

COMPUTER SIMULATIONS OF SHEEP GRAZING IN THE ARID ZONE.

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This thesis describes a computer simulation model of Wertigo paddock near Whyalla, South Australia. Wertigo is a 2200 ha, arid chenopod shrubland paddock grazed by approximately 300 merino sheep under a set stocking management policy.

The thesis emphasises a review and comparison of submodels applicable to arid or semi-arid zone grazing systems, but includes original field work and data analysis where necessary. Several published models of non-specific arid zones sites were taken as a basis for this project. The detail with which the spatial variability of the grazing processes are simulated, distinguishes this model from most published grazing models. The paddock model includes 37 cells (point models) and simulates the hourly movement and behaviour of up to 10 flocks within them.

The paddock model includes 5 major submodels; climate, plant growth, sheep behaviour, consumption, and physiology. The climate submodel includes a Markovian daily rainfall generator, a stochastic diurnal and annual temperature cycle model, a short and long wave radiation model and a soil moisture model. The plant growth model is based on an analysis of the Koonamore Vegetation Reserve photographic records from 1926 to 1972, and includes two perennial and two ephemeral taxa. The sheep behaviour submodel describes the hourly movement of sheep flocks around the paddock. It includes sheep heat and water balance models as the major determinants of flock behaviour. The sheep consumption model is based on grazing experiments carried out near Wertigo, and treats sheep grazing as a predator-prey situation.

No attempt is made to follow energy, or any particular element, throughout the model, although in various parts, water, plant organic matter, nitrogen and energy flows are simulated. Separate validation of each submodel has been attempted. No data of sufficient detail were available to validate the paddock model as a whole, but the output agrees with our present understanding of the system in all important aspects.

A series of management experiments emphasising the spatial aspects of the model are described and discussed. They indicate that spring shearing would be an improvement over the autumn shearing at present practised on the station; that using the existing two water points in the paddock in alternate years results in a significant improvement in range condition; and that new breeds of sheep with improved heat tolerance or walking ability, would result in only a small increase in animal production and some decrease in range condition. The model indicates that the management options available to the grazier are limited, with most options (other than overstocking) producing changes much smaller than those due to the vagaries of the weather and, in particular, the rainfall.

AN AUTECOLOGICAL STUDY OF THE GRASS *ARISTIDA RAMOSA* R.Br. ON THE NORTHWESTERN SLOPES OF NEW SOUTH WALES.

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Aristida ramosa R.Br., a common component of the native pastures of the North-western Slopes of New South Wales, is most abundant in xeric habitats: soils of low moisture holding capacity and/or sites where drainage is enhanced by a high soil gravel content or steep slope. These sites are generally of low soil fertility and the ground

cover for most of the year is poor. Adaptations to these habitats include a rapidly elongating and deeply penetrating seminal root system, a relatively high root/shoot ratio, a high water use efficiency, xerophytic morphology and a large capacity for axillary tiller development. However, *A. ramosa* seedlings were shown to have relatively low tolerance to internal moisture deficits when compared to *Danthonia linkii* Kunth.

The dry matter production of seedlings of *A. ramosa* and *Danthonia richardsonii* Cashmore, was significantly reduced by frequent defoliation to 20 to 46 per cent of the unclipped control for *A. ramosa* and *D. richardsonii* respectively when the plants were defoliated at 17 day intervals. Regular foliage removal also severely depressed root growth of *A. ramosa* and *D. linkii*, significantly reducing the maximum root depth and root density.

The preference of *A. ramosa* for low fertility habitats was evident in the response of seedlings to applied nitrogen, growth being depressed by nitrogen application in contrast to *D. linkii*. It was found that several forms of nitrogen: NaNO_3 , NH_4Cl , and NH_4NO_3 , all produced the same growth depression and/or death, while the effect was greatest when the application occurred immediately before or after seedling emergence. A significant nitrogen-phosphorus interaction was recorded with the negative effect of nitrogen being less at high soil phosphorus levels.

In two seedling competition studies, *Danthonia* spp. suppressed the growth of *A. ramosa*. The mean tiller number per plant decreased for both *A. ramosa* and *D. richardsonii* as the relative frequency of *A. ramosa* decreased in replacement series mixtures of the two species: the growth of *A. ramosa* was controlled by interspecific competition while that of *D. richardsonii* was determined by intra-specific competition. The suppression of *A. ramosa* by *D. linkii* in the second trial was greater than expected from the additive effects of competition for aerial and soil derived growth factors. Fertiliser application to an *A. ramosa* dominated native pasture near Armidale induced an influx of annual grasses and legumes into the pasture, the rapid growth of these species smothering the *Aristida* so that its percentage of total dry matter decreased from 55 where no fertiliser was applied to 12 where 'Nitram' and superphosphate were applied at 280 and 400 kg/ha respectively.

The seedling establishment, mature plant growth and reproductive development of *A. ramosa* were measured at six field sites. Seedlings appeared mainly during late autumn and winter when the moisture supply was adequate and the competition from annual species was minimal. Few of these seedlings established sufficiently to survive the following summer so that of a total of 491 seedlings recorded in an 18 month period, only 18 per cent survived the summer following their appearance.

All tillers initiated by mature plants are potentially reproductive. However, less than 50 per cent of the 2037 tillers marked produced seed, 45 per cent of the total dying at or before elongation. Tillers initiated during summer had the greatest chance of completing the reproductive cycle while axillary tillers were generally more successful than primary tillers in this regard. Growth and reproductive success was closely correlated with rainfall at all sites.

The slow growth rate and poor competitive ability of *A. ramosa* seedlings and mature plants belie the aggressive reputation of the species. Pastures maintained in a vigorous condition will not permit an increase in abundance of *A. ramosa* and where an increase in the vigour of the associated species can be achieved, control of *A. ramosa* is effected. The value of *A. ramosa* as a soil and moisture conserving species in some ecosystem is also recognised.