	2
*	*Poa crassicaudex*	Poa tussock	0	0	0	0	0	0	2
*	*Silene nocturna*	Catchfly	0	0	2	0	0	0	0
-	Unknown Forb		0	0	0	0	0	2	4
-	Unknown annual grass		0	0	0	0	0	0	2
	Total number of species recorded		43	30	33	33	46	43	44
	Mean number of species per transect		21.8	16.6	17.4	17.8	23.4	23.2	22.4

Table A2.3: Percentage species frequency at each time of measurement in Paddock 3 (SSrest) on ‘Anama’.

	Botanical Name	Common Name	Oct '00	Jul '01	Nov '01	Nov '02	Nov '03	Nov '04	Nov ‘05
*	*Brachypodium distachyon*	False brome	90	98	100	92	98	98	100
*	*Homeria flaccida*	Cape tulip	96	100	68	98	100	100	100
*	*Avena barbata*	Wild oats	70	90	96	98	82	94	100
*	*Trifolium angustifolium*	Narrow leaf clover	56	44	64	66	94	94	88
	Aristida behriana	Brush wiregrass	54	54	60	64	76	72	74
*	*Scabiosa atropurpurea*	Pincushion	44	58	58	64	68	62	74
	Cryptogams	Lichen & mosses	32	74	30	40	50	74	62
*	*Lolium multiflorum*	Rye grass	22	26	52	42	54	80	84
	Austrostipa blackii	Crested speargrass	44	50	46	48	56	62	54
*	*Trifolium campestre*	Hop clover	36	10	50	30	68	48	76
*	*Romulae minutiflora*	Onion grass	24	20	8	32	52	60	54
*	*Briza maxima*	Quaking grass	34	10	24	42	44	46	46
	Themeda australis	Kangaroo grass	26	28	32	24	34	24	28
*	*Plantago lanceolata*	Lambs tongue	20	26	24	24	32	26	34
*	*Bromus molliformis*	Soft brome	26	16	26	24	16	24	36
*	*Vulpia myuros*	Silver grass	8	20	8	14	8	42	52
	Austrodanthonia eriantha	Hill wallaby grass	6	16	16	14	20	24	20
	Austrostipa gibbosa	Swollen speargrass	0	0	22	22	28	22	16
	Acaena echinata	Sheep's burr	10	8	10	14	14	14	22
*	*Carthamus lanatus*	Saffron thistle	4	0	0	0	30	20	20
*	*Trifolium arvense*	Hares foot clover	0	0	6	0	20	18	24
*	*Briza minor*	Lesser quaking grass	4	0	2	6	8	16	16
*	*Erodium brachycarpum*	Geranium / Heronsbill	6	8	2	4	4	10	14
*	*Oxalis perennans*	Wood sorrel	10	8	4	2	8	6	8
*	*Aira elegantissima*	Silver hair grass	0	0	0	0	4	12	24
*	*Hypochaeris radicata*	Cat's ear	8	6	6	4	6	2	6
*	*Anagalis arvensis*	Blue pimpernel	2	0	2	0	4	2	24
	Austrodanthonia tenuior	Wallaby grass	0	2	6	6	4	6	8
*	*Bromus diandrus*	Great brome	8	2	6	0	8	4	2
*	*Sonchus oleraceus*	Sow thistle	0	4	2	0	4	0	4
*	*Gyandriris setifolia*	Thread iris	4	0	0	4	0	0	4
	Carex pumila	Sedge	0	0	0	2	2	2	4
	Austrodanthonia setacea	Small wallaby grass	2	8	0	0	0	0	0
	Austrostipa trichophylla	Corkscrew grass	6	4	0	0	0	0	0
	Dichopogon strictus	Chocolate lily	2	2	0	0	0	0	4
	Elymus scaber	Wheatgrass	0	0	4	0	2	0	2
*	*Poa crassicaudex*	Poa tussock	0	2	0	2	2	2	0
*	*Trifolium glomeratum*	Ball clover	0	0	0	0	4	4	0
*	*Echium plantagineum*	Salvation Jane	0	0	0	0	4	0	2
	Maireana spp.	Bluebush	0	0	0	2	0	2	2
*	*Arctotheca calendula*	Cape weed	0	0	0	0	2	2	0
*	*Bromus rubens*	Red brome	2	0	2	0	0	0	0
	Dichanthium sericeum	Queensland blue grass	2	2	0	0	0	0	0
*	*Hypochaeris glabra*	Smooth cat's ear	2	2	0	0	0	0	0
	Schoenus apogon	Bog rush	0	0	2	2	0	0	0
	Sida spp.	Sida	0	2	0	0	0	2	0
	Austrostipa nodosa	Tall speargrass	0	2	2	0	0	0	0
	Chamaesyce drummondii	Caustic weed	0	0	2	0	0	0	0

Table A2.3 continued

Botanical Name	Common Name	Oct '00	Jul '01	Nov '01	Nov '02	Nov '03	Nov '04	Nov '05
Daucus glochidiatus	Native carrot	0	2	0	0	0	0	0
Walwhalleya proluta	Homophilus	0	0	0	0	0	0	2
Total number of species recorded		32	33	33	29	36	35	37
Mean number of species per transect		18.6	18.4	18.6	18.6	22.4	23.0	25.0

Table A2.4: Percentage species frequency at each time of measurement in Paddock 4 (SASrest) on ‘Anama’.

	Botanical Name	Common Name	Oct '00	Jul '01	Nov '01	Nov '02	Nov '03	Nov '04	Nov ‘05
*	*Avena barbata*	Wild oats	90	92	100	100	100	100	100
	Aristida behriana	Brush wiregrass	86	92	96	96	94	96	90
*	*Homeria flaccida*	Cape tulip	78	100	64	96	96	100	94
*	*Brachypodium distachyon*	False brome	80	92	98	82	94	96	76
*	*Trifolium angustifolium*	Narrow leaf clover	70	66	68	74	98	98	96
	Cryptogams	Lichen & mosses	68	92	76	76	80	88	74
*	*Trifolium campestre*	Hop clover	54	28	54	20	94	96	98
	Austrostipa blackii	Crested speargrass	44	36	34	40	52	46	48
*	*Romulae minutiflora*	Onion grass	34	12	32	32	68	52	58
*	*Aira elegantissima*	Silver hair grass	36	0	18	4	32	58	74
*	*Lolium multiflorum*	Rye grass	10	2	28	10	28	46	34
*	*Bromus molliformis*	Soft brome	20	10	18	18	6	16	30
*	*Erodium brachycarpum*	Geranium / Heronsbill	28	20	8	6	2	18	32
*	*Scabiosa atropurpurea*	Pincushion	14	16	16	14	20	18	12
*	*Gyandriris setifolia*	Thread iris	18	2	2	12	26	6	36
	Austrostipa gibbosa	Swollen speargrass	4	0	16	20	22	22	18
	Themeda australis	Kangaroo grass	10	10	12	16	16	12	12
*	*Vulpia myuros*	Silver grass	8	6	6	2	10	24	28
*	*Briza maxima*	Quaking grass	12	0	10	14	14	14	16
	Austrodanthonia tenuior	Wallaby grass	8	14	2	18	14	8	10
*	*Plantago lanceolata*	Lambs tongue	10	6	12	8	10	8	8
*	*Oxalis perennans*	Wood sorrel	6	8	8	8	8	6	6
*	*Trifolium arvense*	Hares foot clover	10	2	6	0	0	14	14
	Acaena echinata	Sheep's burr	2	4	4	4	6	8	6
	Dichopogon strictus	Chocolate lily	12	16	0	0	0	0	4
*	*Hypochaeris radicata*	Cat's ear	6	2	2	2	2	0	14
*	*Arctotheca calendula*	Cape weed	0	4	0	0	4	6	4
*	*Carthamus lanatus*	Saffron thistle	2	0	0	0	8	4	2
*	*Trifolium glomeratum*	Ball clover	0	0	0	0	6	6	2
	Austrodanthonia eriantha	Hill wallaby grass	0	2	2	2	4	2	0
*	*Sonchus oleraceus*	Sow thistle	0	0	0	0	6	2	4
	Lomandra dura	Matrush	4	0	0	2	0	0	4
	Maireana spp.	Bluebush	2	0	0	4	0	0	2
*	*Bromus diandrus*	Great brome	4	0	2	0	0	0	0
	Elymus scaber	Wheatgrass	0	0	0	0	2	4	0
*	*Galium murale*	Small bedstraw	2	0	0	0	0	0	4
	Haloragis acutangula	Raspwort	2	0	2	0	0	0	2
	Austrostipa trichophylla	Corkscrew grass	4	0	0	2	0	0	0
*	*Anagalis arvensis*	Blue pimpernel	0	0	0	0	0	0	4
	Chamaesyce drummondii	Caustic weed	0	0	0	0	2	2	0
	Convulvulus erubescens	Bindweed	2	0	0	0	2	0	0
	Daucus glochidiatus	Native carrot	4	0	0	0	0	0	0
	Walwhalleya proluta	Homophilus	0	2	2	0	0	0	0
	Scaevola albida	Pale fan flower	0	0	0	0	2	2	0
*	*Briza minor*	Lesser quaking grass	0	0	0	0	0	0	2
*	*Cirsium vulgare*	Spearthistle	0	0	0	0	0	0	2
*	*Hypochaeris glabra*	Smooth cat's ear	2	0	0	0	0	0	0
	Maireana villosa	Hairy bluebush	2	0	0	0	0	0	0
*	*Neatostema apulum*	Hairy sheepweed	0	0	2	0	0	0	0

Table A2.4 continued

Botanical Name	Common Name	Oct '00	Jul '01	Nov '01	Nov '02	Nov '03	Nov '04	Nov '05
Unknown Asteraceae		4	0	0	0	0	0	2
Unknown Forb		0	2	0	0	0	0	0
Unknown		0	2	0	0	0	0	0
Total number of species recorded		38	28	30	28	33	32	38
Mean number of species per transect		20.0	15.0	17.2	16.4	19.6	19.4	21.6

Table A2.5: Percentage species frequency at each time of measurement in Paddock 5 (HDSD) on ‘Anama’.

	Botanical Name	Common Name	Oct '00	Jul '01	Nov '01	Nov '02	Nov '03	Nov '04	Nov ‘05
*	*Avena barbata*	Wild oats	74	92	88	86	78	82	92
*	*Lolium multiflorum*	Rye grass	70	98	100	92	86	82	62
*	*Trifolium angustifolium*	Narrow leaf clover	84	80	88	74	78	40	78
*	*Vulpia myuros*	Silver grass	50	78	74	60	66	92	94
*	*Homeria flaccida*	Cape tulip	54	84	64	74	64	72	74
	Austrostipa blackii	Crested speargrass	56	56	56	56	62	58	66
	Aristida behriana	Brush wiregrass	42	58	62	68	66	52	52
*	*Trifolium campestre*	Hop clover	56	46	86	28	68	26	90
*	*Brachypodium distachyon*	False brome	54	52	60	58	58	66	48
	Cryptogams	Lichen & mosses	44	66	52	54	60	48	58
*	*Bromus molliformis*	Soft brome	32	8	52	54	38	42	36
*	*Hordeum leporinum*	Barley grass	34	24	38	38	34	36	36
*	*Romulae minutiflora*	Onion grass	18	28	16	36	34	34	34
*	*Gyandriris setifolia*	Thread iris	12	2	6	44	22	36	48
*	*Erodium brachycarpum*	Geranium / Heronsbill	30	16	14	10	20	12	26
*	*Echium plantagineum*	Salvation Jane	14	12	12	8	52	2	22
*	*Arctotheca calendula*	Cape weed	24	20	16	0	26	6	20
*	*Hypochaeris radicata*	Cat's ear	8	12	20	18	16	8	18
*	*Scabiosa atropurpurea*	Pincushion	8	10	14	12	14	14	14
*	*Poa bulbosa*	Bulbous poa	10	10	6	10	8	14	10
*	*Trifolium arvense*	Hares foot clover	6	0	20	6	10	4	22
*	*Bromus diandrus*	Great brome	16	2	20	10	4	8	0
*	*Trifolium glomeratum*	Ball clover	2	0	26	6	14	2	10
*	*Briza maxima*	Quaking grass	8	0	8	8	8	8	8
	Acaena echinata	Sheep's burr	10	10	10	4	0	6	6
*	*Oxalis perennans*	Wood sorrel	8	10	8	4	0	2	6
	Austrostipa gibbosa	Swollen speargrass	0	0	0	8	10	10	10
*	*Erodium cicutarium*	Geranium / Storksbill	0	12	2	8	2	2	10
	Austrodanthonia eriantha	Hill wallaby grass	4	4	4	4	6	10	2
	Convulvulus erubescens	Bindweed	6	6	6	6	2	4	2
*	*Carthamus lanatus*	Saffron thistle	0	10	4	0	14	0	2
	Austrodanthonia tenuior	Wallaby grass	0	2	2	8	4	6	6
*	*Onopordum acaulon*	Stemless thistle	2	0	0	0	8	6	6
	Austrostipa trichophylla	Corkscrew grass	2	6	2	2	4	0	6
*	*Hypochaeris glabra*	Smooth cat's ear	2	4	2	0	2	2	6
*	*Sonchus oleraceus*	Sow thistle	0	2	4	2	2	0	4
*	*Plantago lanceolata*	Lambs tongue	2	2	0	2	0	2	0
*	*Spergularia rubra*	Red sandspurry	6	0	0	0	0	0	2
	Maireana villosa	Hairy bluebush	0	0	2	4	0	0	0
*	*Trifolium repens*	White clover	4	0	0	0	0	0	2
	Crassula sieberiana	Australian stonecrop	0	4	0	0	0	0	0
	Dichopogon strictus	Chocolate lily	2	2	0	0	0	0	0
*	*Poa crassicaudex*	Poa tussock	4	0	0	0	0	0	0
	Tricoryne elatior	Yellow rush lily	0	2	0	2	0	0	0
*	*Trifolium hirtum*	Rose clover	2	2	0	0	0	0	0
*	*Trifolium subteraneum*	Sub clover	0	0	0	0	0	2	2
*	*Briza minor*	Lesser quaking grass	0	0	0	0	0	0	2
*	*Bromus alopecurus*	Curly brome	0	0	0	0	0	2	0
	Chamaesyce drummondii	Caustic weed	0	0	0	0	2	0	0
*	*Cirsium vulgare*	Spearthistle	0	0	2	0	0	0	0
*	*Medicago minima*	Woolly burr medic	2	0	0	0	0	0	0

Table A25 continued

	Botanical Name	Common Name	Oct '00	Jul '01	Nov '01	Nov '02	Nov '03	Nov '04	Nov '05
*	*Polycarpon tetraphyllum*	Four leaf allseed	0	0	2	0	0	0	0
*	*Polygonum arenastrum*	Wire weed	0	0	2	0	0	0	0
	Rumex brownii	Dock	0	0	2	0	0	0	0
	Sida cunninghamii	Sida	0	0	0	0	0	0	2
*	*Trifolium scabrum*	Rough clover	0	0	0	0	0	0	2
-	Unknown Asteraceae		2	0	0	0	0	0	0
	Total number of species recorded		39	36	39	35	35	36	41
	Mean number of species per transect		20.6	18.2	21.8	19.8	21.4	20.0	22.4

Table A2.6: Percentage species frequency at each time of measurement in Paddock 6 (Nil graze) on ‘Anama’.

	Botanical Name	Common Name	Oct '00	Jul '01	Nov '01	Nov '02	Nov '03	Nov '04	Nov ‘05
*	*Avena barbata*	Wild oats	88	98	100	100	96	100	94
*	*Homeria flaccida*	Cape tulip	94	98	96	90	92	94	100
*	*Brachypodium distachyon*	False brome	88	100	98	84	96	94	96
	Cryptogams	Lichen & mosses	74	100	64	92	94	98	92
	Aristida behriana	Brush wiregrass	84	90	94	72	78	72	78
	Austrostipa blackii	Crested speargrass	62	68	64	68	66	64	62
*	*Trifolium angustifolium*	Narrow leaf clover	78	76	46	26	66	62	52
*	*Romulae minutiflora*	Onion grass	22	22	14	38	58	66	60
*	*Scabiosa atropurpurea*	Pincushion	30	32	30	36	46	44	60
*	*Trifolium campestre*	Hop clover	52	28	34	14	50	40	56
*	*Lolium multiflorum*	Rye grass	42	18	32	10	28	30	46
*	*Plantago lanceolata*	Lambs tongue	14	16	22	20	18	20	14
*	*Aira elegantissima*	Silver hair grass	48	0	8	0	10	4	24
	Acaena echinata	Sheep's burr	10	8	10	10	8	14	20
*	*Oxalis perennans*	Wood sorrel	10	10	14	8	12	8	8
*	*Bromus molliformis*	Soft brome	16	4	12	16	0	4	0
*	*Gyandriris setifolia*	Thread iris	10	2	0	6	8	20	2
	Austrostipa gibbosa	Swollen speargrass	4	0	0	6	12	18	6
*	*Briza maxima*	Quaking grass	6	0	6	8	8	8	6
	Haloragis acutangula	Raspwort	4	4	6	4	6	6	6
*	*Erodium brachycarpum*	Geranium / Heronsbill	14	12	2	0	0	2	2
	Austrodanthonia eriantha	Hill wallaby grass	2	2	8	6	8	0	2
	Austrostipa trichophylla	Corkscrew grass	12	6	4	2	2	2	0
*	*Vulpia myuros*	Silver grass	6	10	6	2	0	0	2
*	*Hypochaeris radicata*	Cat's ear	4	8	4	2	2	2	2
*	*Sonchus oleraceus*	Sow thistle	6	0	2	0	4	4	8
*	*Trifolium glomeratum*	Ball clover	20	2	2	0	0	0	0
*	*Carthamus lanatus*	Saffron thistle	2	6	0	0	12	0	0
	Themeda australis	Kangaroo grass	2	2	4	2	2	2	2
*	*Medicago minima*	Woolly burr medic	4	0	4	0	2	2	0
*	*Bromus diandrus*	Great brome	0	0	2	2	2	4	0
*	*Echium plantagineum*	Salvation Jane	2	2	2	0	4	0	0
	Dichopogon strictus	Chocolate lily	0	2	0	0	0	2	4
	Schoenus apogon	Bog rush	2	2	0	0	2	2	0
	Convulvulus erubescens	Bindweed	6	0	0	0	0	0	0
	Elymus scaber	Wheatgrass	4	2	0	0	0	0	0
	Lomandra dura	Matrush	0	0	0	2	0	2	2
*	*Anagalis arvensis*	Blue pimpernel	2	0	0	0	0	0	0
*	*Arctotheca calendula*	Cape weed	0	2	0	0	0	0	0
	Austrodanthonia tenuior	Wallaby grass	2	0	0	0	0	0	0
*	*Petrorhagia velutina*	Proliferous pink	2	0	0	0	0	0	0
*	*Poa bulbosa*	Bulbous poa	2	0	0	0	0	0	0
*	*Spergularia rubra*	Red sandspurry	2	0	0	0	0	0	0
	Austrostipa scabra	Slender speargrass	0	2	0	0	0	0	0
-	Unknown Asteraceae		4	6	0	0	0	0	0
	Total number of species recorded		40	32	29	26	29	30	27
	Mean number of species per transect		21.2	17.4	17.2	15.8	18.2	17.8	16.4