1.0 INTRODUCTION

Achieving sustainable production from grazed native pastures in south-west Queensland requires an understanding of their productivity, dynamics and grazing capacity. Pastures are composed of annual grasses and forbs, perennial grasses and shrubs, and trees. Their structure and composition are determined by rainfall, frequency of fire, soil type, topography, history of use and grazing pressure. Due to the high degree of variability in the seasonal incidence, amount and reliability of rainfall, the structure and composition of pastures varies from place to place and from year to year (Purdie and McDonald 1990). Managing grazing animals in an environment characterised by such variability is difficult and requires skill.

Prior to European settlement, pastures evolved under light or migratory grazing to produce a landscape dominated by grasses and forbs. Following settlement, the advent of sheep and cattle, artesian water, continuous grazing, utilisation of browse trees Mulga (*Acacia aneura* F. Muell. ex. Benth.), clearing and reduced fire frequency have caused a major shift in pasture productivity as grasses and forbs have been replaced by woody shrubs and trees.

Despite the changes in pasture composition and productivity which occurred over the last 130 years, the region supports a productive grazing industry producing wool and meat. The average gross value of agricultural production for the nine shires in south-west Queensland was 217 million dollars (1988/89 to 1993/94) (Table 1.1). However, evidence has "demonstrated that the mulga lands of south-western Queensland are seriously affected by land degradation" (Mills *et al*. 1989 page 46) and if current levels of animal production are to be maintained, improved management of the pasture resource is necessary.

Table 1.1 Value of the major agricultural commodities ($ 000) produced in south-west Queensland (Shires of Barcoo, Blackall, Bulloo, Diamantina, Isisford, Murweh, Paroo, Quilpie and Tambo) from 1988/89 to 1993/94. (Australian Bureau of Statistics)

Year	Wool and Sheep ($)	Beef and Cattle ($)	South-west Queensland Total ($)	Proportion of Queensland's Wool (%)	Proportion of Queensland's Beef (%)
1988/89	157236	87010	250016		
1990/91	135324	112267	248946	35	8
1992/93	70671	120582	192213	33	7
1993/94	71504	104016	176833	39	6
Average	108684	105969	217002	36	7

One approach to improved management is to provide sound knowledge of the components of the pasture/grazing system. More importantly, the components need to be considered together to develop an understanding of the whole grazing system. A systems analysis, in which the components of the grazing system are brought together and the interactions between them examined offers an approach for examining whole systems. A 'whole' systems analysis approach would include the important linkages between social / economic and scientific / technical aspects of regional productivity. In south-west

Queensland and three other regions of semi-arid Australia, Freeman and Benyon (1983) documented such an approach.

In this thesis the systems analysis approach is confined to a subset of the 'whole' system, and examines the links between rainfall, soil moisture, pasture growth, grazing and forage utilisation with the objective of calculating sustainable ("safe") grazing capacities. The "safe" grazing capacity for an individual property is the number of livestock that can be safely run in the long-term without detriment to the pasture resource. "Safe" stocking is defined here as the long-term average of a flexible stocking policy aimed at matching stock numbers to seasonal conditions. The result of flexible stocking is a stocking rate for a particular property for a particular season.

Adjusting stocking rates in response to varying seasonal conditions is the main management option available to producers in south-west Queensland. In the past, graziers have relied on "gut feeling" and local knowledge to make these decisions, and may have expectations biased by short term favourable conditions. The objective estimation of "safe" grazing capacities based on ecological principles aims to assist in this decision making process to achieve sustainable management of the pastoral resource.

This thesis establishes the pastoral importance of the region and the reliance of its grazing industries on production from native pastures. Characteristics of vegetation communities are described and their influence on grazing management examined. The thesis then quantifies an approach for estimating "safe" grazing capacities for individual properties. The approach is based on estimates of plant productivity and safe levels of plant utilisation.

The hypothesis to be tested, is that grazing capacities for individual properties can be estimated through measurement and extrapolation over time and space of key plant production relationships.