



# Guidelines for the development of extensive cattle stations in northern Australia

**Insights from the Pigeon Hole Project** 









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# Preface

The Pigeon Hole project was initiated to identify strategies to improve the profitability and sustainability of large cattle stations in northern Australia. The economic returns of northern beef businesses at the time were being eroded by an unprecedented increase in key operating costs. Economic modelling suggested that one of the more effective ways to increase efficiency and profitability was to increase the sustainable carrying capacity.

Results from a seven-year small-paddock experiment conducted by the NT Department of Primary Industry and Fisheries (NTDPI&F) on Heytesbury Beef's Mt Sanford Station in the Victoria River District (VRD) suggested that the sustainable carrying capacity of some pastures could be doubled through more even grazing distribution. To investigate the potential for commercial verification of this opportunity, Dr Steven Petty from Heytesbury Beef initiated a joint venture research project between Heytesbury Beef, MLA Donor Company, CSIRO, NTDPI&F, NT Parks and Wildlife and the University of Queensland. Heytesbury Beef invested \$1 million in the development of an experimental complex on Pigeon Hole Station in the VRD.

The study was undertaken at an unprecedented scale. It involved approximately 350km<sup>2</sup> of land and around 5,000 head of cattle. The experimental complex was developed in 2002 and 2003, requiring 213km of new fencing, 14 new water points, a new set of yards and upgrading of the existing infrastructure on the southern portion of Pigeon Hole.

Key staff from CSIRO, NTDPI&F, NT Department of Natural Resources, Environment and the Arts, and the University of Queensland worked co-operatively to conduct many components of the experiment and provided the majority of the scientific and technical input to the project. Data collection began in May 2003 and concluded in October 2007.

This commercial-scale project demonstrated that paddock carrying capacity can be significantly and sustainably increased in some areas. The keys to this are the use of sustainable pasture utilisation rates and appropriate development of paddocks and water points. Grazing management based on set pasture utilisation appeared to be the most profitable grazing system. The use of advanced technologies such as telemetry to manage water points can offer improvements in efficiency and cost savings. The key outcomes and recommendations of this project are presented in this small book.



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Contents

Preface	ii
Acknowledgments	ii
Key messages when intensifying development	iv
1. Increasing property returns	1
2. Principles for increasing carrying capacity	2
3. Assessing potential for development	4
4. Estimating sustainable stocking rates	8
5. Grazing systems	15
6. Improving management efficiency	16
7. Conserving biodiversity	20
8. Economic benefits of intensive development	22
9. Case studies	24
9.1. Beetaloo, Mungabroom and OT Downs	24
9.2. Pigeon Hole Station	26
Appendices	
1. Assumptions for analysis presented in Table 8.1	28
2. Additional reading and resources	29
3. Photos from the Pigeon Hole project	30

# Key messages when intensifying development

- Any development plan must include budgeting for:
  - costs of new infrastructure including maintenance of additional fencing and waters, and changed operating costs
  - possible purchase of stock
  - foregone sales through retention of breeders
  - cash flow during development
  - potential risk due to climate variability or market volatility.
- Increasing the carrying capacity of a property through better distribution of cattle and grazing could be a less expensive option than purchasing new land in the region.
- Cattle should be encouraged into areas of under-utilised pasture through a combination of more frequent water points and subdivision fencing.
- Develop additional waters first, then subdivision fencing.
- Before any program of capital development, assess current and potential carrying capacity of each paddock on the property to identify areas that could be developed economically.
- Complete a property assessment of the potential for development, including estimated costs and benefits.
- Current and potential carrying capacity must be sustainable and related to the capacity of the land system or pasture type and the level of development.
- Increased stock numbers will require extra handling facilities. Decide whether to budget for new yards or for laneways to existing yards.
- Adopt a grazing system that may allow a paddock to be spelled during the wet season. This will restore pasture condition and may allow prescribed burning to control shrub and tree thickening.
- Make use of new management tools to improve management efficiency and minimise costs. These could include remote monitoring of bores and water points through telemetry, and providing dry season supplements through water medication.
- Monitor pasture condition regularly.
- Higher stock numbers demand higher levels of management, and may increase risk.
- Grazing additional stock in previously under-utilised grassland may reduce:
  - the frequency of uncontrollable wild fires
  - feed reserves in times of drought
  - biodiversity.
- Identifying the most cost-effective and practical options will allow development to be focused in the areas offering the highest return.
- Understand and consider the effect of intensifying on the biodiversity of both the property and the region.

# 1. Increasing property returns

The Pigeon Hole project in the VRD explored opportunities to improve profitability of cattle stations through intensification. This book captures the main findings from this project.

### **Management options**

Management strategies that could realise the potential from more intensive development of a property include:

- Increasing the overall carrying capacity without degrading the pasture resource through infrastructure development.
- Reducing the total operating costs of a station through more innovative management such as the use of laneways, different mustering techniques, nutrient supplementation through the drinking water, and telemetry.

Questions that need to be considered before selecting any strategy for development are discussed in more detail in various chapters:

- How much of the property is not being grazed? (Chapter 2 and 3)
- What is the sustainable stocking rate? (Chapter 4)
- Would a different grazing system improve the condition of the pasture? (Chapter 5)
- What tools are available to facilitate management? (Chapter 6)
- How will biodiversity within the property be affected? (Chapter 7)

Other management options to improve productivity and profitability are described in more detail in other MLA publications. These include:

Weaner management in northern beef herds (2012)

Heifer management in northern beef herds (2nd Edition 2012)

Phosphorus management of beef cattle in northern Australia (2012)

Water medication: a guide for beef producers (2005).

## **Budgeting developments**

Before implementing any development strategy, management must plan for and budget for:

- costs of new infrastructure or equipment
- potential purchase of stock to use any new area of pasture
- foregone sales through the retention of breeders to use any new area of pasture
- recurrent costs for maintenance of new infrastructure or equipment, or provision of supplements
- cash flow during development
- training the work force with any new skills
- potential risk due to climate variability or market volatility.



Vast paddocks of over-grazed and ungrazed grassland. Can profitability be improved by spreading cattle into undergrazed areas through better distributed waters and extra fencing?

# **2. Principles for increasing carrying capacity**

Increasing carrying capacity of a property must be achieved through better grazing distribution of the cattle; not by increasing cattle numbers over the same grazed area. Spreading the cattle over the whole paddock will give them access to more of the available pasture, ensuring its more efficient use.

Carrying capacity is a significant factor driving the profitability of businesses in this region.

#### Too few water points

In many paddocks across northern Australia, cattle cannot graze over all the available pasture because water points are not well distributed. If the areas that are not being grazed, or are being grazed inefficiently, can be identified and developed, the carrying capacity of the paddocks could be increased.

As an example (Figure 2.1), a 100km<sup>2</sup> paddock has been running 855AE (adult equivalents) per year over the past 15 years, and the pasture condition has been stable — though not necessarily good.



Figure 2.1. Existing water points and distribution of grazing in a typical paddock in the VRD region

This average paddock stocking rate of 8.5AE/ km<sup>2</sup> has been based on the area of each land system and the sustainable stocking rate for each land system (Table 2.1). But as cattle graze mostly within three kilometres of water, they are probably using only 50% of the paddock (shaded area in Figure 2.1). Thus the actual stocking rate of the watered area of this paddock is 17AE/km<sup>2</sup>.

Table 2.1. Carrying capacity of the example paddoc	k
with existing development	

Land system	Sustainable stocking rate (AE/km <sup>2</sup> )	Total area (km²)	Watered areas (km²)	Current carrying capacity (AE)
Wave Hill	18	85	45	810
Gordon	9	10	5	45
Humbert	5	5	0	0
Total		100	50	855

With additional water points and fencing (Figure 2.2), cattle could graze the whole paddock.

With this additional area of each land system and appropriate carrying capacities, the paddock could carry 1,645AE (Table 2.2).



Figure 2.2. New and better distribution of water points and extra fencing allow cattle access to 100% of the available pasture.

This development is estimated to increase the carrying capacity of the paddock by 790AE.

Table 2.2. Carrying capacity of the example paddock with full development

Land system	Sustainable stocking rate (AE/km²)	Total area (km²)	Watered areas (km²)	Potential carrying capacity (AE)
Wave Hill	18	85	85	1,530
Gordon	9	10	10	90
Humbert	5	5	5	25
Total		100	100	1,645

Land system	Sustainable stocking rate (AE/km²)	Total area (km²)	Current carrying capacity (AE)	Potential carrying capacity (AE)	Increase (AE)
Wave Hill	18	85	810	1,530	
Gordon	9	10	45	90	
Humbert	5	5	0	0	
Total		100	855	1,645	790

Table 2.3. Current and potential carrying capacity of the example paddock

The pre- and post-development capacity of the paddock (Table 2.1 and Table 2.2) is summarised in Table 2.3.

The estimated cost of this development would be around \$130,000 (2010 prices) or \$165 per additional AE developed.

Increasing the capacity of the property could well be a more attractive option than purchasing additional capacity by buying part or all of a neighbouring property. The economic and management efficiencies associated with a larger, more intensive business are discussed in later chapters.

# Water plus fencing



The aim is to spread cattle into under-utilised parts of the paddock by providing extra waters.

Traditionally, the best way to spread out cattle has been to install additional water points. However, work from the Pigeon Hole Project suggests that, in larger paddocks, additional water points alone were less successful than a combination of adding waters and subdividing the paddock. With extra waters alone, cattle tended to continue to graze previously grazed areas despite these areas having a lower bulk of palatable pasture.

Thus the most effective way to spread cattle grazing is to install additional waters and to fence to reduce paddock size. Smaller paddocks force the cattle to be more uniformly distributed across the landscape, providing capacity to better manage selective grazing of:

- preferred pasture types
- previously grazed patches
- riparian areas
- burnt areas.

This is important in areas with variable land types and areas where some land types are preferentially grazed.

#### **Broader application**

There is significant potential for development on many of the extensive stations in north Queensland, the Northern Territory and the Kimberley of Western Australia. Additional benefits will still occur even if the station is currently overstocked and the development is used only to accommodate the existing cattle. These cattle will become more productive, overgrazed paddocks can be restored and additional stock will not have to be purchased for the new grazing areas. Generally, there is less potential on more developed properties in central and northern Queensland.

#### Word of caution

Extrapolation of stocking rates from paddocks that are not fully developed, such as depicted in Figure 2.1, to adjacent paddocks with different levels of development and/or land systems may provide incorrect stocking rates. For example, if the paddock in Figure 2.1 (50% developed) had a sustainable stocking rate of 8.5AE/km<sup>2</sup> and this was applied to an adjacent paddock with a similar pasture type but that was only 30% developed, it would be overstocked.

# **3. Assessing potential for development**

The first step in assessing the potential for development is to prepare a whole-station development plan. This plan will identify the areas of the property with potential for development, the size of these areas, the estimated increase in carrying capacity, the cost of development and economic benefits of development for each area or paddock. Identifying the most cost-effective and practical options will allow development to be focused in the areas offering the highest return.

The areas with potential capacity for development – those with large bodies of unused or very lightly-used **palatable** pasture at the end of the dry season – can be identified by either an on-station assessment (assessing the volume and location of the forage) or through a desk-top assessment using digital mapping.

#### **On-station assessment**

In an on-station assessment, all paddocks need to be assessed late in the dry season (October to December) of an average year. This is best done with a vehicle if there is reasonable access through the paddocks, more broadly but less accurately from an aircraft. Drive or fly a grid over each paddock and mark the level of grazing (ie heavy, medium or light as in Figure 3.1) on a paddock map. Draw a line around the areas of light or no grazing as these are likely to have most potential for development. In the example in Figure 3.1, approximately 40% of the pasture in the paddock has very low levels of grazing while 15% of the paddock is overgrazed.

Check the assessment on the ground using a GPS and roads and fence lines to provide reference points. Once confirmed, this map indicates the area in the paddock that has potential for development.



Figure 3.1. Aerial photograph with overlay of assessment of grazing intensity

Once the well-grazed and lightly-grazed areas are identified, the area of each land system within and outside the grazing radii is calculated (eg Table 3.1) to give the area of each land system with potential for development in each paddock.

Table 3.1. Summary of the area developed (ie within a 3km grazing radius of water) and undeveloped for a paddock in the VRD

Land system	Area of land system (km <sup>2</sup> )	Watered area (km²)	Area with no water (km <sup>2</sup> )	Percentage developed (%)
Wave Hill	85	45	40	53%
Gordon	10	5	5	50%
Humbert	5	0	5	0%
Total	100	50	50	50%

#### **Desk-top assessment**

This is a more sophisticated, but less accurate, method of identifying the ungrazed areas of a paddock. Mark all of the permanent water points (man-made and natural) on a map of the paddock. Draw a typical grazing radius (3km) to define which area is grazed most in a typical dry season; the area outside the 3km grazing radius is assumed to be more lightly grazed.



Figure 3.2. Example based on Mt Sanford Station in the VRD showing paddock boundaries and 3km grazing radii around permanent water points

#### Walking distance

Three kilometres is suggested as a typical grazing distance for cattle for most extensive regions across northern Australia. In the VRD, about 90% of the grazing occurs within a 3km grazing radius of permanent water points, and more than 80% of cattle activity was within 5km of water in the Barkly.

The effect of distance from water on the grazing intensity on Mitchell grass plains is illustrated in these photographs of pasture.



Heavy grazing intensity near water



Moderate grazing intensity within 2-3 km of water



Light grazing more than 3km from water

Permanent waters can influence grazing patterns in both the dry and the wet seasons. During the wet, cattle preferentially graze the areas of fresh pasture regrowth adjacent to the water point thus minimising the energy spent to meet their nutritional requirements.

Factors that influence grazing include:

- adjacent more palatable pasture types
- drainage lines that may be preferentially grazed especially in the dry season
- access to semi-permanent waters for part of the year
- natural territory of the cattle grazing the paddock
- location of alternative waters and supplements.

Areas that have little grazing should be checked on the ground to confirm their potential for development. In particular, confirm that:

- the areas are large enough to justify additional water points
- the carrying capacity of the country/land systems within this area is sufficient to justify development
- there are no physical limitations, such as rugged hills, rivers, or difficult country to muster, that may restrict development
- there is capacity to develop the land, including access to water, suitability for fencing, and access to yards
- at the same time, consider whether the area should remain ungrazed to maintain biodiversity.

#### Fencing costs and optimum paddock size

Progressively fencing into smaller paddocks improves grazing distribution across the landscape; it also significantly increases the cost of development per unit area. There is obviously a balance between size of the paddock, uniformity of grazing and cost of development.

With paddocks that are well watered (where most pasture is within 3km of water), the smaller the paddock the greater proportion of the paddock grazed (Table 3.3).

Table 3.3. The effect of paddock size on the percentage of a paddock grazed (over a six-month period) and the average distance cattle ventured away from water (based on GPS collar data)

Paddock size (km²)	Proportion of paddock used (%)	Average distance of cattle from water (km)
9	94%	0.9
34	80%	1.5
57	76%	1.4
149	76%	2.9

The capital cost of developing smaller paddocks is significant. The cost of subdividing a larger paddock into smaller and smaller paddocks and installing additional water points has been calculated. Typical costs (2010) were based on a three-strand barb-wire fence, the waters supplied from new bores, with poly pipe, tanks and troughs.

The cost of development increases exponentially as the size of the paddock decreases (Figure 3.3). With paddocks of less than 30–40km<sup>2</sup>, the major cost is for fencing; for paddocks larger than this, the provision of water predominates. Actual costs will be sitespecific.

In a highly productive land type in the VRD, a paddock size of 30–40km<sup>2</sup> with two wellseparated waters gives a good balance between improving grazing distribution (Table 3.3) and the cost of development (Figure 3.3). In larger paddocks, waters should be no further than 6km apart.



Figure 3.3. Costing of progressively fuller development, through subdivision, of a large paddock to allow cattle access to 100% of the available pasture

Waters should be located away from fences, riparian areas (creek lines) and areas that have a history of grazing. In the VRD, the number of cattle per water point should be limited to about 300 head, and this will probably be similar across the more extensive grazing regions in northern Australia.

When subdividing to create smaller paddocks care must be taken to include sufficient areas for preferential seasonal grazing, for example areas of well-drained soils suited to wet season grazing.

Subdivision of large paddocks also provides other opportunities including:

- better ability to manage stocking rates
- ability to spell pastures and use rotational grazing
- allow prescribed fire to manage woody shrubs and tree regrowth, and to manage patch grazing through spelling
- less frequent large wildfires due to lower fuel loads from higher grazing levels
- potential to reduce mustering costs.

However, adverse effects from subdivision and higher carrying capacity may include:

- loss of biodiversity (Chapter 6)
- reduced diet selection by cattle (potentially resulting in poorer diet quality) due to the reduced grazing area
- less fodder available as a drought reserve, increasing risk in dry years
- less opportunity to use fire as a management tool as fuel loads are lower
- higher potential degradation of pasture and land if paddocks are not stocked sustainably.



More even grazing management through subdivision may reduce uncontrollable wild fires, but may give less opportunity to use fire to reduce woody shrubs because of lower fuel loads.

On balance, well-managed subdivision is likely to have a major positive and sustainable impact on the economic return of a beef business in the extensive rangelands of northern Australia.

# Managing grazing distribution within paddocks

In intensively developed paddocks of 30–40 km<sup>2</sup>, patch grazing can still occur where cattle selectively graze small localised areas along creeks and elsewhere. These patches are repeatedly grazed because the young regrowth that occurs after grazing is more nutritious; however, if grazing is excessive, valuable perennial grasses can be replaced by annuals that provide little or no dry season bulk.

Patch grazing needs to be managed to minimise the risk of degradation. This may be aided to some extent using fire, wet season spelling and the strategic location of supplements. Burning tall dry grass in lightlygrazed parts of the paddock encourages stock onto green pick in the burned areas, and resets the grazing pattern.



Burning old mature pasture encourages cattle onto new grass in ungrazed areas.

The impact of burning may vary with pasture type; more information can be found in other publications such as *Savanna burning: understanding and using fire in northern Australia* from the CRC for Tropical Savannas.

# 4. Estimating sustainable stocking rates

Keeping stocking rates at sustainable levels is critical to the long-term productivity of a pastoral business. More intensive development is likely to reduce the buffering capacity of a station as more pasture will be more accessible to cattle, and this can increase the risk of overstocking the paddocks and of breeder mortalities in dry years. As a station is developed more intensively, it becomes more critical to manage annual stocking rates to avoid pasture degradation.

#### Why is stocking rate so important?

Stocking rate has the most influence on livestock production and land condition. Choosing an appropriate stocking rate is a matter of striking a balance between achieving good livestock production and avoiding degradation of the pasture or soil. In this chapter, methods for setting appropriate stocking rates will be discussed.

Stocking rate will affect the productivity of the herd. Higher stocking rates result in lower production of each animal and in higher variability in production per animal and production per unit area between years. The production penalty of higher stocking rates was demonstrated at Mt Sanford. Figure 4.1 shows how stocking rate affected animal production per animal and per unit area at over a five-year period of good rainfall.

While the productivity per animal declines with higher stocking rates, the animal productivity per unit area will increase – up to a limit. When

Figure 4.1. Effect of stocking rate on average liveweight gain (LWG) per head (blue line) and per unit area (red line) on Mt Sanford Station (2001–2005)



the stocking rate becomes too high, individual animal production crashes – cows are in too poor condition to re-conceive and growing stock fail to reach target weights. At the same time, valuable pasture species are lost while runoff and soil loss increase from poor ground cover.

Over the five-year trial period with good rainfall, pasture condition of these resilient black soil pastures did not decline further significantly with the higher stocking rates. However, if this pasture was stocked heavily for more than a decade, the pasture condition, and animal productivity, would be likely to decline further.

Increasing the productivity per unit area by increasing the stocking rate (up to an optimum level) results in an increase in profitability or EBIT (earnings before interest and tax) (Figure 4.2).





Although the production per animal declined at higher stocking rates, the profitability per unit area increased at stocking rates which were equivalent to a sustainable pasture utilisation rate of 20% on these Mitchell grass pastures.

#### **Pasture utilisation**

Pasture utilisation is the proportion of the *annual* pasture growth that is eaten in a 12-month period. It depends on the stocking rate and pasture growth within that period.

Note that 'utilisation' is not the same as the level of defoliation of individual plants in the short term.

The Mt Sanford and Pigeon Hole projects were conducted over periods of seven and four years respectively and during relatively good seasons. These relatively short time spans, combined with the good seasons, allowed higher stocking rates without a major decline in range condition or animal production. (Note that many VRD pastures are already in only moderate condition after a century of heavy grazing.) Land condition must be monitored to ensure that stocking rates are maintaining stable land condition; long-term overgrazing will result in a decline in pasture condition.

# Sustainable levels of pasture utilisation

A sustainable rate of utilisation of a pasture reflects the proportion of the average annual pasture growth that can be grazed while maintaining or encouraging good land condition. This sustainable utilisation level allows a 'safe' long-term carrying capacity to be calculated.

A safe utilisation rate prevents:

- loss of desirable perennial species or an increase in undesirable species
- heavy soil loss or water run-off as at least 40% of the ground is covered at the end of the dry season
- a decline in livestock production over the medium to long term
- low pasture yields that prevent the use of fire to manage woody plant thickening.

Safe utilisation rates will vary with land or pasture condition and local environmental (soil type and climate) conditions.

Pasture utilisation rates consistent with good land condition have been defined by grazing trials and the experiences from properties where good pasture condition has been maintained over many years (Table 4.1).

Sustainable utilisation rates for native rangeland pastures in Queensland and the Northern Territory range between 10 and 22%. The 20% utilisation recommended for the Queensland and VRD black soils is probably applicable to other cracking clays in northern Australia.

Table 4.1. Suggested sustainable rates of utilisation of annual growth for common pasture types across northern Australia

Land type	Safe utilisation rate
Mitchell grasslands Qld	22%
Black soil NT	20%
Good red soil NT	15%
Poor red soil NT	10%
Spinifex NT	0–5%

### Some definitions

- Stocking rate the number of stock per unit area at a particular time.
- Short-term carrying capacity the number of animals that a paddock can support on an annual or seasonal basis.
- Long-term carrying capacity the average number of animals that a paddock can be expected to sustainably support over a long period (eg 10–20 years).
- Current carrying capacity the number of animals that can be carried under present levels of development and pasture condition.
- **Potential carrying capacity** the number of animals that could be carried after development.

## Livestock carrying capacity

More intensive water and fencing development will improve grazing distribution and therefore increase the carrying capacity of a property. In theory, calculating this increase in carrying capacity is a relatively straightforward exercise. However, some paddocks may already be stocked above or below the sustainable carrying capacity, and pasture condition and the level of development will also influence the carrying capacity of a paddock.

#### **Current carrying capacity**

The current carrying capacity is the number of adult equivalents the paddock or station can sustainably run given the current level of development (waters, fencing and current pasture condition).

#### **Potential carry capacity**

The potential carrying capacity is the total number of adult equivalents that a station or paddock could sustainably run if it was fully developed and cattle were able to graze more or all of the paddock.

The difference between potential carrying capacity and current carrying capacity is the potential for development.

Calculating the potential for development requires a good understanding of the sustainable carrying capacities of each of the land systems or pasture types on the station. This chapter describes how to calculate the sustainable carrying capacity of key pasture types.

# Estimating short- and long-term carrying capacities using the GLM method

The Grazing Land Management (GLM) manual (produced by MLA EDGE*network*) provides considerable detail on estimating the short-term, long-term, potential and current carrying capacities.

An example that relates to results in the VRD region has been included below.

# Estimating short-term carrying capacity – forage budgeting

The short-term carrying capacity is the number of adult equivalents that a paddock can sustainably carry in any particular year or season. Short-term carrying capacity is determined by the amount of useful forage currently available and safe levels of consumption. It involves estimating the average herbage mass (bulk of pasture) in each land system at the end of the growing season and multiplying this by a utilisation rate for each land system to provide the kilograms of forage per hectare that can be eaten over the next year. The carrying capacity is determined from the number of standard animals (adult equivalents or AEs) that this bulk of pasture can carry, as in the following formula.

Estimating the carrying capacity using this method requires:

 An estimate of the average bulk of standing grass forage (kg/ha) at the end of the growing season. • The proportion of pasture that can be sustainably grazed over a year (ie the sustainable pasture utilisation rate).

$$CC = \frac{P \times 100 \times U\%}{FD}$$

The standard animal (1AE) is assessed to eat on average 3,650kg of herbage in a year.

CC = Carrying capacity in AE/km<sup>2</sup> P = Current standing pasture (kg DM/ha) U = Utilisation rate of pasture (%)FD = Forage demand (3,650kg/AE/year)

Thus, if the standing forage (P) is 2,000kg DM/ha and we can sustainably utilise (U) 20% (0.20) of this, we could graze 400kg of this pasture per hectare (multiply this by 100 for kg/km<sup>2</sup>). With an average forage demand (FD) of an AE at 3,650kg DM/year, the paddock could carry 400kg x 100/3,650 =  $11AE/km^{2}$ .

On properties where cattle numbers can be altered easily through sale or purchase or agistment, carrying capacity and hence stocking rates may be varied between years to reflect inter-annual rainfall variability.

The variation in short-term carrying capacity at the Pigeon Hole site during the grazing trial is shown in Table 4.2.

Table 4.2. Variation in annual carrying capacity at the	e
Pigeon Hole grazing trial (2003–2007)	

	Standing forage in May (kg/ha)	Short-term carrying capacity (AE/km <sup>2</sup> )
Poorest year – 2003	1,000	5.5
Average (2003–2007)	1,900	10.4
Best year - 2004	2,700	14.8

#### Estimating standing bulk of pasture

The amount of pasture growth is a function of the timing and amount of rainfall and varies significantly between years. The amount of pasture growth present can be estimated from photo-standards or by cutting representative areas of pasture as described in the GLM manual.

Pasture growth needs to be estimated for each land type. The photo-standard examples shown on the next page are for a mixed tropical tall-grass pasture.



Estimate of standing bulk as dry matter - 1,000kg/ha



Estimate of standing bulk as dry matter - 3,000kg/ha

#### Estimating long-term carrying capacity

Long-term potential carrying capacity is calculated using the average pasture growth based on pasture growth models or long-term data—but discounted if the pasture is not in good condition. The local government adviser or a consultant can be asked to complete these calculations for a station as it needs to be done only infrequently. Carrying capacity may eventually increase if the general condition of the pasture improves under a better management regime.

# Estimating long-term average pasture growth

The GRASP pasture growth model developed in Queensland is used to estimate longterm average pasture growth for different land types and rainfall. The model has been calibrated using local field data for a range of land types across the VRD, Sturt Plateau and Barkly regions (Figure 4.3).



Estimate of standing bulk as dry matter - 2,000kg/ha



Estimate of standing bulk as dry matter - 4,500kg/ha



Figure 4.3. Estimated annual pasture growth (blue bars) on Mt Sanford between 1901 and 2010 (calculated using the GRASP pasture growth model), and the 10year running average (black line)

#### Calculating the station's long-term carrying capacity

A station's current carrying capacity and potential carrying capacity can be calculated by totalling the carrying capacities of the individual paddocks (Table 4.3).

The current station carrying capacity is the sustainable carrying capacity over an average run of seasons, but modified by current

Photo-standards for a mixed tropical tall-grass pasture

Paddock	Land system	Area (km²)	Access due to topography (%)	Carrying capacity (AE/ km²)	Watered and accessible area (km <sup>2</sup> )	Current CC (AE)	Potential CC (AE)
Bullock	Wave Hill Gordon Humbert	85 10 5	100 85 75	18 9 5	50 5 -	900 45 -	1530 77 19
	Subtotal	100			55	945	1,625
Ten Mile	Wave Hill Richenda	104 31	100 1	18 5	75 Not ec	1,350 conomic to d	1,872 levelop
	Subtotal	135			75	1,350	1,872
Weaner	Wave Hill Gordon	35 12	100 85	18 9	33 10	594 90	630 92
	Subtotal	47			43	684	722
Backblock	Gordon Humbert	125 38	85 75	18 5	50 5	900 25	1,913 143
	Subtotal	163			55	925	2,055
Etc for all pa	addocks on st	tation					
Total		2,158			1,250	16,525	27,622
Average sto	cking rate (AE	E/km²)				7.7	12.8

Table 4.3. An example of the sustainable current and potential carrying capacities of a station

pasture and land condition and the present level of development (access to water).

The potential carrying capacity is the capacity once the station is developed to the maximum watered area, and any eventual improvement in land condition.

The difference between the two carrying capacities is the potential for development. Not all land types will be economical to develop further, especially if they have low carrying capacities, such as spinifex ridges and desert country with carrying capacities of less than 3AE/km<sup>2</sup>.

#### Managing station stocking rates

Managing the station's carrying capacity each year is challenging given the variability in rainfall and in pasture growth between seasons and years.

Variability in wet season rainfall for a VRD station is illustrated as year by year and as a three-year moving average in Figures 4.4 and 4.5.

Results from a long-term grazing trial in north Queensland suggest the most profitable medium- to long-term grazing strategy is to maintain a moderate (sustainable) stocking rate. Varying animal numbers simply in line with pasture growth (eg at the end of the wet season) has been less successful. Greatly increasing the stocking rate in response to above-average pasture growth over the past





Figures 4.4 and 4.5. Wet-season (October to April) rainfall at Victoria River Downs Station – (top) year by year, (bottom) as three-year moving average

wet season has resulted in economic loss and land condition decline when the next wet season has been below-average.

However, assessing the adequacy of pasture at the end of the wet (through forage budgeting) can avoid costly supplementation or forced sales of cattle. It also helps ensure adequate ground cover to protect the soil at the start of the next wet season.

The stocking rate may be varied by 10– 15% each year in direct line with seasonal conditions, but preferably with a general decline during a run of poor seasons or a general increase during a run of good seasons. Stocking rates should still not exceed carrying capacity as a run of good seasons will not last for ever (Figures 4.4 and 4.5).

This strategy relies on the pasture having a reasonable level of resilience to allow for an averaging of the annual utilisation rates. Pasture in good condition can recover from two to three years of drought, as long as stock numbers are reduced proportionately to the decline in pasture growth. However, a severe drought may require a rapid reduction (30–40%) in stocking rates to guard against long-term declines in pasture productivity and to prevent serious animal losses, although this will reduce returns in the short term.

A generalised example of opportunistic management is shown in Figure 4.6.

Flexible stocking can have production benefits per unit area, but requires a higher level of management to ensure paddocks are not overstocked in a run of below-average years, and this becomes more critical with the level of development.

A station with moderate to low levels of development will have large areas of pasture that are distant from water. In drought conditions, the cattle can walk further and access these 'reserves' of grass. In a fully developed station, this 'reserve' is no longer available putting more responsibility on the land manager to adjust the annual stocking rate to compensate for the seasonal conditions. Thus the higher the level of development, the higher the risk, and the greater the need to manage this risk by reducing stocking rates in poorer seasons.

With between-year variability, it is challenging to estimate how much the stocking rate needs to be varied up or down in a particular year to ensure the annual stocking rate does not excessively exceed the sustainable carrying capacity of each paddock, or of the station, in that season.

#### Calculating annual grazing pressure

Knowing the annual stocking rate applied and relating this to the impact on the pastures provides the basis for a review of the annual stocking decisions. The manager needs to understand and be able to calculate the annual grazing pressure within each paddock for each year but this can be difficult if the paddock holds several classes of stock each with a different AE rating.



Figure 4.6. Example of opportunistic management of stocking rate over variable seasonal conditions (from GLM Manual)

Paddock	Area	Long carrying	-term capacity	Breeders	Bulls	Spay cows	Joiner heifers	Heifers	Weaner heifers	Steers	Weaner steers	Current AE	% of CC used (%)
	km²	AE/km <sup>2</sup>	AE	1.4	1.6	1.2	1	0.75	0.5	0.75	0.5		
Bullock	120	12	1,440	900	36							1,318	92
10 Mile	85	16	1,360	1,000	40							1,464	108
Adder	45	14	630			550						660	105
Watsons	72	8	576				600					600	104
Lyons	88	9	792					800				600	76
Coles	130	6	780						550		550	550	71
Etc for all p	addocks	on station											
Total	3,550	9	31,950	9,000	405	1,200	2,700	5,063	3,510	5,265	3,510	28,644	90

Table 4.6. Example of a simple spreadsheet that calculates annual paddock stocking rate and total station stocking rate from the number of each class of cattle

Few tools are commercially available to help with these calculations. One option is a simple spreadsheet that calculates the annual stocking rate for each paddock based on the class of animals in that paddock (Table 4.6). For example, 900 breeders and 36 bulls kept in the Bullock paddock for 12 months would equate to 1,318AE for the year.

The spreadsheet also calculates the proportion of the annual carrying capacity used in the paddock. In the above example, the stock are using 92% of the carrying capacity of the paddock, and this can then be related to the annual carrying capacity for that year (eg if the season received 90% of the average annual rainfall, this stocking rate would be considered safe). These calculations are difficult to do on the run as cattle are being drafted through the yards, and need to be planned before the muster.



Ungrazed land wastes a resource and allows uncontrollable hot fires, but can provide a reserve of feed for cattle in a drought year and for biodiversity.

#### Adult equivalents in a paddock

Calculating the annual stocking rate for a paddock with breeders (as above) is a relatively simple, but the calculations are more difficult in grower or other paddocks where the number, weight and class of cattle varies through the year. For example if the target annual stocking rate for a grower paddock was 1,000AE and 1,400 steers with an average weight of 300kg (0.7AE/steer) were removed in June for sale (ie 1,000AE) and 1,000 weaners averaging 210 kg (0.5AE/steer) were put back in August after the first round, about 1,080 head second-round weaner steers of 190kg (0.4AE/steer) can be put in the paddock in October to take the annual carrying capacity to 1,000AE.

The point being made is that the calculation is not simple, but needs to done to maintain a sustainable stocking rate. These calculations can also be completed on a spreadsheet accounting for the stocking rate on a monthly basis.



Constant heavy grazing degrades pasture and land condition.

# 5. Grazing systems

Development with extra waters and fencing provides the opportunity to manage the native pasture resource more efficiently through more intensive grazing systems. These grazing systems have sometimes been reported to improve grazing distribution, increase the sustainable utilisation of the pasture resource and regenerate degraded pastures.

Research at Pigeon Hole evaluated four grazing systems:

- set stocking
- changing the stocking rate annually to match seasonal conditions
- wet season spelling
- cell grazing.



Systems with wet season spelling could improve the condition of locally degraded pasture over the long term.

None of the more intensive grazing systems provided a significant improvement in animal production or pasture condition over the duration of the trial (four years of good rainfall).

Another project evaluating a range of grazing systems on a large number of stations across Queensland has also concluded that that intensive grazing systems do not produce any significant advantage in carrying capacity or land condition over that in which paddocks were continuously grazed and stocked to match carrying capacity. Rainfall had a greater impact on pasture condition than grazing system.

Never the less, certain grazing systems may provide some advantages from an animal management or a pasture management perspective.



Cell grazing gives most control over pasture management but may not improve animal productivity or economic returns.



Frequent heavy traffic between paddock cells during the wet season can create problems on cracking clay soils. For example, wet season spelling can allow recovery of degraded pastures.

Cattle can be forced to spread their grazing across a paddock with multiple waters by sequentially turning the waters off for a period.

#### Turning off the water

At Rockhampton Downs on the Barkly Tableland, cattle were trained to move between waters in large paddocks, thus progressively spelling the pasture as different waters were turned off, leaving only one water on at a time. This approach may increase carrying capacity without the cost of additional fencing although there is much less control over the cattle and where they graze. It requires additional effort and cost in the early stages to train the cattle and to ensure none perish near waters that have been switched off.

# 6. Improving management efficiency

More intensive development of infrastructure involving additional water points, fencing and an increase in cattle numbers can significantly increase the total operating cost of the station, but must not be allowed to increase operating costs per head.

The potential increase in operating costs per head can be managed by introducing more efficient management strategies and/or more innovative technologies. These may include:

- laneways and yards to manage the cost of mustering the additional cattle
- alternative mustering techniques to manage the cost of mustering the additional cattle
- telemetry to manage the cost of monitoring the additional water points
- delivering supplements via the water supply – using water medication to reduce the cost and improve the effectiveness of diet supplementation.

As these strategies will require investment of additional capital, they have to be cost effective.

### Laneways and yard location

The optimum location of yards is usually central to the developed paddocks. With 500–800 head per paddock (depending on the pasture type), an efficient configuration is a small set of yards central to a set of four paddocks. This provides easy mustering, minimises the distance the cattle have to walk to the yards during mustering and to return to the paddock, and allows easy processing of breeders and growers. But as yards are an expensive capital item, an alternative is a network of laneways leading from each paddock to a larger set of yards.

Other factors that will influence the location of a set of yards include:

- availability of water
- type of soil (avoid dusty soils)
- suitable access to the location
- prevailing wind.



Build new yards or fence laneways to existing yards?

### **Mustering technique**

Additional fences, waters and laneways under an intensive development program will significantly change the mustering strategy. Smaller paddocks are likely to simplify mustering, leading to additional smaller musters. The increase in numbers per unit area may also reduce the mustering cost per head. The most appropriate mustering technique will be a function of the topography, labour costs, helicopter costs, management system and other site-related factors.

Four mustering styles were tested in the intensively-developed paddocks on Pigeon Hole to determine which was the most cost-effective in this environment (Table 6.1). The mustering strategies tested were:

- helicopter plus riders on horses
- plane plus riders on horses
- helicopter alone with no support staff
- riders on horses only

Although the helicopter on its own was cheapest, calf mortality or loss (wet cows in the yard versus calves in the yard) was 1.3% higher than using the helicopter plus riders on horses. This could be equated to \$2.50/head in the herd if all of the calves left behind died and if the calves are valued at \$250 each; it represents an additional cost for helicopteralone mustering.

# Table 6.1. Comparison of the cost of four mustering strategies on the intensively developed paddocks (10–35km<sup>2</sup>) on Pigeon Hole in the VRD

Mustering technique	Cost/head	Cost/km <sup>2</sup>
Helicopter plus riders on horses	\$4.80	\$55
Plane plus riders on horses	\$3.50	\$40
Riders on horses	\$3.00	\$34
Helicopter alone	\$1.80	\$21

In smaller, more intensively developed paddocks, mustering costs per head and calf losses may be reduced through more ground-based support.

Many commercial businesses with larger paddocks (150km<sup>2</sup>) are using helicopters without ground-based support due to lack of experienced staff or to save labour costs. Along with the many other factors that influence their choice of mustering strategy, these properties need to consider calf loss and the medium- to long-term impacts of unmustered cattle.



Using helicopters alone for mustering is cheapest but may miss cattle and lose small calves.

## **Telemetry**

Telemetry can be used to reduce the cost of monitoring waters.

Additional waters and fencing are likely to increase the total cost of monitoring water points; telemetry has the potential to reduce the average cost of managing and monitoring them.

Telemetry involves the use of computers and UHF radios to monitor and manage water points and other equipment remotely. A telemetry system can record water level data and so reduce the number of times the bores need to be physically inspected, saving labour and vehicle costs.



Solar-powered Observant telemetry unit

In its simplest form, the telemetry unit monitors the depth of water in the tank or trough, and sends a signal via a UHF radio link directly back to the homestead computer. At the homestead, the computer shows depth information and provides the history for the previous hours, days, weeks, months or years.

The bores will still need to be checked physically, but the regularity may be reduced (eg from three times a week to once a week) with the use of telemetry.

A telemetry unit can be used for many associated tasks (usually at the same time).

These include:

- monitoring water depth in a trough, tank, turkey nest or dam
- monitoring water flow rate
- taking photographs of a site and sending these back to the homestead
- automatically starting and stopping bore motors
- monitoring water medication units
- turning taps on and off
- collecting rainfall information
- relaying information from other telemetry sites
- monitoring gates

- measuring, logging and sending animal weight information, and automatic drafting with a walk-over weighing system
- allowing the monitoring of water points over the internet.



Pump engine fitted with automatic start and stop device

The cost-effectiveness of any telemetry system depends on the site and how it is used. Typically, they recover their initial cost within six months to three years. Selection of an appropriate system, its design and its setup need to be considered carefully, especially in remote areas where there is little technical support. Telemetry systems are not 'set and forget', and typically require a significant level of ongoing maintenance to ensure their reliability. The units also need to be replaced regularly, eg every three to five years as would be done for a pump or vehicle.

Telemetry units may also require a change in the skills of the bore runner to include a basic understanding of electronics and computing; this can be a significant constraint to the adoption of the technology.

#### Water medication

Water medication may be a suitable addition to an intensively developed system. The higher average pasture utilisation, higher stock density and more controlled waters in the smaller paddocks make water medication a practical option.

If a herd of, for example, weaners or first-calf heifers, needs dry season supplementation, water medication can provide a nitrogenbased supplement at about a quarter the cost of supplement blocks—often at less than 3c/ head/day. Phosphorus was not considered deficient on these black soils and so phosphorus supplementation is not normally provided over the wet season.



Telemetry unit with camera monitoring a water medicator

Note: Water medication strategies are described in detail in the MLA publication – *Water Medication – A guide for beef producers* (2005).

Water medication requires a high level of management and care to deliver a consistent and safe supply of supplement. Telemetry can help manage some of these risks and increase the confidence in the safe delivery of the supplement.



Digital images taken by a telemetry unit can be displayed at the homestead.

# **Cattle management**

Subdivision fencing may allow more intensive management of cattle and pasture.

Improved animal management could include:

- segregation of classes of replacement heifers to allow management to improve fertility
- segregation of breeders and aged cows for targeted management
- strategic bull removal or controlled mating
- segregation of grower cattle into class and weight classes for targeted management.



Subdivision fencing allows better management of grassland and cattle.

Improved pasture management could include:

- Wet season spelling to improve pasture condition and ultimately increase carrying capacity
- Rotational burning to manage woody weeds and patch grazing.

## **Development plan**

An intensively developed system will usually have more waters and more paddocks per unit area, and the extra cattle will have to be processed through the yards. Although this reduces the mustering cost per head, there may be a logistical challenge if each paddock needs to be mustered independently (for breeders) and if each paddock mob needs to be moved to the yards and returned to their paddock independently. Good planning during development will help allow this to be practically and efficiently achieved.

Laneways, holding paddocks and additional yards can significantly reduce the cost and time required to get cattle to and from the yards while efficient yard design will speed up processing.

The choice between establishing laneways to help move the cattle to existing yards, or to build a new, more central set of yards will depend on:

- location of the paddocks relative to the yards
- number of cattle in the paddocks
- the cost of the laneway versus a new yard.

A plan of the fully developed site should be prepared before starting the development, starting with the end in mind.

This plan needs to include at least:

- all proposed new fencing
- gate location
- laneways
- all proposed new waters
- location of the poly pipe and troughs
- vards
- roads
- country type
- pasture monitoring sites
- any telemetry systems.

This plan also needs to consider:

- how to maximise the grazing distribution and use of the pasture resources
- the impact of land type and wind on grazing distribution
- access to new waters (eg location of dam sites or bore sites)
- most cost-effective way to muster the cattle
- most cost-effective way to process the cattle
- most cost-effective way to manage and monitor the additional waters
- flood gate issues
- efficient locations for new roads (also consider track and fence erosion issues)
- efficient monitoring of the fences.

The most effective way to manage the costs of development and any impact on operating costs is with efficient infrastructure. Development of efficient infrastructure starts with a carefully considered plan.

# 7. Conserving biodiversity

Biodiversity is the diversity of all living things in a particular area – plants, mammals, reptiles, birds and insects – and the range of habitats in which they live. Biodiversity is an indicator of a healthy environment where natural processes (such as water and nutrient cycling) are functioning well.

Pastoralism in most of northern Australia is based on native pastures with little broadscale clearing of trees or scrubs. These savannas support an impressive diversity of native species.

On the black soil grasslands within the Pigeon Hole trial area, a total of 223 plant, 75 bird, 20 reptile, seven mammal and 63 ant species were recorded. A single hectare of country near a small creek had 85 plant species and supported 26 bird species.

More diverse areas that contain a variety of land types, creeks and rocky areas would harbour even greater numbers of native plants and animals.

## Good pasture management

Cattle can adversely affect native species that are sensitive to grazing, restricting them to areas with low levels of grazing pressure.

Land near permanent waters typically is grazed more heavily and the most grazing-sensitive species are unable to survive there, whereas some other native species (increaser species) benefit from the development of water points or prefer areas where disturbance from grazing is high. Examples of increaser species include common birds such as galahs and crested pigeons, while grazing-sensitive decreaser species include the small mammal *Planigale ingrami* and the lizard *Ctenotus joanae*, which are more abundant further away from water.

Such patterns are familiar to pastoral managers. Under sustained heavy grazing, some of the most palatable pasture plants (such as Mitchell grass) can decrease to be replaced by less desirable increaser species such as wiregrasses and asbestos grass. The spread of native increaser species is not generally a positive biodiversity outcome (they



Heavy grazing from cattle closer to waterpoints may increase or decrease the abundance of native species.

are often already common and widespread), but the loss of decreaser species is a negative outcome if they are not common or are restricted to particular habitats.

More intensive development of previously ungrazed areas in a paddock can have a negative effect on the more grazingsensitive species, and therefore on the overall biodiversity values of that property or region. This effect will become more serious as larger areas become subject to development, and the refuges available to grazing-sensitive species become smaller and more isolated.

Sustainable grazing management can help ensure that many biodiversity values are maintained within the pastoral regions.

This is more effective than relying just on scattered national parks to conserve species as many species either do not occur in the park areas or rely on access to healthy habitat across broader landscapes.

### Mitchell grass is fairly resilient

The impact of intensive development on biodiversity was investigated at Pigeon Hole and Mt Sanford. Over the short period of the five years of the study, there were no clear and consistent effects on biodiversity. The black soil grasslands appear to be resilient to the impacts of grazing, and the areas studied had already been grazed for many decades. Except in the most sensitive land-types, changes in native plant and animal populations under heavier grazing are likely to be gradual. They may take longer than the duration of these grazing trials to become evident or they may be accentuated by extended drought.

#### Leave some areas ungrazed

Leaving selected areas unsupported by new water points or fencing off grazing exclosures are ways to protect biodiversity on a property that is undergoing more intensive development.

Ungrazed 'conservation areas' should be relatively large (square kilometres rather than hectares) to maintain viable populations of birds, mammals and other species.

#### **Fenced-off exclosures**

To investigate their value, areas of varying size (up to 400ha) were fenced off within the grazed paddocks at Pigeon Hole.

After five years, some grazing-sensitive species were becoming more abundant, but exclosures need to be maintained over a longer period to show any major changes in species composition.

### Protecting biodiversity regionally

In areas subject to intensification, biodiversity is best protected by a regional plan to develop a network of conservation areas that will protect 'decreaser' species. Long-term monitoring of biodiversity values should include a broad range of animal and plant groups.



The tiny but ferocious marsupial predator, the Longtailed planigale (Planigale ingrami), is widespread in northern blacksoil grasslands, but decreases under grazing pressure (photo: Adam Liedloff, CSIRO)



Spencer's monitor (Varanus spenceri) is found only in the Mitchell grasslands of the Barkly Tableland and western Queensland. (photo: Alaric Fisher, DLRM)

Recommendations to protect biodiversity values where wide-spread intensification is occurring include:

- Manage stocking rates to achieve conservative rates of utilisation of pasture. This will maintain a good ground cover and a diversity of desirable perennial grasses.
- As a guide, keep at least 10% of each land type within a region under nil or minimal grazing. To offset more land being intensively grazed, increase the proportion of lightly grazed land.
- Biodiversity 'hotspots' such as waterholes, riparian zones, rocky outcrops and the habitat of threatened species – should be actively protected from overgrazing. Some significant sites may have specific management needs, such as a certain fire regime.
- The ideal size of individual 'conservation areas' is uncertain, but should be as large as possible. However, a number of medium-size 'conservation areas' scattered across a property are likely to be more effective than a single large one.
- Scatter the lightly-grazed 'conservation areas' across the landscape, both at property and regional levels. This will allow these areas to connect and will capture the geographic turnover of species.
- Monitoring the 'health' of the country should include a range of plant and animal groups, including 'increaser' and 'decreaser' species.

# 8. Economic benefits of intensifying development

All development of infrastructure is expensive, and the best direction for development has to be assessed. To identify the profitability of a range of strategies, various development and management options were investigated for a typical pastoral business in the VRD.

### **Management options**

Management options for development include:

- Increasing the carrying capacity from the district average of 5.8 to 6.8AE/km<sup>2</sup> through infrastructure development.
- Reducing the total operating costs of a station by 10% through more innovative management such as use of laneways, different mustering techniques, nutrient supplementation through the drinking water, and telemetry.
- Increasing the annual weight gain of growing stock from 120kg/year to 130kg/ year through the use of supplements.
- Increasing the branding percentage from 70% to 80% through improved management of the breeding herd, such as by early weaning and supplementing breeders.
- Reducing herd mortality from 2.5% to 1.5% through additional supplementation and weaning strategies.

#### **Economic modelling**

A herd and economic model was run for a typical station in the Victoria River District -10,000 breeders and with limited capital resources.

Commercial operating costs (in 2010) and regional average production data (derived from the Department of Primary Industry, Fisheries and Mines survey of the VRD region) were used. (See Appendix 1 for details). Operating costs were based on best practice management proposed by the Department minus the all-year supplementation option for the breeders.

The results of the economic modelling show that the best return comes from carrying more cattle (Table 8.1).

Carrying capacity significantly drives profitability in this region; for this station in the VRD region, the greatest increase in annual profitability and return on invested capital would come by increasing the overall carrying capacity by 1AE/km<sup>2</sup>. But this must be achieved by spreading cattle into previously ungrazed areas through provision of additional waters and fencing, not by overgrazing presently watered areas.

### **Steady state**

This economic exercise looked at a steady state with the management strategy in place for 10 years, the herd structure stabilised and the stocking rate sustainable.

It does not include the capital costs of development or associated recurrent costs.

Table 8.1. Estimated increase in annual profitability as earnings before interest and tax (EBIT) per year above the base business, and return on invested capital (ROIC)

Development option	Improvement in			
	EBIT (\$)	ROIC (%)		
Increase carrying capacity by 1AE/km <sup>2</sup>	608,000	1.9		
Increase branding percentage from 75% to 85%	301,000	1.2		
Decrease operating costs by 10%	184,000	0.8		
Improve weight gains from 130 to 140kg/yr	133,000	0.6		
Reduce herd mortality from 2.5% to 1.5%	99,000	0.4		

### More waters and fencing

This exercise looks at providing additional waters and subdivision of large paddocks.

The cost of a proposed development can be calculated by listing the cost of each additional capital item as illustrated in Table 8.2 using the example shown in Chapter 2. Table 8.2. Costs of developing a paddock (2010)

Capital item	Unit	Cost/ unit (\$)	Total cost (\$)
Poly pipe 50mm (km)	22	2,100	46,200
Tanks	4	3,500	14,000
Troughs	4	2,000	8,000
Telemetry units for waters	5	3,000	15,000
Subdivision fencing (km)	14.5	3,000	43,000
Laneway fencing (km)	10.5	3,000	31,500
Biodiversity fencing (km)	3	3,000	9,000
Gates (double gates)	8	1,000	8,000
Strainers	4	900	3,600
Total			178,800

## Develop property or buy new land?

The cost to develop the additional capacity is estimated as the total cost of the development divided by the number of additional animal equivalents created. For the example paddock (from Chapter 2), this is 178,800/790 = 225/AE developed.

This cost can be compared to the land value (land and fixed improvements, excluding cattle and plant) for recent property sales in the region.



Develop the property with new waters and subdivision or buy new land?

In 2010, land value of properties in the VRD was estimated to be in the order of \$900/ AE (excluding cattle and plant). Thus in this example, the station owner can create additional capacity for significantly less than the cost of additional capacity from buying a station in the region. The owner has spent \$225/AE to develop an asset valued at \$900/ AE over a 12-month period.

Another major cost of development is that for the cattle to stock this additional capacity after either development or purchase of new land. In the above example, the capital costs were \$225/AE for development while the cost to stock this capacity is likely to be in the order of \$450-\$650/AE, taking the investment to \$675-\$875/AE.

Increasing the number of cattle within a paddock is likely to reduce some of the direct operating costs per animal, such as mustering costs/head, while also reducing the station's fixed costs per head (eg costs of maintaining waters, administration and power). This direct reduction in cost per head reduces the cost of production and increases the management efficiency of the business.



Laying poly pipe from existing windmill to new water troughs.

# 9. Case studies

Case studies of the commercial application of intensive development principles are presented for Beetaloo, Mungabroom and OT Downs in the Barkly Tablelands and for Pigeon Hole Station in the Victoria River District.

# 9.1 Beetaloo, Mungabroom and OT Downs

Beetaloo, Mungabroom and OT Downs are three extensive cattle stations in the northern Barkly Tableland of the Northern Territory. They were purchased in 2002 by the Dunnicliff family and formed into the Barkly Pastoral Company.

On first viewing the station, John Dunnicliff could see the large areas of unutilised pasture at the end of the dry season, and how these were often a major fire hazard. John recognised the potential for development, and set about planning and implementing a capital development program.

When purchased, the stations had a moderate level of infrastructure with 40 waters and 18 paddocks (Figure 9.1), and an estimated carrying capacity of 20,500AE.

The potential for development was calculated, as described in Chapter 2, by subtracting the current carrying capacity from the potential carrying capacity. The potential carrying capacity of the three stations (Table 9.1) is calculated from the carrying capacity of each land system multiplied by the area of that land system; the carrying capacity at the time of purchase was calculated from the area of each land system within a three-kilometre radius of each water point and the carrying capacity of that land system.

			Pre-dev	velopment	2010 dev	velopment	
Land system	Area (km²)	Estimated carrying capacity (AE/km <sup>2</sup> )	Watered area (km²)	Carrying capacity (AE/km²)	Watered area (km²)	Carrying capacity (AE)	Potential carrying capacity (AE)
Beetaloo Black soil plains Broad drainage lines Red country savanna Red country (lancewood)	1,018 181 2,673 411	16 16 8 4	292 37 464 46	4,676 594 3,712 186	791 100 1,256 126	12,660 1,608 10,048 502	16,285 2,893 21,382 1,642
Total	4,283		840	9,167	2,273	24,820	42,202
Mungabroom Black soil plains Broad drainage lines Red country savanna Red country (lancewood)	1,271 147 2,080 26	16 16 8 4	371 32 487 5	5,938 520 3,896 20	1,005 88 1,319 13	16,077 1,407 10,550 50	20,328 2,344 16,637 102
Total	3,524		895	10,393	2,425	28,084	39,411
OT Downs Black soil plains Black soil with drainage lines Red country savanna Red country (lancewood) Other	0 400 1,743 398 527	16 16 8 4 5	0 9 88 9 14	- 148 704 36 70	0 25 239 25 38	402 1,909 100 188	- 6,403 13,944 1,592 2,635
Total	3,068		120	960	327	2,600	25,574
Overall total Development relative to poten	10,875 tial		1,855	20,500 19%	5,025	55,503 52%	106,187

#### Table 9.1. Potential and current carrying capacities of the Beetaloo stations in 2010



Figure 9.1. Level of development of Beetaloo in 2002

### The development program

When the Dunnicliffs purchased the stations, the carrying capacity of 20,500 was less than 20% of the estimated total potential carrying capacity of approximately 106,000AE (Table 9.1). Their capital development program towards realising the potential was based on:

- installing water points at a maximum of four kilometres apart
- connecting all water points to a network of polypipe lines supplied from a number of bores
- develop waters first, then fencing.

#### **Development (as at 2010)**

By 2010, the three stations had 403 water points (tanks, troughs and dams) and 38 paddocks (Figure 9.2). This resulted in the estimated carrying capacity increasing to 47,500AE – 50% of the potential carrying capacity.

The carrying capacity had increased by 29,952, and the station was comfortably



Figure 9.2. Level of development of Beetaloo in 2010

carrying 42,000 head of cattle, with 10% of the area being spelled to improve pasture condition. Many water points had palatable perennial grasses within 100 metres of the troughs.

The cost to achieve this increase in carrying capacity is summarised in Table 9.2.

#### Economic benefit to 2010

The cost of the development has been \$7.8 million for 29,952AE = \$261/AE. The additional AE are equivalent to two mediumsize properties (ie 15,000AE) in this region. This cost can be compared to the estimated land and fixed improvement value for this region in the order of \$900–1,200/AE or a cost of \$32–42 million to buy additional properties to give the same capacity. This development program has been most successful, and the Dunnicliff family plan to continue developing the business. Economic analysis suggests a good return from this investment (Table 9.3).

Table 9.2. The capital invested in the development program since the purchase of the properties

Capital item	Unit	Cost/unit (\$)	Total cost (\$)
Water points	378	15,000	5,670,000
Dams	70	12,000	840,000
Fencing (inc. gates and strainers) (km)	400	2,800	1,120,000
Yards (inc. upgrade and build)	4	50,000	200,000
			7,830,000

Input	Assumptions	Value (\$)				
Capital investment Cattle required Annual benefit Annual costs Discount rate	See Table 9.4 24,464 heifers @ \$400 24,464 head x \$175 EBIT/hd Net increase in cost/hd = \$15/hd <sup>1</sup>	7,830,000 9,785,600 4,281,200 366,960 8%				
Economic return						
Net present value (NPV) Internal rate of return (IRR) Years to break even Benefit:cost ratio		13,181,895 20.6% 6 2.8				

Table 9.3 Economic benefit of the intensive development program at Beetaloo (2010)

<sup>1</sup>Increase in operating cost per head

#### Pigeon Hole in the VRD region

Before development, the Pigeon Hole Research and Development complex (on the southern boundary of Pigeon Hole Station) consisted of four large commercial paddocks ranging in size from 79km<sup>2</sup> to 110km<sup>2</sup> (Figure 9.3). There were five permanent water points in these paddocks and a number of semi-permanent water points. The estimated carrying capacity of the site was 1,528AE (Table 9.4).

### **Capital development**

The site was developed over a two-year period (Figure 9.4) with key criteria including:

- establish water points to ensure all of the pastures were within 3km of the water
- · capacity to run intensive grazing systems
- laneways from all paddocks to the yards
- water medicator at each water point
- telemetry unit at each water point.



Figure 9.3 The Pigeon Hole R&D site before development.



Relief

No. 13

development. (Note that much of the development was for the intensive research program.)

				Pre-devel	opment	Potential
Land system	Land type	Area (km²)	Estimated carrying capacity (AE/km <sup>2</sup> )	Watered area (km2)	Carrying capacity (AE)	Carrying capacity (AE)
Wave Hill	Black soil Intermediate Creek line Riparian Red soil	230.2 58.4 4.0 35.6 2.0	12.5 9.0 8.0 15.0 7.0	99 13 2 8 5	1,235 117 18 126 32	2,878 526 32 533 14
Total		330	12.0	127	1,528	3,983

#### Table 9.4. Pre-development and potential carrying capacity of the R&D area on Pigeon Hole Station in the VRD

Table 9.5. Capital cost of developing the Pigeon Hole R&D site

Capital item	Number	Cost/unit (\$)	Total (\$)	
Yards	2	41,085	82,171	
Fencing (km)	170	2,198	373,593	
Waters (inc. pipe)	14	29,377	411,274	
Water medicators	12	4,197	50,366	
Telemetry units	14	3,500	49,000	
Total			966,404	

The cost of this development is summarised in Table 9.5.

The incorporation of varying paddock sizes for the research program increased the cost beyond what would normally be required for the commercial development of a site.

#### **Economic benefits**

The cost to develop the complex and create an additional 2,455AE was \$966,404 or \$394/ AE. This can be compared to the estimated value of land and fixed improvement for this region of \$850–\$1,150/AE. (This region has a lower value per AE than the Barkly which has greater marketing options.)

Economic analysis suggests this was a good return on investment (Table 9.6).

Table 3.0. Economic benefit of the intensive development project at rigeon nor	<b>Table</b>	9.6.	Economic	benefit o	of the	intensive	developn	nent pro	ject at	Pigeon	Hole
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Input	Assumptions	Value
Capital investment Cattle required to stock site Annual benefit Annual costs Discount rate	See Table 9.5 2,455 heifers @ \$350 2,455 hd x \$175 EBIT/hd Net increase in cost/hd = \$10/hd <sup>1</sup>	966,404 859,250 429,625 24,550 8%
Economic indicators Net present value Internal rate of return Years to breakeven Benefit:cost ration		1,287,412 20.1% 6 2.7

<sup>1</sup>This is a non-research increase in operating cost per head. It started at \$20/hd and reduced to nil by the end of the Project

**Note:** These analyses for the Beetaloo and Pigeon Hole case studies were calculated in 2010 and are for illustrative purposes. Since then, there have been significant and on-going changes in the market prices for cattle and land. This emphasises the need for each individual development plan to be budgeted fully, and include a sensitivity analysis to assess risk.

# **Appendices** 1. Assumptions for analysis presented in Table 8.1

Financial analysis	Base	Reduced mortality (-1%)	Increased annual LWG (+10kg)	Reduced operating (-10%)	Increased branding (+10%)	Increased carrying capacity (+1 AE/km <sup>2</sup> )
Gross sales revenue	\$3,941,392	\$4.046.608	\$4.084.829	\$3,941,392	\$4.272.973	\$4.615.944
Direct cost of sales (Levy/commission)	\$(113,358)	\$(116,442)	\$(116,227)	\$(113,358)	\$(122,854)	\$(132,764)
Cattle cartage/yard fees	\$(285,753)	\$(293,911)	\$(293,079)	\$(285,753)	\$(308,081)	\$(334,710)
Net sales	\$3,542,281	\$3,636,255	\$3,675,524	\$3,542,281	\$3,842,038	\$4,148,470
Gross profit %	28	28	30	28	28	28
livestock trading margin	\$3 542 281	€3 636 655	\$3 675 524	\$3 542 281	\$3 842 038	\$4 148 470
Annual bull replacement	\$89.600	\$84.800	\$89.600	\$89.600	\$88.000	\$105.600
Monthly controlled costs (net of 'other income')	\$802,418	\$802,418	\$802,418	\$722,177	\$802,418	\$794,526
Annual overheads (net of 'other income')	\$1,037,610	\$1,037,610	\$1,037,610	\$933,849	\$1,037,610	\$1,027,404
Replacement capital/depreciation	\$95,698	\$95,698	\$95,698	\$95,698	\$95,698	\$95,698
Total on-station costs/beast area (BA)	\$97.79	\$97.55	\$97.79	\$88.47	\$97.71	\$97.69
Gross margin per BA (or LSU-AF)	ֆՍ.80 \$180	φ0.77 \$184	φ0.77 \$186	φ0.72 \$180	φ0.74 \$195	\$0.00 \$210
Station profit/loss (EBIT)	\$1.516.955	\$1.616.128	\$1.650.197	\$1.700.957	\$1.818.311	\$2.125.242
Increase in profit		\$99,174	\$133,243	\$184,002	\$301,356	\$608,287
ROIC%	6.1	6.5	6.7	6.9	7.3	8.0
Opening asset value	\$24,776,357	\$24,749,957	\$24,776,357	\$24,776,357	\$24,785,973	\$24,782,890
Plant	\$197,316 \$138,121	\$197,310 \$138,121	\$197,310 \$138,121	\$197,310 \$138,121	\$197,310 \$138,121	\$197,316
Land	\$9 865 800	\$9,865,800	\$9,865,800	\$9,865,800	\$9,865,800	\$9,865,800
Fixed improvements	\$3,946,320	\$3,946,320	\$3,946,320	\$3,946,320	\$3,946,320	\$3,946,320
Total asset value/AE	\$1,256	\$1,254	\$1,256	\$1,256	\$1,256	\$1,256
Inventory average value	\$400	\$400	\$400	\$400	\$400	\$400
Average sell price/kg	\$1.68	\$1.67	\$1.68	\$1.68	\$1.69	\$1.68
Heiter sell price/kg	\$1.70	\$1.70	\$1.70	\$1.70	\$1.70	\$1.70
Steer sell price/kg	\$1.85 \$1.20	\$1.85 \$1.20	\$1.85 \$1.20	\$1.85 \$1.20	\$1.85 \$1.20	\$1.85 \$1.20
	ψ1.20	ψ1.20	ψ1.20	ψ1.20	ψ1.20	ψ1.20
Production analysis Opening numbers	26 572	26 506	26 572	26 572	27.040	31 138
Closing numbers	26,572	26,500	26,572	26,572	27,040	31,138
Opening breeders	10,005	9,909	10,005	10,005	9,516	11,723
Closing breeders/jnrs	10,005	9,909	10,005	10,005	9,516	11,725
Kilograms produced	2,425,214	2,494,585	2,507,733	2,425,214	2,610,883	2,840,742
Sale kilograms	2,425,214	2,494.582	2,507,733	2,425,214	2,610,883	2,840,742
Area (Km <sup>2</sup> ) Stocking ratio - Boast area (AEs)/km <sup>2</sup>	3,402	3,402	3,402	3,402	3,402	3,402
Beast area (AFs) available	19 732	19 732	19 732	19 732	19 732	19 735
Actual Beast area (AEs) utilised	19,736	19,734	19,736	19,736	19,766	23,138
Current herd utilisation level (%)	100.0	100.0	100.0	100.0	100.2	117.3
Annual steer LWG	135	135	145	135	135	135
Annual heifer LWG	125	125	135	125	125	125
Heiter sell age (months)	25	25	25	25	25	25
Heifer sell weight (kg)	20	20	20	20	20	20
Steer sell weight (kg)	332	332	346	332	332	332
Cow sell weight (kg)	420	420	420	420	420	420
Bull sell weight (kg)	565	564	565	565	565	562
Weighted average sell weight (kg)	341	341	352	341	339	341
Cow sales (% of total)	15	15	15	15	13	15
Iransit Shrinkage/hd (%)	3	3	3	3.0	3.0	3.0
Spaved cow to breeder ratio (%)	42	39 14	42	42	37	41
Breeder % of herd	38	37	38	38	35	38
Number of calves branded	7,506	7,434	7,506	7,506	8,094	8,794
Bull % to mated females	4	4.0	4.0	4.0	4.0	4.0
Annual mortality (% of opening herd numbers)	2.5	1.4	2.5	2.5	2.5	2.5
Annual mortality + branding + purchase (%)	1.9	1.1	1.9	1.9	1.9	1.9
Branding %	75 26.0	75 26.8	75 26.0	75 26.0	80 27 7	75 26.0
Turnoff % of branding	92.0	95.5	92.0	92.0	92.4	92.0
Grower yield to breeder (%)	27.5	27.5	27.5	27.5	29.1	27.5
Kilograms produced per beast area	123	126	127	123	132	144
Sale cattle						
Cows	1,051	1,099	1,051	1,051	997	1,229
Heifers	2,237	2,348	2,237	2,237	2,585	2,621
Steers	3,571	3,612	3,571	3,571	3,851	4,182
Buils	47	50	47	47	46	57
Total	6,906	7,102	6,906	6,906	7,479	8,089

# 2. Additional reading and resources

More details of the results of the Pigeon Hole project can be found on the MLA web site as:

 B.NBP.0375 Sustainable development of VRD grazing lands http://www.mla.com.au/Research-and-development/Final-report-details?projectid=15366

and in:

• Grazing management systems for cattle in the tropical savannas of northern Australia (2011) PhD Thesis, White, I. A. (2011) The University of Queensland. 266 pp.

General resource information relevant to the beef industry in northern Australia can be found on the Internet and in printed publications.

- Victoria River District Land Condition Guide http://www.nt.gov.au/d/Content/File/p/pi/GLM\_VRD\_web\_june11.pdf
- Sturt Plateau District Land Condition Guide http://www.nt.gov.au/d/Content/File/p/pi/GLM\_Sturt\_web\_10\_08.pdf
- Barkly District Land Condition Guide http://www.nt.gov.au/d/Content/File/p/annualreport0506/GLM\_Barkly\_web\_june11.pdf
- Water instead of wire: managing grazing by alternating waterpoints on the Barkly Tablelands, Northern Territory http://www.nt.gov.au/d/Content/File/p/General/Rockhampton\_Downs\_Grazing\_Trial.pdf
- Pastoral Industry Survey 2004 Katherine http://www.nt.gov.au/d/Content/File/p/Tech\_Bull/PastoralSurvey\_Katherine.pdf
- Pastoral Industry Survey 2004 Tennant Creek http://www.nt.gov.au/d/Content/File/p/Tech\_Bull/PastoralSurvey\_Barkly.pdf
- Managing for healthy country in the VRD (2000) Kraatz, M. CRC Tropical Savannas, Darwin.
- Mitchell grasslands: Quality and quantity guide (2005) Materne, C. NT Department of Primary Industries, Fisheries and Mines.
- EDGE*network* Grazing Land Management Katherine Version (2004) Chilcott, C., Oxley, T., Dyer, R., and MacDonald, N. Meat & Livestock Australia, Sydney.
- Savanna Burning: Understanding and using fire in northern Australia (2001) Eds. Dyer, R., Jacklyn, P., Partridge, I., Russell-Smith, J. and Williams, R. CRC Tropical Savannas, Darwin.
- Slower than the eye can see: Environmental change in northern Australia's cattle lands (2002) Lewis, D., CRC Tropical Savannas, Darwin.
- The Ecograze Project: developing guidelines to better manage grazing country (2001) Ash, A., Corfield, J. and Ksiksi, T. CSIRO Sustainable Ecosystems, Townsville.
- Managing grazing in northern Australia (1990) Partridge, I. Department of Primary Industries Queensland.
- Water medication: a guide for beef producers (2005) Entwistle, K. and Jephcott, S. Meat & Livestock Australia, Sydney.
- Weaner management in northern beef herds (2012)
   Tyler, R., English, B., Sullivan, M., Jackson, D., Matthews, R., Holmes, W., MacDonald, N., and Smith, P. Meat & Livestock Australia, Sydney.
- Heifer management in northern beef herds (2012) Schatz, T. Meat & Livestock Australia, Sydney.
- Phosphorus management of beef cattle in northern Australia (2012) Jackson, D., Rolfe, J., English, B., Holmes, W., Matthews, R., Dixon, R., Smith, P., and MacDonald, N. Meat & Livestock Australia, Sydney.

# **Appendix 3. Photos from the Pigeon Hole project**



Greater productivity...

... by carrying and so marketing more cattle...

... by spreading them over more of the total land area...





... into areas of previously ungrazed grassland ...



... and reducing pressure on overgrazed existing water points ...



... by expanding waters with new dams ...



... and piped troughs.



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