# 6.0 APPLICATION AND EVALUATION OF A "SAFE" GRAZING CAPACITY MODEL

## 6.1 Introduction

Concern over the decline in agricultural productivity of south-west Queensland has been expressed by a number of authors e.g., Ratcliffe (1937), Burrows and Beale (1969), Pressland (1976, 1984), Mills (1986), WGA (1988), Mills *et al*. (1989), Miles (1989), Passmore and Brown (1992) and Anon (1993). Reliance on feed from browse trees and maintenance of inappropriate stocking rates at critical times have reportedly caused pasture degradation and productivity losses in the region. The processes and extent of degradation have been described by Beale (1986), Burrows (1973), Brown (1981), Pressland and Cowan (1987), Mills (1986), Mills *et al*. (1989), and Miles (1993). The most common forms of degradation reported by these authors are the lack of ground cover, accompanied by increases in sheet erosion and woody shrub cover. Mills (1989) estimated that the gross value of wool production from the "Paroo" Mulga area (3M ha bounded by Charleville, Quilpie, Thargomindah and Cunnamulla) had been reduced by $4.4m (4.2%) per annum through the effects of erosion and woody shrub cover.

In focussing on these concerns a review of "carrying capacities" / "stocking rates" was suggested by WGA (1988), Mills *et al.* (1989), Miles (1989) and Anon. (1993). At the same time the Department of Lands was concerned that its traditional long-term carrying capacities generally represented an over-estimation of the ability of land types in the Mulga region to sustainably carry stock in the long-term (P.R. Tannock, pers. comm.). The majority of these capacities were based on subjective judgments during the 1940's and 1950's and were no longer considered appropriate by local land managers and administrators. In 1989 the Department of Lands reviewed the carrying capacities on a number of properties in south-west Queensland based on personal assessment and "gut" feeling. While this review generally reduced carrying capacities the process remained a subjective one.

Determining the number of animals or grazing capacity of grazing lands, and understanding the consequences are the most difficult tasks in grazing management (Vallentine 1990a). Several approaches are available for determining grazing capacity and appropriate stocking rates. Most are based on experience of "average" properties in "average" years (Wilson *et al*. 1990), and trial and error coupled with regular adjustments. Due to the variability in climate and base resources in south-west Queensland, the use of "district averages" is unlikely to yield appropriate grazing capacities for individual properties.

To review grazing capacities of individual properties in south-west Queensland an objective assessment was required. As grazing capacities largely determine the value of land bought and sold (Holechek *et al.* 1989) any review of these values directly affects the livelihood of individuals. Examination and discussion of grazing capacities are therefore sensitive issues. Due to these sensitivities the methodology developed to review grazing capacities needed to be rigorous, defendable and most importantly respected in the grazing community.

To remove the subjectivity and perceived inaccuracies in carrying capacity values, the Department of Lands appointed three experienced graziers from the region as consultants in February 1994. Their role was to apply and evaluate a methodology for objectively assessing long-term carrying capacities on a number of selected properties. The development of an objective assessment of carrying capacity for individual properties was considered important for several reasons:

1. A general review of grazing capacities in south-west Queensland required a more open and defendable review process;
2. The method for review needed to account for the condition of the land resource;

3. Specific reviews of carrying capacities for properties being amalgamated under an integrated regional adjustment and recovery program (Williams 1995) required open and defendable means of conducting assessments;
4. The method needed to recognise and accommodate the unique combination of land systems comprising individual properties in south-west Queensland;
5. To avoid the intellectual loss of local information as industry and government personnel leave the region; and,
6. Better communicate basic resource information to those unfamiliar with the region.

The method chosen to estimate long-term grazing capacities of individual properties needed to:

(i) be quantitative;

(ii) be based on ecological principles;

(iii) be defendable;

(iv) be transparent;

(v) have resolution at a practical scale (individual property or paddock);

(vi) use appropriate terminology (acres/dry sheep equivalent);

(vii) complement existing property management; and,

(viii) build on existing community knowledge.

These characteristics were important to facilitate the training of the grazier consultants and to ensure the consultants could convey the methodology among the grazing community. Omission of several of these factors from modelling efforts in the dryland cropping area has lead to "communication errors" between farmers and scientists (Ridge and Cox 1995).

This Chapter describes my role in: (1) packaging an appropriate methodology; (2) the selection and training of three grazier consultants; and, (3) application of the method to selected properties. It describes an attempt to utilise a participatory approach to technology transfer, where partnerships among researchers, extensionists, graziers, financiers and administrators (grazing community) were developed (Jiggins 1993). The industry and community benefits and the scientific insights gained from the analysis of individual property data are described with a focus on outcomes (improved grazing land management in south-west Queensland) rather than outputs (computer packages). This is in contrast to Cox (1996) who suggests similar modelling exercises in broadacre agriculture have focussed on the production and adoption of decision support systems rather than the improved management of agricultural production systems.

## 6.2 Materials and methods

### 6.2.1 Selection of appropriate methodology

The method for estimating grazing capacities developed in Chapter 5 was chosen. It met each of the criteria above. Briefly, the method entailed estimating the potential annual average forage growth (kg/ha) of the different land systems on each property. This estimate was based on the product of average annual rainfall use efficiencies for each land system and long-term average rainfall. Actual forage growth was estimated after accounting for the effect of tree and shrub cover. An estimate of the number of livestock to utilise a "safe" portion of the actual forage grown was then calculated. The level of "safe" forage utilisation was based on utilisation levels observed in grazing trials conducted in northern Australia, utilisation levels estimated on three "benchmark" properties and on consensus data of utilisation levels considered "safe" by a group of experienced graziers, land administrators and researchers. Summing the livestock numbers for each land system on a property produced an estimate of the "safe" long-term grazing capacity for that property. The term "safe" implies conservative levels of forage utilisation by domestic livestock and subsequent sustainable resource use. The derivation of these conservative levels of forage utilisation was conducted without quantification of the grazing pressure attributed to other herbivores such as kangaroos, goats and insects (Chapter 5). The ability to manage populations of other herbivores and estimate their contribution to total grazing pressure would result in a different levels of "safe" forage utilisation.

### 6.2.2 Selection and roles of grazier consultants

The Department of Lands placed advertisements in January 1994 seeking to employ three experienced graziers as grazing capacity consultants. Their role was to apply and evaluate the above methodology (Chapter 5 and Chapter 6.2.1) as a means to estimating "safe" long-term grazing capacities on selected properties in the Mulga lands of south-west Queensland. They were appointed in February 1994 and training in the methodology conducted by myself commenced in March 1994. A consultant was chosen from each of three broad bio-geographical regions (eastern Mulga lands (Booringa, Balonne and Warroo shires), central Mulga lands (Paroo and Murweh shires - east of the Warrego river) and western Mulga lands (Paroo, Bulloo and Quilpie shires - west of the Warrego river).

The duties of the consultant were to:

(1) Undertake training in the concepts and techniques behind the methodology,

(2) Trial the model and techniques on the consultant's own property. This entailed:

(a) a detailed inspection of the property,

(b) refinement of the land system mapping where necessary to reflect actual country types,

(c) estimating tree and woody weed density using step point methodology, and

(d) calculating a long-term grazing capacity for each land system and the property overall.

(3) Contact selected receptive graziers in their regions willing to have their properties assessed and arrange inspection times,

(4) Arrange for relevant maps to be prepared prior to property inspections,

(5) Visit each property to discuss the methodology, refine the land system maps (if necessary), assess the condition of each land system and estimate a "safe" long-term grazing capacity,

(6) Prepare a report for each property for the benefit of each landholder, and

(7) Prepare a public report for the Department of Lands summarising the findings from all properties.

The technical component in each of the above steps was closely supervised by myself to ensure the methodology developed in Chapter 5 was adhered to, and to solve difficulties in application should they arise.

### 6.2.3 Packaging the methodology and consultant training

A "user-friendly" manual was compiled by myself to summarise the concepts and steps in estimating "safe" grazing capacities as described in Chapter 5. Apart from the land system maps for each property, the manual provided the necessary formulae, data and working sheets to estimate a "safe" grazing capacity for any property in south-west Queensland. Maps for each property surveyed in this exercise were supplied by the Department of Lands. The maps consisted of cadastral and land system boundaries overlain on recent satellite imagery for the property. The working sheets were designed to enable grazing capacity calculations to be performed either by hand or with a calculator.

In March 1994, a three day training session lead by myself was held to introduce the grazier consultants and Department of Lands staff to the background and steps involved in estimating grazing capacities for individual properties. The three grazier consultants, and a number of staff from the Department of Lands and Department of Primary Industries district offices participated in the training session. The session included sections on the ecological principles behind the methodology, techniques for sampling foliage projected cover of trees and woody weeds using the step point methodology of Evans and Love (1957) and sighting tube of Buell and Cantlon (1950) and performing the calculations.

As a case study, I lead an exercise where the method was applied to the 5362 ha Department of Primary Industries research station "Croxdale" (26°27' South, 146°09' East) located 12 km from Charleville. The land system mapping for "Croxdale" was examined and representative locations within the various land systems sampled for tree and woody weed cover. The calculations to estimate a "safe" long-term grazing capacity for "Croxdale" were performed and discussed as a group.

Following the initial training, each of the consultants assessed their own properties as a team. The objective of this was to resolve any problems and consolidate the approach to be used. Following these assessments the grazier consultants approached an additional 20 properties, offering to conduct an assessment and evaluate the methodology (Figure 6.1). The selection of properties was determined by the grazier consultants and aimed to cover their respective regions. The confidentiality of individual property information was assured for each of the 20 properties selected.

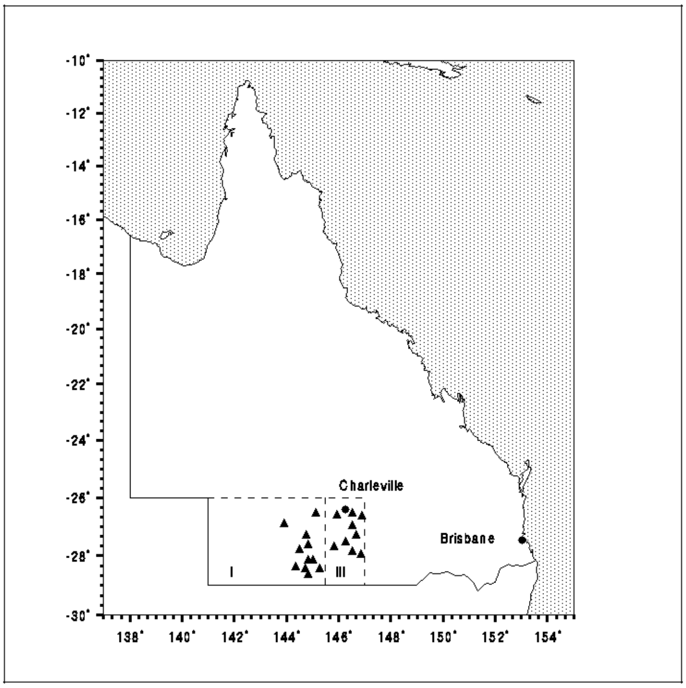


**Figure 6.1** Location of 20 grazing properties in south-west Queensland selected by two grazier consultants to apply and evaluate a model for calculating "safe" long-term grazing capacities of individual properties. The WARLUS land system map areas of (I) Dawson (1974) and (III) Mills and Lee (1990) are shown dotted.

## 6.3 Results

### 6.3.1 Training evaluation

No formal evaluation of the training session was conducted. The following are qualitative observations regarding the learning process and grazier perceptions of the methodology.

#### 6.3.1.1 The learning process

Each of the grazier consultants rapidly grasped the issues relating to the grazing capacities in south-west Queensland and the need to review these values using a rigorous, quantifiable and defendable method. When presented with the basic ecological principles behind the approach to estimating grazing capacities it was difficult initially to determine the depth of understanding. However, in the field at "Croxdale" the graziers rapidly developed an understanding of the principles and techniques for recognising different land systems and sampling tree and woody weed cover. They became conversant with the terminology quickly and began using it regularly when discussing the work.

However, due to the unavailability of the land system mapping used in model development east of 147$^{o}$, only two of the consultants were able to fully proceed with application of the model. The land system mapping of Mills and Lee (1990) ends at 147$^{o}$ East.

During the property assessments a number of aspects in the methodology required clarification and or modification. The questioning and identification of these aspects indicated the consultants had developed a sound understanding of the components of the methodology. Issues regarding the methodology were solved as they arose. However, no change was made to the methodology until the final workshop held in June 1995. This was to ensure consistency in applying the methodology among properties.

In June 1995 I lead a workshop where the consultants presented their findings for discussion. Modifications to the methodology based on issues they identified were discussed. A "safe" long-term grazing capacity for each of the twenty properties was then calculated using the refined methodology and the data collected by the grazier consultants.

#### 6.3.1.2 Grazier observations regarding the methodology

Regarding the methodology the two remaining consultants (Cooney (1995) and Crichton (1995)) reported:

1. More research should be conducted into all aspects of the methodology, particularly the rainfall use efficiencies and the effect of tree and shrub cover on pasture growth.
2. The methodology should not be set in concrete and should be reviewed and refined at regular intervals to account for the findings of new research. These reviews would also cater for improving satellite technology and other techniques as they arise.
3. Continual upgrading of the WARLUS land system mapping on a property by property basis would improve the accuracy of the grazing capacity estimation. Eventually, every property should be done separately.
4. Most landholders have a deep suspicion that this exercise is the first step towards controlled stocking and greater government control in how they run their properties. Security of tenure and property size of an adequate "living area" were two issues identified as being closely linked with "safe" grazing capacities.
5. The presentation of grazing capacities should be re-thought. Rather than hectares per DSE the land's capacity should be expressed as "units of production" per hectare. Everything leaving the property

would have a "unit of production value" which can be related to the current components of the grazing capacity estimation (land system, rainfall, tree and woody weed cover).

6. Various relevant bodies and particularly the grazing industry accept the methodology for estimating the grazing capacities in the Mulga lands of south-west Queensland.
7. Grazing capacities must be looked at in the full context of land care, and not simply how many animals the land resource can support.
8. The impact of less palatable forage species (e.g. *Aristida* spp. (Wire grasses)) on the level of forage utilisation needs to be examined.

#### 6.3.1.3 Scientific insights gained through grazier participation

Following discussion with the grazier consultants, use of a variable level of "safe" forage utilisation as a function of site fertility (Figure 5.9) was confirmed. Early testing of the methodology on the case study property 'Croxdale' and the consultants own properties also prompted a close examination of the derivation of the rainfall use efficiencies for land systems outside of those examined in Chapters 3 and 4. This lead to the development of the relationship between rainfall use efficiency and site characteristics. A factor to accommodate the frequency of flooding on regularly flooded land systems (alluvial plains (A) and wooded alluvial plains (W)) was also developed. Annual rainfall was increased by 30% and 15% for land systems experiencing flooding every 1 in 3 years and 1 in every 4 to 10 years respectively. The estimation of the quantity of mulga leaf available as browse was considered an important component of the methodology. While only 5% of this material was available to livestock, the fact that it was a component was important for the credibility and acceptance of the methodology amongst graziers.

Components of the methodology identified by the grazier consultants requiring further refinement

included:

(i) the relationships between different woody species and forage production across different land systems and rainfall gradients (e.g. comparable to Scanlan (1984) on brigalow and eucalypt communities in central Queensland);

(ii) examination of the long-term utilisation of browse across different land systems, density of mulga, forms of mulga and management of mulga;

(iii) examination of the degree of complementarity between sheep and cattle across different land systems;

(iv) inclusion of a measure of grass density as an additional indicator of land condition; and,

(v) comparison of domestic livestock numbers to total herbivore grazing pressure at the paddock and property scale.

### 6.3.2 Property assessments

Twenty grazing properties in south-west Queensland (average size 32916 ha) were assessed by the grazier consultants during the period March 1994 to June 1995 (Cooney 1995 and Crichton 1995) (Figure 6.1). Properties were not assessed in the eastern region due to unavailability of the mapping on which the method was developed (McLean 1995). The land system mapping of Mills and Lee (1990) ends at 147$^{o}$ East. The next two sections summarise the data collected by two of the grazier consultants (Cooney 1995 and Crichton 1995).

**6.3.2.1 Land systems and land condition**

A total of 6583 $km^2$ was assessed covering 77 different land system combinations described by Dawson (1974) (WARLUS Part I) and Mills and Lee (1990) (WARLUS part III). The average annual rainfall for the twenty properties was 357 mm. Sixty-one percent of the area assessed was either the Soft Mulga land zone (2065 $km^2$ or 31%) or the Hard Mulga land zone (1966 $km^2$ or 30%). The average foliage projected canopy cover of trees on the twenty properties was 9.6% (range 0.0% to 30.6%) and the average foliage projected canopy cover of woody weeds was 6.5 % (range 0.0% to 38.3%) (Appendix 9). The Soft Mulga land zone supported the highest density of trees (13.6%) and the Open Downs the lowest (0.0%) (Table 6.1). The Sandplain land zone had the highest density of woody weeds (21.6%) and the Open Downs the lowest (0.0%) (Table 6.1). The Sandplain land zone also had the highest total woody vegetative cover (28.1%) and the Open Downs the lowest (0.0%) (Table 6.1).

**Table 6.1** Total area, average rainfall, average foliage projected cover (FPC%) of trees and shrubs and total cover for the 13 of the 15 land zones (Dawson (1974) and Mills and Lee (1990)) encountered in the assessment of 77 land systems on 20 grazing properties in south-west Queensland. (Detailed data for the 77 land systems presented in Appendix 9)

| Land Zone | Area (ha) | Rainfall (mm) | Tree (FPC%) | Shrub (FPC%) | Total (FPC%) |
|---|---|---|---|---|---|
| Alluvial Plains Open (A)+ | 33340 | 327 | 3.5 | 1.2 | 4.7 |
| Brigalow (B)* | 0 | | | | |
| Channel Country (C) | 718 | 303 | 5.0 | 0.0 | 5.0 |
| Dunefields (D) | 13614 | 338 | 5.3 | 15.6 | 20.0 |
| Poplar Box Lands (E) | 18528 | 434 | 10.8 | 4.6 | 14.9 |
| Downs (F) | 247 | 325 | 0.0 | 0.0 | 0.0 |
| Gidgee Lands (G) | 40546 | 328 | 8.4 | 4.8 | 12.8 |
| Hard Mulga Lands (H) | 196626 | 354 | 8.1 | 5.0 | 12.6 |
| Claypans (L) | 11542 | 376 | 5.2 | 1.4 | 6.5 |
| Soft Mulga Lands (M) | 206512 | 372 | 13.6 | 4.8 | 17.7 |
| Spinifex Sandplains (N) | 18204 | 423 | 9.3 | 17.6 | 25.3 |
| Dissected Residuals (R) | 37309 | 360 | 9.8 | 12.2 | 20.8 |
| Mulga Sandplains (S) | 39856 | 344 | 8.3 | 21.6 | 28.1 |
| Wooded Downs (T) * | 0 | | | | |
| Alluvial Plains Wooded (W) | 41283 | 338 | 5.9 | 3.0 | 8.7 |
| Mean | 43888 | 308 | 6.2 | 6.1 | 11.8 |

\+ Code letter for land zones used by Dawson (1974) and Mills and Lee (1990).

* Land zones not encountered on the properties assessed.

**6.3.2.2 Grazing capacity comparisons**

The average pre-1989 Department of Lands rated carrying capacity (3.31 ha/DSE) was 40% heavier than the owner assessed capacities (4.62 ha/DSE) which was 7% heavier than the "safe" long-term grazing capacity (4.95 ha/DSE) calculated using the model described in Chapter 5 (Table 6.2).

Seventy-five percent of the owner's average grazing capacities were within $\pm$ 10% of the calculated grazing capacity (Table 6.2). There was a significant relationship (slope nsd 1.0 and intercept nsd 0.0 at $P<0.05$) between the calculated grazing capacity and the owners average livestock numbers (Figure 6.2) when two outliers were removed on recommendation of one of the consultants (more livestock were run on these properties due to a greater use of mulga leaf as a source of forage due to the regular pushing and feeding of mulga for pasture development). The ratio of owner grazing capacities to those calculated (average 1.08, range 1.39 to 0.95) was neither related to property nor flock size (Figures 6.3a and 6.3b). Six of the twenty properties on average ran less livestock than the calculated "safe" grazing capacity.

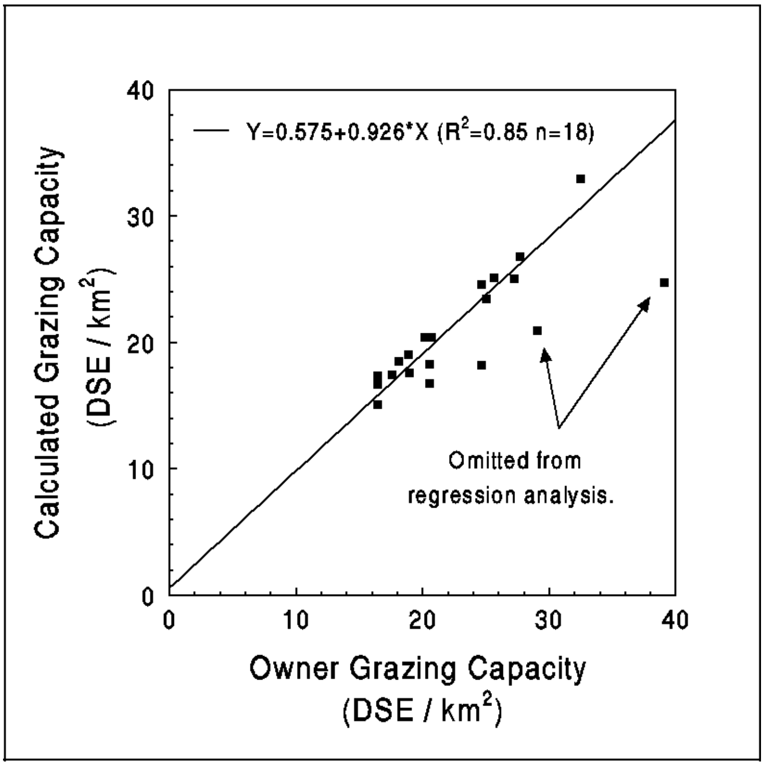


**Figure 6.2** Comparison between calculated "safe" grazing capacities and average livestock numbers on 18 grazing properties in south-west Queensland selected by two grazier consultants applying and evaluating a methodology for estimating "safe" long-term grazing capacities of individual properties (slope nsd 1.0, intercept nsd 0.0 $P<0.05$).

Similarly there was no relationship between the ratio of owner grazing capacities to the pre-1989 Department of Lands rated grazing capacities (average 0.73, range 1.00 to 0.50) and property or flock size (Figures 6.3c and 6.3d). All twenty properties supported fewer livestock than that rated by the pre-1989 Department of Lands values (Table 6.2).

The ratio of Department of Lands capacities to those calculated (average 1.51, range 2.18 to 1.15) was not related to property or flock size (Figures 6.3e and 6.3f). On all twenty properties the pre-1989 Department of Lands rated capacities were heavier than the calculated "safe" grazing capacity (average 50% heavier) (Table 6.2).

**Table 6.2** Pre-1989 Department of Lands (DOL) rated carrying capacities, average owner grazing capacities, calculated "safe" grazing capacities and grazing capacity ratios for twenty properties in south-west Queensland assessed by grazier consultants.

| Property | Owner ($DSE/km^2$) | Calculated ($DSE/km^2$) | DOL ($DSE/km^2$) | Owner: Calculated | Owner: DOL | DOL: Calculated |
|---|---|---|---|---|---|---|
| A | 17.6 | 17.5 | 33.9 | 1.01 | 0.52 | 1.94 |
| B | 20.7 | 20.4 | 29.1 | 1.02 | 0.71 | 1.42 |
| C | 19.0 | 17.6 | 31.6 | 1.08 | 0.60 | 1.80 |
| D | 20.6 | 16.8 | 26.6 | 1.22 | 0.78 | 1.58 |
| E | 16.5 | 16.7 | 22.5 | 0.99 | 0.73 | 1.35 |
| F | 16.5 | 17.4 | 22.5 | 0.95 | 0.73 | 1.29 |
| G | 20.6 | 18.3 | 27.5 | 1.12 | 0.75 | 1.50 |
| H | 18.9 | 19.0 | 29.1 | 0.99 | 0.65 | 1.53 |
| I | 16.5 | 15.1 | 32.9 | 1.09 | 0.50 | 2.18 |
| J | 18.1 | 18.6 | 24.7 | 0.98 | 0.73 | 1.33 |
| K | 24.7 | 24.6 | 33.9 | 1.01 | 0.73 | 1.38 |
| L | 27.2 | 25.1 | 30.9 | 1.09 | 0.88 | 1.23 |
| M | 32.5 | 33.0 | 38.0 | 0.99 | 0.86 | 1.15 |
| N | 29.1 | 21.0 | 29.1 | 1.39 | 1.00 | 1.39 |
| O | 20.2 | 20.4 | 30.9 | 0.99 | 0.68 | 1.51 |
| P | 25.6 | 25.1 | 41.2 | 1.02 | 0.62 | 1.64 |
| Q | 27.8 | 26.8 | 35.3 | 1.03 | 0.79 | 1.32 |
| R | 24.7 | 18.2 | 35.3 | 1.35 | 0.70 | 1.93 |
| S | 31.5 | 24.8 | 32.9 | 1.27 | 0.96 | 1.33 |
| T | 25.1 | 23.5 | 31.6 | 1.07 | 0.79 | 1.35 |
| Mean | 22.7 | 21.0 | 31.0 | 1.08 | 0.73 | 1.51 |
| SE | 1.1 | 1.0 | 1.1 | 0.03 | 0.03 | 0.06 |
| Lightest | 16.5 | 15.1 | 22.5 | 1.39 | 1.00 | 2.18 |
| Heaviest | 32.5 | 33.0 | 41.2 | 0.95 | 0.50 | 1.15 |

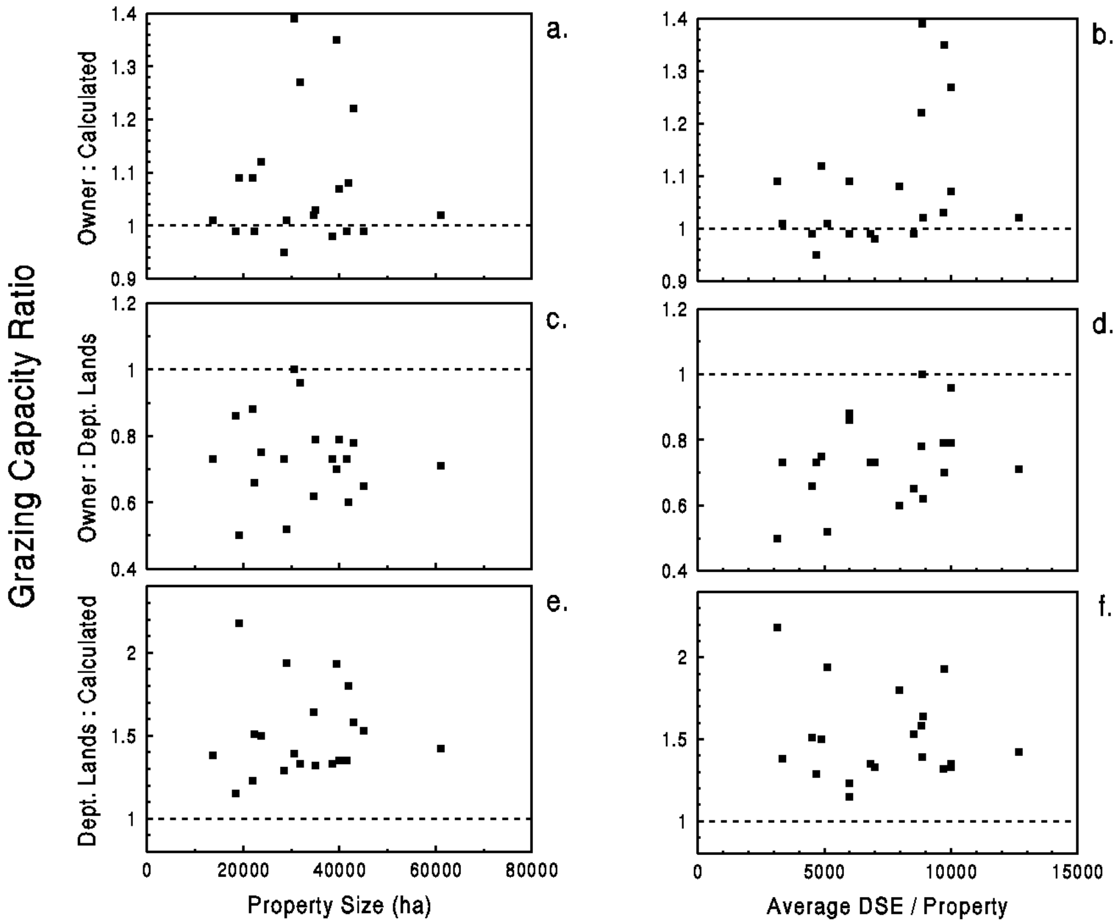


**Figure 6.3** Comparison of livestock ratios (a) owner assessed grazing capacities : calculated grazing capacity and property size, (b) owner assessed grazing capacities : calculated grazing capacity and flock size, (c) owner assessed grazing capacities : Department of Lands rated carrying capacities and property size, (d) owner assessed grazing capacities : Department of Lands rated carrying capacities and flock size, (e) Department of Lands rated carrying capacities : calculated grazing capacity and property size and (f) Department of Lands rated carrying capacities : calculated grazing capacity and flock size for 20 grazing properties in south-west Queensland selected by two grazier consultants applying and evaluating a model for estimating 'safe' long-term grazing capacities of individual properties.

## 6.4 Discussion

### 6.4.1 Graziers as consultants and the scientific insights gained

Employing experienced graziers as consultants to test and help refine a methodology for objectively estimating grazing capacities was a positive step towards gaining community confidence in the process. However, in failing to include all the clients from the outset the approach described in this Chapter did not conform entirely to the participatory model of technology transfer as described by Jiggins (1993). Despite this, the employment of the grazier consultants was considered appropriate and useful in developing partnerships among researchers, extensionists, graziers, financiers and administrators. As experienced graziers, the consultants had long established links within the grazing community. Using these links and assurance of confidentiality, the consultants were able to build confidence and discuss concerns regarding the methodology using their own personal "grazier" terminology.

Feedback from the consultants and the scientific insights gained, led to a more rapid development and refinement of the methodology than would have been possible under conventional evaluation. As a form of action-research, the training sessions, case study and follow-up meetings provided the consultants with the background ecological principles and understanding of the terminology necessary for examining grazing capacities. For the researchers, valuable insight into the practicalities regarding the estimate of grazing capacities at the property scale were gained (refinement of rainfall use efficiencies, inclusion of flooding, mulga as browse, variable forage utilisation and the need to work at the paddock scale). For both the grazier consultants and researchers, use of a common terminology expedited discussion and identification of problems in the methodology as they arose.

Insight was also gained into areas requiring further refinement from a grazier's perspective (tree/grass relationships, use of browse, sheep/cattle ratios, grass density/land condition relationships and the impact of other herbivores). Of these, a closer examination of the role of browse may not have been a priority from a researchers viewpoint. However, for the methodology to gain recognition in the wider grazing community improvements to the browse component may be critical. Humphreys (1997) in examining the work of Jones Q.R. suggests some of the difficulties in determining the importance of components on which to focus is due to basic differences in personality types between graziers and researchers.

These insights have highlighted the valuable and innovative role that can be played by experienced graziers in linking science and practice. In tackling sensitive issues such as grazing capacities the approach described here may serve as a model for dealing with other issues in other regions. Cox (1996) in discussing the role of decision support systems in cropping areas also highlights the need for participation and communication between the producers and the users of decision support systems. A comparable approach is currently being proposed to investigate long-term property grazing capacities in the Dessert Uplands region of central Queensland (Edwards and Caltabiano pers. comm.).

Use of the methodology by the grazier consultants provided an independent evaluation of the method for estimating grazing capacities. From their documented observations (section 6.3.1.2) and personal communication their was general support for and acceptance of the methodology on the 20 properties assessed. This indicates that wider application of this methodology for estimating grazing capacities of individual properties could proceed. This is currently happening as a project under the resource management component of a regional reconstruction initiative termed "The South West Strategy" (Williams 1995). Funding for this initiative is provided jointly by the Queensland state government and the federal government (National Landcare Program).

### 6.4.2 Land Condition

The methodology assessed only tree and shrub cover as an indicator of land condition. Surveys at a regional scale where these or other forms of land condition data are recorded in south-west Queensland are rare. In three previous regional scale surveys, Dawson and Boyland (1974), Mills *et al.* (1989) and Passmore (1990) used different techniques to those used by the grazier consultants. This makes it difficult to compare the present results with earlier surveys (Table 6.3) and highlights a need for regular regional scale surveys using techniques that are comparable over time.

Some land condition data for selected land zones were reported in WARLUS Part I (Dawson and Boyland 1974). The Alluvial Plains and Wooded Alluvial Plains land zones were surveyed with 85% of the area recorded as having less than 3% cover of shrubs. This approximated values of 1.2% and 3.0% respectively reported by the grazier consultants. For the Soft Mulga land zone, Dawson and Boyland (1974) reported 35% of the area had a shrub canopy cover greater than 6%, and 15% of the area had a cover of greater than 10%. This compared to a shrub cover of 4.8% observed by the grazier consultants. However, caution is required when making these comparisons, as survey techniques, sample size and sample regions varied between land zone surveys.

**Table 6.3** Comparison of tree, shrub and total woody cover from regional scale surveys of land condition in south-west Queensland.

| Survey | Method | Tree Cover (%) | Shrub Cover (%) | Total Cover (%) |
|---|---|---|---|---|
| Crichton (1995) and Cooney (1995) | sighting tube from step points (fpc%) | 9.6 | 6.5 | 15.5 |
| Passmore (1990) | visual from step points | 9.9 | 7.1 | 16.3 |
| Mills et al. (1989) | step point and photo standards | 4.4 | 5.0 | 9.4 |

### 6.4.3 Grazing capacity comparisons

#### 6.4.3.1 Ratio of owner assessed grazing capacity to calculated "safe" grazing capacities

A significant relationship between the owner's assessed grazing capacity and the calculated grazing capacity indicated the model was capable of estimating a long-term "safe" grazing capacity for these "participants" properties. However, this was only and small sample of south west Queensland properties and may have been biased towards producers with more conservative grazing practices. It was also a comparison of owner assessed grazing capacities which may not necessarily reflect actual livestock numbers. This result supports further development and a cautious broader application of the methodology. This is currently (July 1996) occurring in two activities being conducted under a regional reconstruction initiative in south-west Queensland (Williams 1995).

#### 6.4.3.2 Ratio of owner assessed grazing capacity to Department of Lands rated carrying capacities

Results presented in this Chapter support the general consensus that Department of Lands pre-1989 rated carrying capacities for the Mulga lands were less conservative than those assessed by the grazing community (participants properties). This contrasts with the results presented in Chapter 5, where an analysis of 46 randomly chosen properties (Passmore 1990) indicated the Department of Lands rated carrying capacities were more conservative than the graziers actual stock numbers. This apparent contrast may be due to:

1. Differences in the method of choosing properties. Passmore (1990) made a random choice of properties to survey across the Mulga lands of south-west Queensland. The consultants based their choice of properties on the basis of local knowledge and geographical location. In selecting "participants" properties (Cooney 1995), the consultants may have selected a more conservatively stocked group of properties. No guidelines for property selection apart from covering a geographical range were provided to the grazier consultants.

2. Differences between average and actual livestock numbers. The Passmore (1990) survey was conducted during a period of high wool prices (1986 to 1988) and surveyed actual livestock numbers on the 46 properties during that period. These data represent a stocking rate for that unique period based on conditions at that time and did not reflect a long-term capacity for those properties (based on the benchmarks analysed in Figure 5.8). The consultants data were based on the owners assessed long-term average grazing capacity for the properties (not actual numbers in 1995) and were perhaps more closely aligned to the concept of a long-term or "safe" grazing capacity for the properties (i.e. 15%-20% utilisation of average long-term forage growth by domestic livestock.)

These results highlight the difficulties in examining grazing capacities of properties in south-west Queensland. Careful consideration needs to be given to the presentation of the data and how it is interpreted as recommended by Heady and Child (1994). Criticism of the Department of Lands rated carrying capacities may or may not be warranted depending on how and when grazing capacities are compared. This is highlighted by the fact that property and flock size were not related to the variation between the average owner records and the Department of Lands rated capacities.

#### 6.4.3.3 Ratio of Department of Lands rated carrying capacity to the calculated "safe" grazing capacity

The greatest difference in grazing capacities occurred between those calculated by the model and the pre-1989 Department of Lands values. This may be due to the Department of Lands values not reflecting either changes in the land's condition and therefore declining productive capacity or changes in grazing practices. Pre-1989 values were determined in the 1940's and 1950's. In 1989, an attempt was made in south-west Queensland to review these capacities. This review was based on a response to perceived long-term changes in land condition and a recognition that actual grazing practice was not aligned to the values on record for many properties.

The Department of Lands is at the front-line in government land administration. Society is expecting the agency to be more proactive in influencing sustainable land use decisions (e.g. a change in the name to the Department of Natural Resources in April 1996). If the Department of Lands adopts the model evaluated here by the grazier consultants, "safe" grazing capacity estimates will become more dynamic and better reflect changes in land condition. There will also be a greater chance that "safe" grazing capacities will more closely reflect grazing practice. For land administrators, the end result will be greater confidence in the information base, and this will lead to more informed decisions regarding sustainable land management and administration. For land managers, there will be greater respect for the information used by land administrators in decision making affecting their properties and livelihoods.

### 6.4.4 Grazing capacities at a practical scale

The estimate of a "safe" long-term grazing capacity provides a valuable target around which seasonal livestock numbers on a property would be expected to fluctuate following responsive management. At this scale, grazing capacity information is of value to land administrators and to those purchasing and selling properties. However, for land managers, decisions regarding livestock generally occur at the paddock level. For the "safe" grazing capacity concept to be most useful to land managers, grazing capacities for individual paddocks must be estimated. The principles and procedures to conduct paddock scale estimates are the same for the whole property. The only difference lies in mapping land systems at the paddock level. When applied at the paddock scale, the estimate would provide a target around which livestock numbers would be adjusted depending upon season and management decisions (stocking rate). The paddock scale decisions on stocking rate therefore require application of the same objective of "safe" long-term grazing capacity as for a property, but are more aligned to practical livestock management. This is the scale where sustainable resource management decisions are made.

However, application of the approach at a more detailed scale requires recognition of the limitations of the broad-brush (property scale) approach when applied to paddocks (Table 6.4). Errors in estimating forage growth, FPC of trees or utilisation levels on relatively small land systems may not be significant to the overall result when the model is applied at the whole property scale. At the paddock scale these errors may become significant. Other factors would also become important when applying the approach to grazing capacity decisions at the paddock scale. The size and shape of paddocks, relative proportions of different land systems, location of waters and wind direction all influence the grazing behaviour of livestock and other herbivores. Application of the method at the paddock scale may need to include some or all of these factors.

**Table 6.4** Strengths and weaknesses of the grazing capacity model as developed in Chapter 5 and applied to properties in south-west Queensland.

| |
|---|
| **Strengths** |
| Provides an objective quantitative approach to estimating long-term strategic (20-30 years) grazing capacities. |
| Can be applied to individual properties. |
| Recognises the unique mix of land systems on each property. |
| Could be adapted to the paddock scale with recognition of the potential for errors. |
| The method can be repeated to monitor grazing capacity over time. |
| Has been evaluated on actual properties. |
| **Weaknesses** |
| Does not link perennial grass basal area to forage growth. |
| Does not accommodate for grazing preferences and distribution of herbivores across the landscape. |
| Does not separate the effect of different tree and shrub species / land type combinations on forage growth. |
| Does not include the re-distribution of water in the landscape. |
| Does not include available browse from standing mulga trees. |
| Does not separate palatable and unpalatable forage. |
| Does not include a level of complementarity between sheep and cattle. |
| Assumes a average background level of grazing by feral and native herbivores. |

### 6.5 Conclusions

This Chapter has summarised a successful approach to technology transfer in the area of grazing land management in south-west Queensland. In applying and evaluating a model to calculate a "safe" long-term grazing capacity for individual properties the grazier consultants developed a sound understanding of the ecological principles (rainfall-average forage growth-"safe" forage use-"safe" grazing capacity) and terminology behind the model. They contributed to refinement of the model and enhanced its introduction to the region through the development of partnerships among researchers, extensionists, graziers, financiers and administrators. In addressing sensitive issues such as grazing capacities of individual properties this approach may serve as a model for dealing with other issues and other regions.