

final report

Project code: B.GOA.0114
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Date published: 2 June 2015
ISBN: 9781741919004

PUBLISHED BY
Meat and Livestock Australia Limited
Locked Bag 991
NORTH SYDNEY NSW 2059

Assessment of the impact of wild dogs on the Western Australian rangeland goat industry

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

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Abstract

Wild dogs can be identified as currently the major factor responsible for a precipitous decline in rangeland goat production in Western Australia. The resultant total unrealised annual farm gate income to Western Australian rangeland goat producers is calculated to be of the order of \$11M. This is based upon an estimated stable and sustainable rangeland goat population of 900,000 with a modest harvest rate of 35%, or 315,000 annually. Current annual harvest is of the order of 65,000 goats.

The annual loss as foregone income to the associated sheep industry from wild dog impacts, in addition to that experienced by the rangeland goat industry in the same region, is estimated to be of the order of \$14M.

The rangelands goat population has declined from approximately 1,000,000 in 2005 to 150,000 in 2011, the most recent estimate. With current dog impacts and harvest rates the industry is in a critical position.

Current wild dog control efforts would appear to be well resourced but still in need of an overall rangelands coordination facility. Their impacts cannot be objectively evaluated: this is a glaring inadequacy and should be rectified so as to guide the necessary dog population reduction and permit the restoration of rangeland goat populations, together with the re-introduction of sheep enterprises where appropriate. The National Wild Dog Action Plan is seen to provide the necessary tools.

If the rangeland goat industry is to be a key Southern Rangelands enterprise, alone or in association with other commercial grazing livestock, the overall grazing pressure should be regularly and consistently monitored so that the industry is and is seen to be a leader in rangelands biodiversity outcomes.

It is recommended that the industry in the eastern States be ever vigilant and maintain vigorous, coordinated wild dog control as recommended and facilitated within the framework of the National Wild Dog Action Plan.

It is also recommended to monitor goat populations and harvest rates to ensure growth and sustainability. Recent harvest rates are relatively high and current harvest numbers continue to increase. More recent goat population data would provide a basis for industry planning.

Executive summary

It is acknowledged that wild dogs are a serious pest within Australia and have a significant impact on agricultural industries.

While estimates exist for the economic impacts of wild dogs on some sectors of the Australian sheep and cattle industries there is no quantitative and documented information currently available regarding the impact on the Australian goat industry.

The overarching aim of this project is to quantify the impact of wild dogs to allow informed investment decisions for the rangeland goat industry around dog related research and development. The Western Australian (WA) rangeland goat industry is the focal point of this desktop study/literature review.

As a background, publications assessing the impacts of pest animals on Australian agriculture are reviewed, isolating as much as possible the impact of wild dogs on sheep and cattle enterprises. These reports can provide a basis on which to assess the impact on the rangeland goat industry, which typically shares the rangeland (more so with sheep) and provides a similar target for wild dog predation.

Field studies concentrated on the Southern Rangelands of Western Australia, where the industry is almost exclusively located. Information was obtained from producers, government and non-government organisations and local industries associated with the industry. The desktop study involved sourcing published information from literature, peer-reviewed journals, and Government and non-government organisations.

The review and comparison of the Australian publications dealing with wild dog impacts reveals that there is a degree of consensus in the magnitude of the impact costs, for sheep and cattle on a stock equivalent basis, when expressed nationally. This is of the order of \$0.20 per sheep equivalent. An exception is the study confined to the impacts of wild dogs in Queensland, where the impact on the sheep industry was considerably higher. In terms of similarity to the goat rangeland environment this report would have more relevance. Using the value of stock lost through predation was a common method of estimating loss to the producer. For cattle, there are potentially additional losses through diseases transmitted by wild dogs.

The publications deal in various ways with the more difficult to quantify environmental and social costs of pest animals, but it is clear that these may be even greater than the direct economic impact on producers.

In addition to the methodologies of all the publications reviewed, the nature and findings of this report introduce the concept of considering the impact of a pest animal from the aspect of severely reducing or eliminating the industry, being responsible for ongoing foregone income.

For example, all reviews of pest animal impacts reviewed measured impacts on industries as they existed at the time of their respective publication; with this approach measured total impacts diminish over time as the industry contracts. In fact the pest has so diminished the industry that, while pest impacts decrease on the existing industry, income foregone escalates as an industry contracts. No published reports identify this.

With regard to the Western Australian rangeland goat industry, although the numbers of rangeland goats harvested had been significant since the 1980's, the industry became more important as Merino sheep, the historical enterprise, gradually lost profitability in the rangelands. Damara and Dorper sheep were introduced as replacements by some pastoralists from about 2000, along with in some cases cattle - in the belief that the latter

were more resilient in co-existing with wild dogs, in spite of their acknowledged reduced suitability to the arid rangeland environment.

Official published reports of the growing presence and impact of wild dogs, and of their incompatibility with sheep and goat enterprises, were becoming increasingly public from this time.

Reference to slaughter and live export numbers, and rangeland goat population studies conducted over the time, indicated annual turnoff numbers between approximately 200,000 and 350,000, from a population which fluctuated from approximately 700,000 to 1,000,000. This was the case from 1999/2000 until 2007/2008, representing a harvest rate considered modest by industry standards of about 36%. There was some influence of market price on harvested goat number, the latter being reduced in response to lower prices. From 2007/2008, with relatively stable and increasing price, both population and harvested number dropped dramatically, with harvest rate increasing to on average 46%. The most recent population estimate, (150,000) is from 2011, and local estimates are that it is likely to have further declined. With annual harvest numbers then and since of 50,000 to 80,000, harvest rates may be unsustainably high.

As confirmation of the impact of wild dogs, the number and distribution of sheep has followed a similar pattern in spite of best practice management.

The significance of wild dogs to the Western Australian rangeland goat industry is further highlighted by comparison to the eastern States figures. Largely driven by NSW, with a strong possibility that the population in Queensland may have fallen, the total goat population in NSW, Queensland and South Australia has risen from approximately 900,000 in 1999 to 3,000,000 at the last estimate in 2010, with harvest rates on average higher than WA (46% compared with 39% over the period). This would indicate little influence other than human harvest on goat numbers. It also indicates the resilience of goat populations to withstand intermittent harvest as opposed to continual predation.

A summary of the interaction between overall grazing pressure and the Southern Rangelands vegetation indicated as a generalisation reduced grazing animal populations at the Land Conservation District level overall over the last 15 years, but some continuing rangeland resource degradation. The grazing animals considered comprised sheep, goats, cattle and kangaroos. With increasing proportions of pastoral leases destocked for various reasons, including a significant number of former pastoral leases now managed by government for conservation purposes, the grazing pressure on remaining pastoral operations may be higher. Seasonal conditions over recent years are documented as being very much below average.

It is concluded that wild dogs as a major identified factor have reduced the rangeland goat population of Western Australia in number and distribution, from what was demonstrably a sustainable number and harvest rate, to the current levels. Over the period 1990 to 1999 the rangeland goat population was relatively stable, being of the order of 750,000 at beginning and end of the period falling and rising by 20% at the middle of the period. There was no change in contribution to rangeland grazing pressure. Harvest rates were modest – an average over the 10 years of 41%, this figure including removal rates of more than 70% in the early years of an organised culling campaign. The population withstood this. From 1999/2000 till 2005/2006 the industry matured with increasing population and harvest, again at modest and sustainable harvest rates (35.4%).

From this basis, it is not unreasonable to propose a stable and sustainable rangeland goat population of 900,000 with a harvest rate of 35%, or 315,000 annually. The current annual harvest is of the order of 65,000.

Using average 2015 goat prices (\$51/head) and a standardised transport cost per goat of \$7, the loss of potential annual income to rangeland goat producers in the rangelands would presently equate to a total of \$11M.

Referring to earlier and current sheep population and production figures over a similar time period, it is estimated that in the Southern Rangelands wild dogs are predominantly responsible for further pastoral sheep enterprise losses, in addition to that experienced by the rangeland goat industry in the same region, of the order of \$14M annually.

Post farm gate the impact of wild dogs is largely through regional abattoirs, with the loss of up to 20 employees or full time equivalent salaries over the period. This was considered to have a direct economic impact of the order of \$1,000,000 with community flow on. The other direct impact is through trucking companies, the estimated reduction in truck driver salaries over the period being of the order of \$600,000. Both of these post farm gate economic impacts are in part due to the simultaneous reduction in rangeland sheep turnoff.

From interview responses, with wild dogs controlled to a satisfactory degree, pastoralists would as a generalization plan to manage either a mixture of sheep and goats or a mixture of sheep, goats and cattle. Such a business plan was based on the desire to have diversity of enterprise with some protection from market price vagaries. A small number of producers would opt to have rangeland goats as a sole harvesting enterprise.

It is obvious that wild dogs have multiplied and spread throughout the rangelands over the time period considered. Numerous reports indicate that control was of reduced effectiveness, for a variety of reasons, which has led to this imbalance. There are many improvements in wild dog control at present, with considerable effort and expense, but there exists no system or metric to monitor objectively the results of this. If wild dog control is to be achieved this will be essential. There remains a need for an overall rangelands coordination facility. The National Wild Dog Action Plan is seen as providing the necessary guidance and tools.

Effective wild dog control is needed for industry to recover. In addition to the above it is recommended that a strong and unified WA wild dog management strategy be developed and implemented, Government Department local staffing support be increased, construction of a fence for the already planned Murchison Region Vermin Cell be commenced and coordinated wild dog control activities be enforced.

With the current low population and restricted rangeland goat distribution there is a danger that excessive commercial harvest may impact upon population restoration in WA. Regional information should be sought and used by the industry to ensure its future sustainability.

The decline in the rangeland goat population, for almost a decade, would indicate that any recent identified adverse trends in rangeland vegetation conditions are likely to be due to season and/or the impacts of other grazing livestock.

If the rangeland goat industry is to be a key Southern Rangelands enterprise, alone or in association with other commercial grazing livestock, the overall grazing pressure should be regularly and consistently monitored so that the industry is and is seen to be a leader in rangelands biodiversity outcomes.

Given the relatively recent introduction of cattle as significant enterprises in the rangelands, a number of issues urgently need clarifying. Apart from the unknown impact of wild dogs on cattle in this environment, the presumed foregone income from cattle as being inherently less suited by comparison to small ruminants requires clarifying.

It is recommended that the industry in the eastern States, although buoyant at present, be ever vigilant and maintain vigorous, coordinated wild dog control as recommended and facilitated within the framework of the National Wild Dog Action Plan. The Western Australian experience teaches that wild dog population growth and movement can be swift along with consequent impacts on small ruminants.

It is recommended that the eastern States industry monitor goat populations and harvest rates to guide and ensure growth and sustainability. Recent harvest rates are relatively high and current harvest numbers continue to increase. More recent goat population data would provide a basis for industry planning.

As a guide to actions which may eventuate from this report, 13 recommendations are made in considered order of priority (Section 6, Conclusions/Recommendations, pages 49-51).

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1 Background

It is acknowledged that wild dogs are a serious pest within Australia and have a significant impact on agricultural industries through production losses from livestock attacks, the potential to spread disease, the expense of control measures as well as the emotional distress on landholders themselves.

It is estimated (National Wild Dog Action Plan 2014) that wild dogs have a national impact conservatively ranging from \$48 million (M) to \$60M annually, while anecdotal industry sources estimate the economic impact to be much greater, in the hundreds of millions of dollars per annum.

While estimates exist for the economic impacts of wild dogs on some sectors of the Australian sheep and cattle industries there is no quantitative and documented information currently available regarding the impact on the Australian goat industry.

The overarching aim of this project is to quantify the impact of wild dogs to allow informed investment decisions for the rangeland goat industry around dog related research and development. The Western Australian (WA) rangeland goat industry is the focal point of this desktop study/literature review.

2 Project objectives

1. Desktop study/literature review of information relating to the economic, social and environmental impacts of wild dogs and dingoes on the WA rangeland goat focussing on the situation from 1 January 1999 to present day. This includes:
 - An extensive review of published and un-published material relating to the economic, social and environmental impacts caused by dingoes and wild dogs upon the WA rangeland goat industry. This includes local sources not available electronically or through library acquisition.
 - A literature review of national goat production and turn off is incorporated.
 - A review of publications relating to estimates of the impact of wild dogs on the sheepmeat, wool and cattle industries is incorporated to identify and take learnings from those processes which may be applicable to this study and to the goat industry.
2. The gathering of relevant anecdotal information gathered from current and former rangeland goat suppliers through interviews/surveys to address information gaps identified in the desktop study/literature review. This is achieved through:
 - Survey of current and former commercial rangeland goat suppliers, depots, abattoirs, live exporters either in person or via teleconference. Information collected through the survey of abattoirs, live exports and depots (past operations) includes throughput and wild dog-related downgrades and rejects.
 - Information collected from producers through the survey includes volumes turned off and estimated losses during the specified time period.
3. Provision of a final report for the project detailing the process, its success/constraints, a historic case study of the production decline in WA and recommendations to MLA to assist with awareness, delivery and uptake of information within the goat industry. The report addresses and includes information relating to:
 - The value of annual production losses due to predation, stock harassment, mutilation and disease impacts at:

- the pastoral enterprise level
 - the livestock transport sector
 - abattoir/processor sector
 - The impact of limitations to livestock enterprise choices
 - Numbers of stock losses over time overlaid with maps of known dog populations and dog numbers and other circumstances contributing to the contraction of the industry
 - A summary of control practices undertaken in the region and an indication of their effectiveness
 - The financial cost of direct and indirect control practices
 - What role/impact wild dogs and dingoes have played/had in the contraction of the industry and rangeland goat populations since 1 January 1999, distinct from other relevant issues
 - The opportunity lost, including projections regarding the value of the WA goat industry without the constraints of wild dogs
 - Identification of information gaps and their implications
 - Key learnings other Australian jurisdictions may take from this study
4. Desktop study/literature review of information related to the economic impact of wild dogs and dingoes in the WA sheep industry.

3 Methodology

3.1 Definitions

3.1.1 Goats

For the purpose of this report the term “rangeland goat” is used to describe the goat. The terms “feral”, “wild” and “unmanaged” may be seen in publications referring to goats in rangeland environments. Although goats in these environments may originally be of feral origin (escaped or released from domestication), it is recognised that although free-living and not subject to husbandry interventions, they and the rangeland vegetation they consume can be managed by harvesting operations. In this regard they are essentially similar to the more traditional sheep and cattle livestock historically deliberately introduced.

3.1.2 Wild dogs

In this report the term “wild dog” is used to encompass the various possible canine predators implicated. As described by Fleming et al. (2001) these may be:

Dingoes: *Canis lupus dingo*. Native dogs of Asia. Dingoes were present in Australia before European settlement and still occur in the wild here. Pure dingoes are populations or individuals that have not hybridised with domestic dogs or hybrids.

Domestic dogs: *C. l. familiaris*. Dog breeds (other than dingoes) selectively bred by humans, initially from wolves and/or dingoes, that usually live in association with humans. They were introduced to Australia by European settlers.

Hybrids: dogs resulting from crossbreeding of a dingo and a domestic dog and the descendants of crossbred progeny.

Feral dogs: wild-living domestic dogs.

Free-roaming dogs: dogs that are owned by humans but not restrained so they are free to travel away from their owner’s residence.

3.2 Approach

3.2.1 Review of publications relevant to goat industry

There have been published a number of reports, each with a different approach, dealing with the impacts of pest animals on Australian agriculture and the community. Within all of these wild dogs are reviewed. The rangeland goat industry is not in any report discussed as an industry impacted upon by pests (in fact historically it has been in the “pest” category)! However these reports do provide a basis on which to assess the impact on the rangeland goat industry, which typically shares the rangeland particularly with sheep and provides a similar target for wild dog predation.

These reports are discussed and compared, leading to a consensus of providing a balanced basis on which to assess the impacts of wild dogs on the WA rangeland goat industry, in context with the more common and more scrutinised cattle and sheep industries.

3.2.2 Field and desktop studies

The “home” of the Western Australian rangeland goat industry is the area commonly known as the Southern Rangelands, comprising the Rangelands NRM sub regions of Gascoyne and Murchison (Fig.3.1).

This area was visited and producers past and present interviewed concerning their experiences and to obtain production data, where possible over the time frame 1999 to 2014.

At the same time regional state government, local government, and non-government organisations were contacted and interviewed as likely sources of information and data availability.

Information was sought from local industries associated with livestock industries, for example abattoirs, transport companies and stock agents.

For the WA industry goat slaughter figures were obtained from individual abattoirs and the Western Australian Meat Industry Authority (WAMIA) and from Livecorp in the case of live export. Industry statistics were also provided by Meat and Livestock Australia (MLA) and the Australian Bureau of Statistics (ABS).

The desktop study involved sourcing published information from literature, peer-reviewed journals, and Government and non-government organisations.

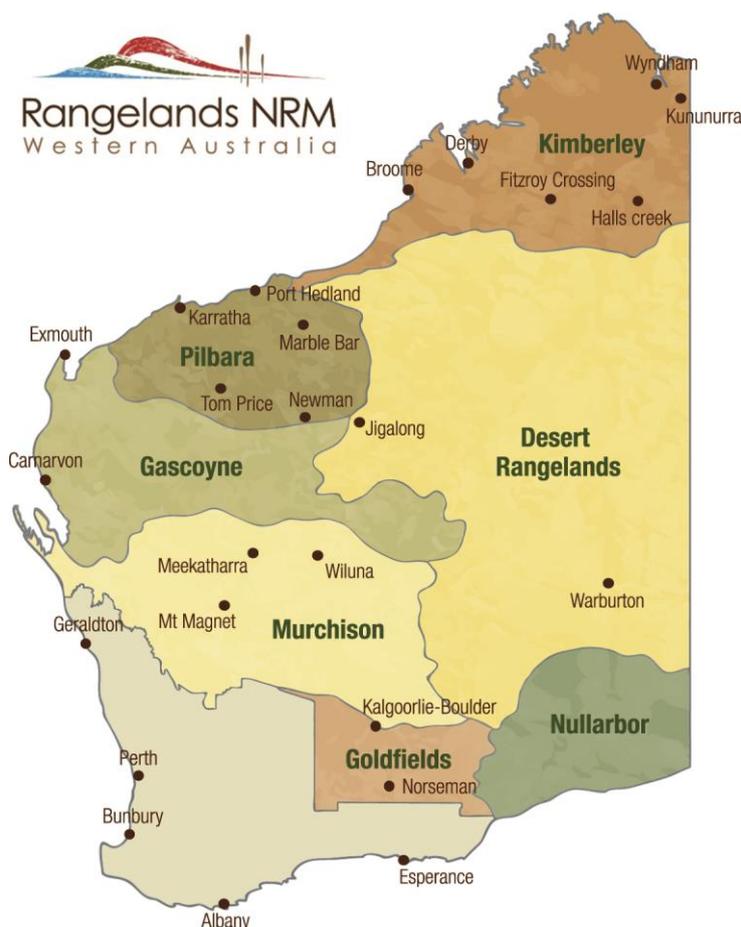


Fig. 3.1 Rangelands NRM Western Australia sub regions (Source Rangelands NRM)

4 Results

4.1 The Impact of Wild Dogs on Australian Grazing Livestock. A review of relevant publications

Within the past decade there have been published a series of reviews, each with somewhat distinct priorities, which include aspects of the impacts of wild dogs on Australian grazing livestock industries. Because of their national prominence the emphasis on the cattle and sheep industries is not surprising, but for the goat industry there are lessons to be learned.

If goats are mentioned at all, it is in the amalgamation “sheep and goats”. Hence it must be said at the outset that, firstly, any quantitative data used as an estimate for goat industry impacts will be of necessity drawn from sheep industry figures. This data is likely to be quite relevant for goats as a small ruminant often co-grazing with sheep or occupying the same ecosystems. Secondly, and most importantly, the goat industry is largely a rangeland industry as distinct from the sheep industry which occupies agricultural and rangeland environments. The conclusions from publications with data based on national assumptions need to be considered with this understanding.

4.1.1 McLeod (2004). Counting the Cost. Impact of Invasive Animals in Australia 2004

The benchmark or initial publication. This work attempted to provide a framework comparing a “triple bottom line” (economic, environmental and social) national perspective on 11 major vertebrate pests of Australian agricultural industries.

With regard to *economic impacts*, production losses were calculated for the sheep and cattle industries simply by estimating the predation of young stock. Major control costs included in the economic impact assessment included baiting, fencing, shooting, and research associated with the improved management of the specific species.

In addition to these agricultural losses, public sector research and management costs were included in the economic cost section.

Environmental impacts were typically based on the vertebrate pest’s impact on biodiversity. Where possible, these impacts were quantified in cost terms, although it should be noted that accurate information relating to ecological cause and effect relationships, along with the communities’ valuation of species preservation, was rarely available.

Social impacts were the most difficult impacts to estimate. Within this report, pest impacts on employment, health and indigenous peoples’ ways of life are documented in relevant sections, but a costing is not attempted.

In order of economic impact the wild dog ranked third behind rabbits and feral pigs, ahead of foxes and mice. With regard to sheep, foxes assumed greater importance on account of lamb predation. Table 4.1 is included to place the wild dog in perspective and to illustrate the national pest animals considered by this study.

Table 4.1 Annual Impact of Pest Species in Australia (after McLeod 2004)

	Total (\$M)	Economic(\$M)	Environmental(\$M)
Foxes	227.5	37.5	190.0
Feral cats	146.0	2.0	144.0
Rabbits	113.1	113.1	nq
Feral Pigs	106.5	106.5	nq
Wild Dogs	66.3	66.3	nq
Mouse	35.6	35.6	nq
Carp	15.8	4.0	11.8
Feral Goats	7.7	7.7	nq
Cane Toads	0.5	0.5	nq
Wild Horses	0.5	0.5	nq
Camels	0.2	0.2	nq
TOTAL	719.7	373.9	345.8

The impact of wild dogs was quantified as shown in Table 4.2. Together with production loss estimates are included estimated costs of control. The production loss figures were derived as follows:

Sheep: Assumed 0.5% of all sheep (71.2 million {M} from 2003 population data) taken by dogs at a cost of \$30 per head. Cattle: Assumed 1% of calves nationally (6 million from 2003 ABS data) are killed by dogs, at a cost of \$540 per calf.

Table 4.2. Annual National Cost Impact of Wild Dogs. After McLeod (2004)

Cost component	Total (\$M)	Production loss (\$M)	Control costs (\$M)
Sheep		15.9	
Cattle		32.4	
Management			6.50
Fencing			10.00
Research			1.50
TOTAL COST	66.3	48.3	18.00

4.1.2 Gong et al. (2009). The economic impacts of vertebrate pests in Australia. Invasive Animals Cooperative Research Centre

This report, confined mainly to the impacts of foxes, rabbits, pigs and dogs, was differentiated by using the economists' standard concept of welfare, that of "economic surplus". This could be explained by the sum of the economic surplus to the producer (price received minus cost of production) together with the consumer surplus (the difference between what they pay and what they are willing to pay). Of necessity a complex economic modelling approach was employed, incorporating elasticities of supply and demand to predict how producers and consumers would react to new prices generated.

The agricultural industries considered were the beef, wool, sheep meat and grains industries.

Inputs to the model included estimations of the distribution of pest density across the industries by state, and production impacts of pest animals at low, medium and high densities.

The changes in economic surplus were calculated with a model used particularly for agricultural research evaluation.

The agricultural losses were measured for a five-year period ending in 2001–02, so 2001–02 was used as the base year for these values. These losses were estimated separately for foxes, rabbits, wild dogs and feral pigs, and for the main agricultural industries (beef, wool, sheep meat and grains). Data on the expenditures by governments and landholders on management, administration and research were derived from 2007–08 figures.

The analysis indicates that if the combined impact of dogs, foxes, rabbits and pigs were

removed from the beef, sheep and grains industries, then the total economic surplus would be improved by some \$284.87M per annum (Table 4.3). The results for the change in producer and consumer surplus show that producers will receive the majority of the benefit (\$282.73M), compared to consumers (\$2.14M). The beef industry would incur the greatest benefit (\$187.73M) from a reduction in invasive animals, followed by the wool industry (\$71.28M) and the lamb industry (\$20.00M). These industry changes reflect the relative size of the different agricultural sectors.

Table 4.3 Annual economic loss in Australia due to rabbits, wild dogs, foxes and feral pigs, 2001/02 values \$M (After Gong et al. 2009)

	Economic Surplus (\$M)	Producer Surplus (\$M)	Consumer Surplus (\$M)
Foxes	21.15	20.79	0.35
Wild Dogs	48.53	48.30	0.22
Rabbits	206.01	204.52	1.49
Feral Pigs	9.19	9.11	0.08
TOTAL	284.87	282.73	2.14

In Table 4.4 the impact of wild dogs on the sheep and cattle industries is demonstrated, nationally and for Western Australia. The sheep industry has been partitioned into wool and meat categories, largely to deal with regional industry distributions.

Table 4.4 Annual Australian and Western Australian economic loss on sheep and cattle industries due to wild dogs (After Gong et al. 2009)

Industry	Economic Loss Australia (\$M)	Economic Loss WA (\$M)
Wool	20.95	5.75
Sheep meat	0.90	0.03
Beef	26.68	2.84
TOTAL	48.53	8.62

The authors considered the main strengths of this report to include the use of the economic surplus concept, and the use of data on estimated pest distribution across industry and State. The model estimated the production impacts of pest animals at low, medium and high densities.

They acknowledged the potential weakness from lack of data and difficulties in applying the modeling methods.

4.1.3 Hewitt (2009). Major Economic Costs Associated with Wild Dogs in the Queensland Grazing Industry

This Queensland Government study used survey information provided by producers (209 respondents), saleyards, processors, and State and Local governments to calculate the major economic costs associated with wild dogs. The costs were associated with stock losses and stress, bites from wild dogs, disease impacts (*Neospora* and hydatidosis in cattle) and wild dog management. From a whole-of-industry perspective, wild dogs were found to have a significant economic impact on Queensland grazing industries, costing an estimated \$67M in 2008/09. The majority of this was born by cattle and sheep producers. The findings are summarized in Table 4.5.

Table 4.5. Major Economic Costs Associated with Wild Dogs in the Queensland Grazing Industry (Hewitt 2009)

Category	Origin of loss estimate	Costs 2008/2009 (\$)
Cattle Producers	Calf losses	22,840,000
	Saleyard loss dog bites	1,036,914
	Loss dog bites (Processors)	1,031,441
	<i>Neospora caninum</i>	3,143,536
	Hydatids	2,057,685
	Wild dog management costs	11,460,498
Sheep/Goat producers	Stock losses and attacks	16,950,000
	Wild dog management costs	2,248,642
Local Government	Management programs, bounties	2,623,543
Wild dog barrier fence	Local and State Govts	1,870,316
State Government		1,754,000
TOTAL COST		67,016,575

Comparing the impacts on the sheep and cattle industries confined to livestock related losses, i.e. without the costs of control and research, indicates amounts of \$16.95M for sheep producers and \$30.10M for cattle producers (Table 4.6)

Table 4.6. Cost of livestock-related wild dog impacts on Queensland industries. (After Hewitt 2009)

Industry	Livestock-related loss (\$M) 2008/2009
Sheep	16.95
Cattle	30.10
TOTAL	47.05

4.1.4 Rural Management Partners (2004). Economic assessment of the impact of dingoes/wild dogs in Queensland

Commissioned by the Queensland Government Department of Natural Resources and Mines, this project used a smaller survey base of 32 graziers affected by wild dog predation to estimate the state losses attributable to wild dogs. The estimated livestock (sheep and cattle) losses in 2002/2003 prices were found to be in total of the order of \$33 million, with direct predation estimated to have an impact of \$18.3M. The breakdown of cost areas is shown in Table 4.7.

Table 4.7. Economic impact of wild dogs on the Queensland livestock industry. After Rural Management Partners 2004

Industry	Category of loss	2002/2003 Cost (\$M)
Cattle producers	Calf losses	9.53
	Neospora	3.4
	Hydatids	6.0
Sheep producers	Predation losses	8.77
	Control programs	5.4
TOTAL		33.11

The authors acknowledged the difficulty of estimating statewide losses from the information and opinion of this relatively small number due to local variations in season, livestock numbers and other factors affecting stock performance.

Also acknowledged as a cost but not included in the estimate was the reduced enterprise mix flexibility associated with wild dog predation where sheep were likely to be replaced by cattle, regardless of normal market conditions. In the more arid regions of Queensland the satisfactory performance of cattle would be expected to be confined to better than average seasons only, whereas sheep were considered more sustainable over a range of seasons.

4.1.5 Wicks et al. (2014). An integrated assessment of the impact of wild dogs in Australia

This research report by ABARES provided an assessment of the impact of wild dogs in Australia, using a method based on three case study regions. The economic cost of the wild dog impacts was not estimated explicitly in this study, but estimated under a plausible range of dog attack rates over 20 years. The range of attacks modelled was from 2% to 20%. The impact of the dog attacks was estimated from ewe, lamb and calf loss calculations.

The regions were:

Eastern Victoria - sheep and cattle grazing, with 46% of area managed for nature conservation (Fig.4.1)

South Australian northern Arid Lands - predominantly cattle grazing (Fig. 4.2)

South Western Queensland - sheep and cattle grazing (Fig. 4.3)

A bioeconomic model was used as the basis for the impact estimates, calculating the net revenue from livestock production with and without wild dog control. The model was one developed by ABARES to estimate the cost of a foot and mouth disease outbreak in Australia.

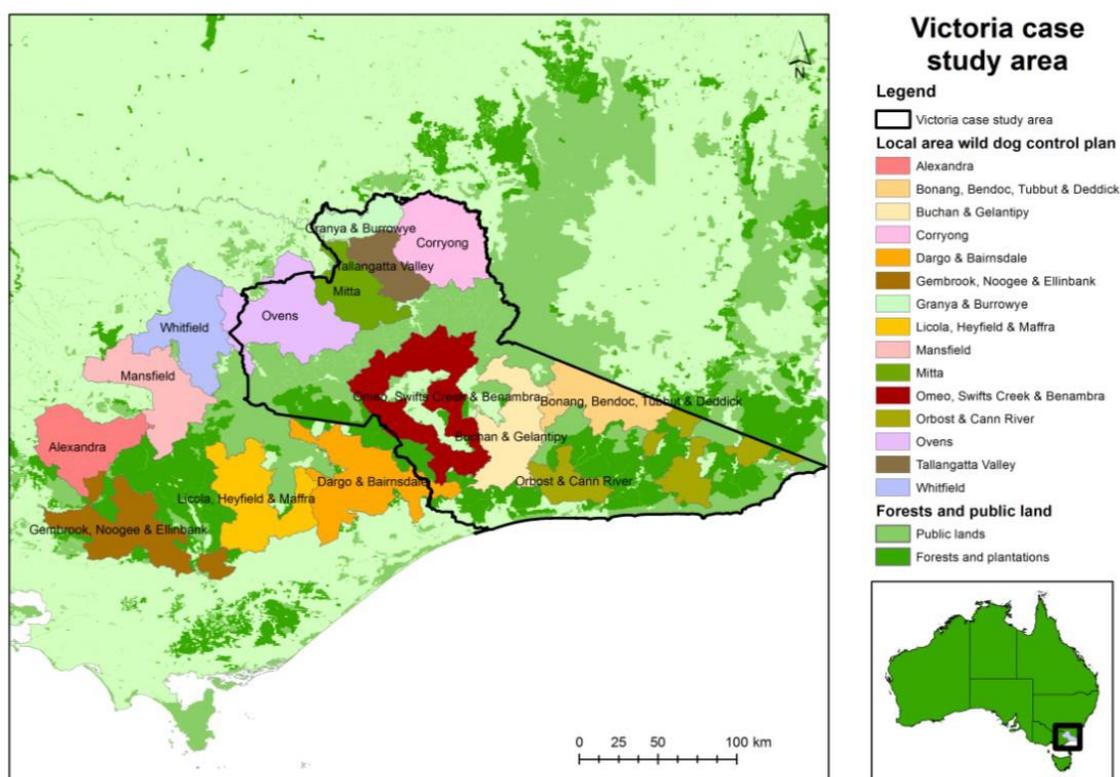


Fig.4.1 Eastern Victoria case study region (Source: Wicks et al. 2014)

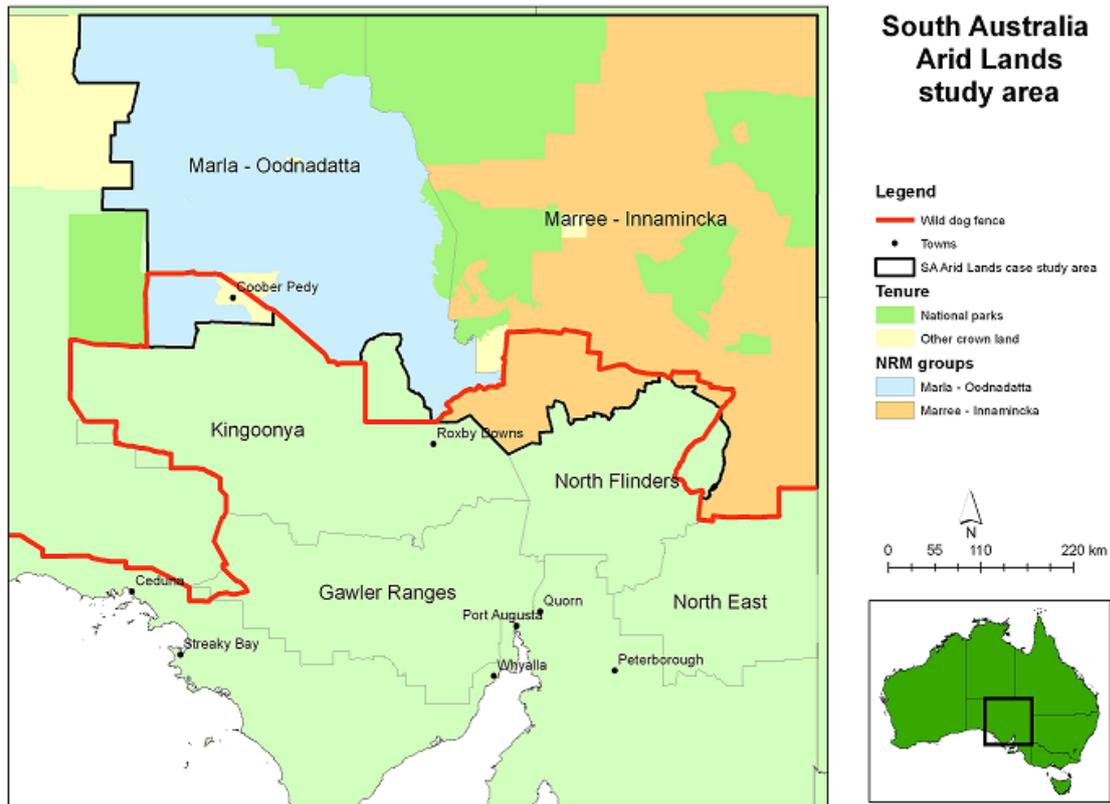


Fig. 4.2 South Australia northern arid lands study region (Source: Wicks et al. 2014)

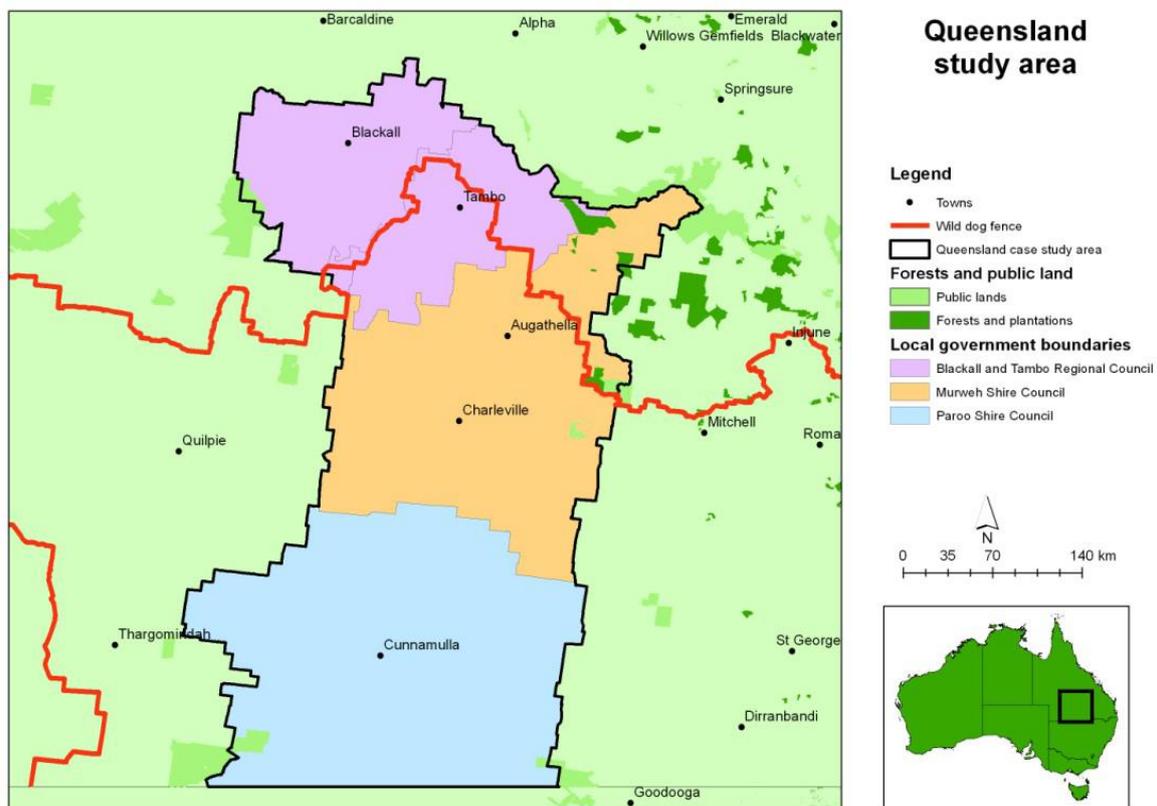


Fig. 4.3 South-western Queensland study region (Source: Wicks et al. 2014)

In each region there were positive net economic returns to wild dog management under most assumptions about the rate of growth in attack rates. The benefits to the cattle industries were greater at most points of the response curve due mainly to the greater magnitude of local turnoff and to the greater value of product.

In addition to significant economic benefits of wild dog control, there were also significant non-market benefits associated with wild dog management. These “non-market” benefits were estimated by including the willingness of individuals to pay for the management of wild dogs in order to reduce social and environmental impact – “non-market” goods. These amounts were obtained in a “choice” interviewing process. They are included for interest in this report.

The magnitude and range of the estimates are shown in Table 4.8

Table 4.8. Net benefits over 20 years from the management of wild dog programs in three regions, over a range of dog attack rate increases. (After Wicks et al. 2014)

Region	Market segment	Economic Benefit* (\$M)	
		2% dog attack rate increase	20% dog attack increase
Eastern Victoria	Market	1.85	31.66
	Non-market	42.89	434.24
	TOTAL	44.75	465.91
South Australian Arid Lands	Market	1.84	34.48
	Non-market	12.39	112.58
	TOTAL	14.23	147.06
South Western Queensland	Market	2.42	53.57
	Non-market	26.58	228.37
	TOTAL	29.00	281.94

* Cost is in net present value, over 20 years, using 2011/2012 dollars. The non-market cost figure is the lower bound estimate of the possible range.

In the South Australian case study, the scenario of increasing dog control being associated with increased kangaroo numbers with competition for grazing vegetation was modelled. Not surprisingly this modified the response curve to the cost effectiveness of dog control. Also, the expected increase in wild dog attacks on calves in times of drought, when the availability of wildlife prey was reduced, increased the cost benefit of control measures.

4.1.6 Fleming et al. (2012). Wild dog ecology, impacts and management in northern Australian cattle enterprises: a review with recommendations for RD&E investments

This report was commissioned by MLA to review wild dog ecology, impacts and management in northern Australian cattle enterprises, with recommendations for RD&E investments. They reviewed some of the previous publications, specifically those

components dealing with the cattle industry, and passed additional comment with regard to their accuracy and relevance. Although they did not dispute the findings, they qualified their comments pointing out the need for further research in areas where conflicting or paradoxical results had been observed.

4.1.7 Summary of publications on wild dog impacts on Australian livestock industries

Those of the reviewed publications for which there are calculated approximately comparable figures are included in a table for comparison (Table 4.9)

Table 4.9 Comparable aspects of 4 publications describing wild dog impacts on Australian livestock industries

Publication	Year	Region	Sheep pop'n (M)	Annual *cost sheep (\$M)	Cattle pop'n (\$M)	Annual *cost cattle (\$M)	Total †cost incl. mgt (\$M)
McLeod (2004)	2003	Aust.	71.2	15.9	23.6	32.4	66.3
IACRC Gong et al.(2009)	2001/02	Aust.	111.0	21.85	24.5	26.68	58.00
Qld Govt Hewitt (2009)	2008/09	Qld	4.4	16.95	11.5	30.11	67.02
Rural Mgt Qld (2004)	2002/03	Qld	7.0	8.77	11.0	18.93	32.7

*Cost of lost production, to producer. † Total cost including management on and off farm.

4.2 Background – Market and social change

Over the period encompassing declining wool price (essentially 1988 to 2005, see Fig. 4.4) the number of pastoral leases producing wool from Merino flocks gradually decreased. This is captured in Table 4.10 recording wool receivals from the Western Australian Wool Statistical Areas W04, W05 and W06, being the central region areas most relating to the Southern Rangelands. The increasing availability of wool shedding meat breeds of sheep adapted to rangeland conditions (Dorper, Damara) from about 2000, together with rangeland goat harvesting, provided a seemingly more profitable alternative (Young et al. 2002). A major attractant was less need for increasingly expensive and difficult to source labor, both on station and from contractors. With the loss of station labor went the necessary consistent time and effort for wild dog control, along with valuable local knowledge.



Fig.4.4 Price for 19 and 21 micron wool 1979 to present (Wool Agency Fremantle WA)

Table 4.10. W04, W05, W06 and WA State wool production 1996/97 and 2013/2014 (Source L Plunkett AWEX)

	Wool delivered (bales)			
	*WSA W04	WSA W05	WSA W06	All areas WA
1996/97	15,156	14,611	74,389	1,057,280
2013/14	464	761	24018	380,927
2013/2014 proportion of 1996/97 (%)	3.1	5.2	32.3	36

* Wool Statistical Area

The data from Tables 4.10 would confirm this, with wool output from the whole region declining by 71% over a proximate time frame, more tellingly from the northern and inland regions by 95%.

With regard to sheep numbers, in the Pastoral Lands Board submission to the Inquiry into Pastoral Leases in Western Australia (2014) data from the annual returns were used to highlight the change in livestock referred to above. Table 4.11 provides a snapshot of the changing enterprise mix in the Gascoyne and Murchison between 1990 and 2012. For sheep there is recorded a decline of more than 700% to be only 14% of the earlier figure over the years indicated.

Cattle were seen by some as a replacement enterprise in the rangelands, although not formerly considered as suited to that environment. One reason was the opinion they were not as susceptible to the impact of wild dogs as sheep, another that the labor requirements of a cattle enterprise were considerably less (Southern Rangelands Pastoral Advisory Group 2009). This further impacted upon wild dog control in the region in that cattle producers were less likely to devote as much time, effort and expense to dog control activities.

Table 4.11 Change in stock numbers on pastoral leases in Gascoyne and Murchison regions between 1990 and 2012. (Source: Pastoral Lands Board submission 2014)

Region	year	Cattle number	Cattle units (cu)	Sheep number	Sheep* (cu)	Total cu	Change (%)
Gascoyne	1990	29,368	27,592	675,943	96,563	124,155	
	2012	70,528	66,263	125,937	17,991	84,254	-32
Murchison	1990	43 718	41,074	808,828	115,433	156,507	
	2012	76 893	72,243	83,947	11,992	84,235	-46
Gascoyne/ Murchison combined	1990	73,086	68,666	1,484,771		280,662	
	2012	147,421	138,506	209,884		168,489	
	Change 1990 to 2012 (%)	202		-707			-40

*7 sheep are rated as equivalent to 1 cattle unit

Over this period many of the dog control supporting activities (coordinating control operations, and training and advising pastoralists in wild dog management) provided by the Department of Agriculture were gradually diminished as staff numbers reduced. In many cases there was less coordinated dog control between neighboring leases, and as a consequence the efforts of those remaining committed to energetic dog control was of much reduced effectiveness. From 1999 to 2005 up to 35 leases in the regions were acquired by the Department of Conservation and Land Management (CALM) - now Department of Parks and Wildlife (DPaW), with different priorities and management structures which further inhibited communication, leading to less effective regional wild dog control (Economics and Industry Standing Committee 2010).

Anecdotally wild dogs have become more noticeable visibly and in their impacts on small livestock in the last decade, starting in the eastern regions and over time moving westward. A typical history was the increasing evidence of wild dog attacks on both sheep and goats from 2000 onwards; often sheep (Merinos) had been discontinued some years earlier due to the combination of enterprise economics compounded by wild dog losses. By 2012 many had ceased to find rangeland goats and sheep when attempting to muster or trap.

The eventual creation of and funding support for Recognised Biosecurity Groups (RBGs) subsequent to the Zone Control Authorities maintained a structure to facilitate intelligently coordinating dog control, but for many it was too late.

At the current time small ruminants are confined largely to a coastal strip varying in width between 100 and 200 km, with wild dog impacts increasingly evident on the eastern fringe of this area. This is confirmed by the pattern of wool delivery (Table 4.10) and goat supply to the local abattoir (Fig. 4.5). The latter representation is especially graphic, as it highlights the extent of the impacts.



Fig. 4.5 Former (blue) and current (red) rangeland goat suppliers to regional abattoir (Source: M Edmiston Geraldton Meat Exports)

4.3 Goat populations, turnoff and harvest rates

Pople and Froese (2012) provide robust data on goat populations in the rangelands of NSW, South Australia, Queensland and Western Australia, over the period 1984 – 2011. This has been systematically measured in aerial surveys associated with kangaroo management.

The authors estimated the survey precision to be of the order of 10 -15 % for NSW and South Australia, about 20% for Western Australia and possibly 20 - 40% in Queensland because of lower sampling intensity. These are considered sufficiently precise to detect medium- to long-term changes in goat abundance, but not short-term changes or “steep declines in times of drought or similar catastrophic events”.

Surveys over larger areas in each state have indicated that the core areas that are surveyed regularly capture the bulk of the distribution. That distribution is largely restricted to the semi-arid rangelands where sheep grazing is or has been the predominant land use and, notably, where wild dogs are controlled. Changes in the pattern of distribution of goats within states over the study period have not been dramatic. Increases in density have been associated with expansions of distribution and decreases with contractions. Maps of the rates of increase over the study period show some variation, but trends have generally been uniform. An exception is the recent collapse in goat numbers in the eastern part of the goat distribution in Western Australia.

The annual turnoff of goats in Western Australia over the timeframe 1999/2000 to 2013/2014 is calculated from combined slaughter and live export statistics. When accompanied by population data from a proximate period a harvest rate can be calculated (Table 4.12).

Table 4.12. Annual Western Australian goat turnoff, population and harvest rate 1999-2014

Year	Slaughter	Live export	Total	*Population	Harvest rate (%)
1999/2000	199,869	33,773	233642	732,847	32
2000/2001	280,530	57,370	337,900	827,613	41
2001/2002	299,960	63,900	363,860	827,532	44
2002/2003	287,659	41,592	329,251	694,058	47
2003/2004	204,542	27,194	231,736	743,548	31
2004/2005	234,356	26,100	260,456	923,170	28
2005/2006	250,605	18,696	269,301	1,080,677	25
2006/2007	249,378	16,580	265,958	635,230	42
2007/2008	109,945	6,306	116,251	834,399	14
2008/2009	188,143	5,023	193,166	596,147	32
2009/2010	205,079	13,404	218,483	446,590	49
2010/2011	112,201	3,763	115,964	143,894	80
2011/2012	81,947	20	81,967	150,080	55
2012/2013	50,411	1,219	51,630		
2013/2014	83,305	1,012	84,317		

*Population is from Pople and Froese and is for the calendar year encompassing the first half of the fiscal year. i.e for 1999 against the 1999/2000 fiscal year. Domestic goats not included. Slaughter data from WAMIA and live export data from ABS.

Data for goat turnoff and population, with the calculated harvest rate, are shown for the national (Table 4.13) and eastern states (Table 4.14) goat flocks over the same period. Eastern states data are combined on account of goat movement interstate for slaughter; for example a significant proportion of the New South Wales goats harvested are transported to Victoria for slaughter.

Table 4.13 Australian Total goat turnoff 1999/2000 to 2013/2014 (Source: ABS, Pople & Froese 2012)

	Slaughter	Live Export	Total	Population *	Harvest rate (%)
1999/2000	686,201	67,401	753,602	1,632,706	46
2000/2001	729,510	87,713	817,223	2,250,521	36
2001/2002	895,480	138,781	1,034,261	2,870,498	36
2002/2003	1,108,657	88,667	1,197,324	2,354,821	51
2003/2004	1,056,454	52,771	1,109,225	2,434,857	46
2004/2005	1,256,641	44,444	1,301,085	2,927,426	44
2005/2006	1,146,193	43,767	1,189,960	3,243,469	37
2006/2007	1,113,208	75,344	1,188,552	3,115,398	38
2007/2008	991,176	78,227	1,069,403	3,625,262	29
2008/2009	1,367,504	87,507	1,455,011	4,073,744	36
2009/2010	1,781,387	95,310	1,876,697	3,550,687	53
2010/2011	1,697,040	68,282	1,765,322	3,273,397	54
2011/2012	1,635,054	71,895	1,706,949		
2012/2013	1,989,797	61,330	2,051,127		
2013/2014	2,180,426	81,167	2,261,593		

*Population is from Pople and Froese and is for the calendar year encompassing the first half of the fiscal year. i.e for 1999 against the 1999/2000 fiscal year. Domestic goats not included. Slaughter and live export data from ABS

Table 4.14 Eastern States goat turnoff, population and harvest rates 1999/2000 to 2011/2012.

Year	Slaughter	Live export	Total	*Population	Harvest rate (%)
1999/2000	479,297	33,628	519,925	899,860	58
2000/2001	462,917	30,343	493,260	1,422,908	35
2001/2002	698,962	74,881	773,843	2,042,966	38
2002/2003	899,900	47,075	946,975	1,660,763	57
2003/2004	892,843	25,577	918,420	1,691,308	54
2004/2005	1,029,236	18,344	1,047,580	2,004,256	52
2005/2006	898,927	25,071	923,998	2,162,793	43
2006/2007	865,311	58,764	924,075	2,480,169	37
2007/2008	880,643	71,921	952,564	2,790,863	34
2008/2009	1,178,877	82,484	1,261,361	3,477,597	36
2009/2010	1,583,917	81,906	1,665,823	3,104,097	54
2010/2011	1,586,636	64,519	1,651,155	3,129,503	53
2011/2012	1,556,185	71,875	1,628,060		
2012/2013	1,968,468	60,111	2,028,579		
2013/2014	2,160,433	80,155	2,240,588		

*Population is from Pople and Froese and is for the calendar year encompassing the first half of the fiscal year. i.e for 1999 against the 1999/2000 fiscal year. Domestic goats not included. Slaughter and live export data ABS.

State goat populations 1984 to 2011 are shown graphically in Fig. 4.6, and harvest rates for Western Australia in Fig. 4.7. Notable here are the relatively high harvest rates 1992 – 1994 associated with the organised culling campaign, and the minor and transient impact this had on population.

Goat population densities nationally as estimated are displayed (Figs. 4.8, 4.9, 4.10)

The degree of change over the time frame indicated can be appreciated from Fig. 4.11, noticeably a general increase in the eastern states and decrease in Western Australia. (Note absence of data beyond 2001 for Queensland).

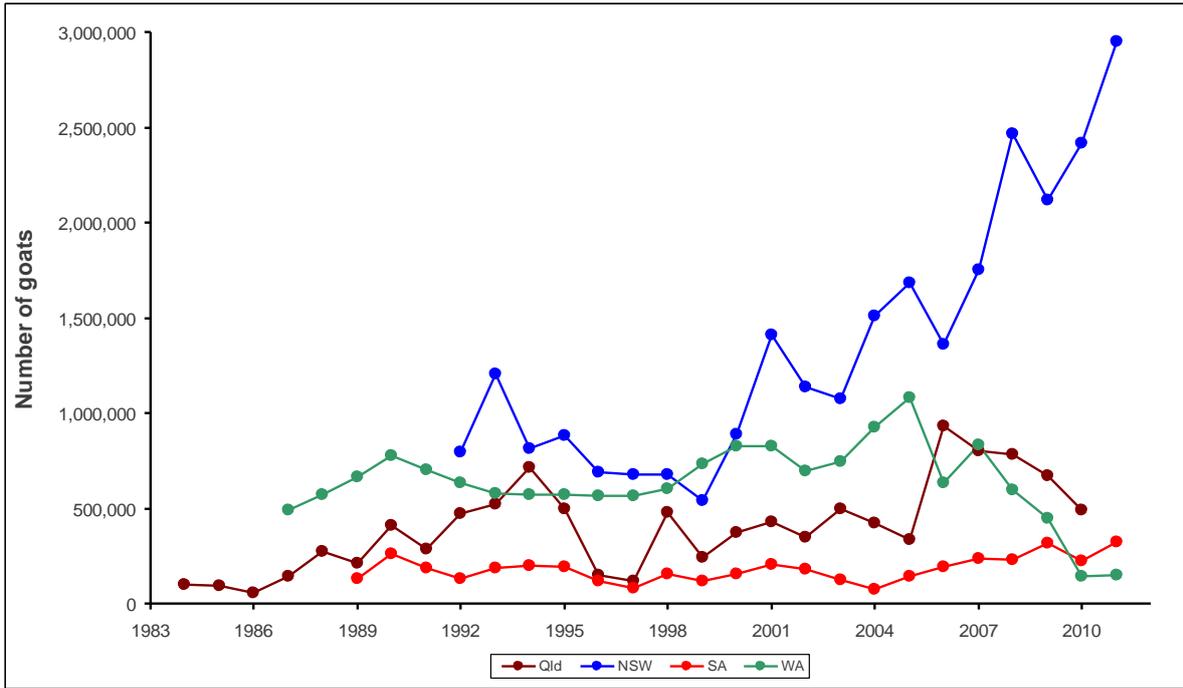


Fig. 4.6 State goat populations 1984 to 2011. (Source: Pople and Froese 2012)

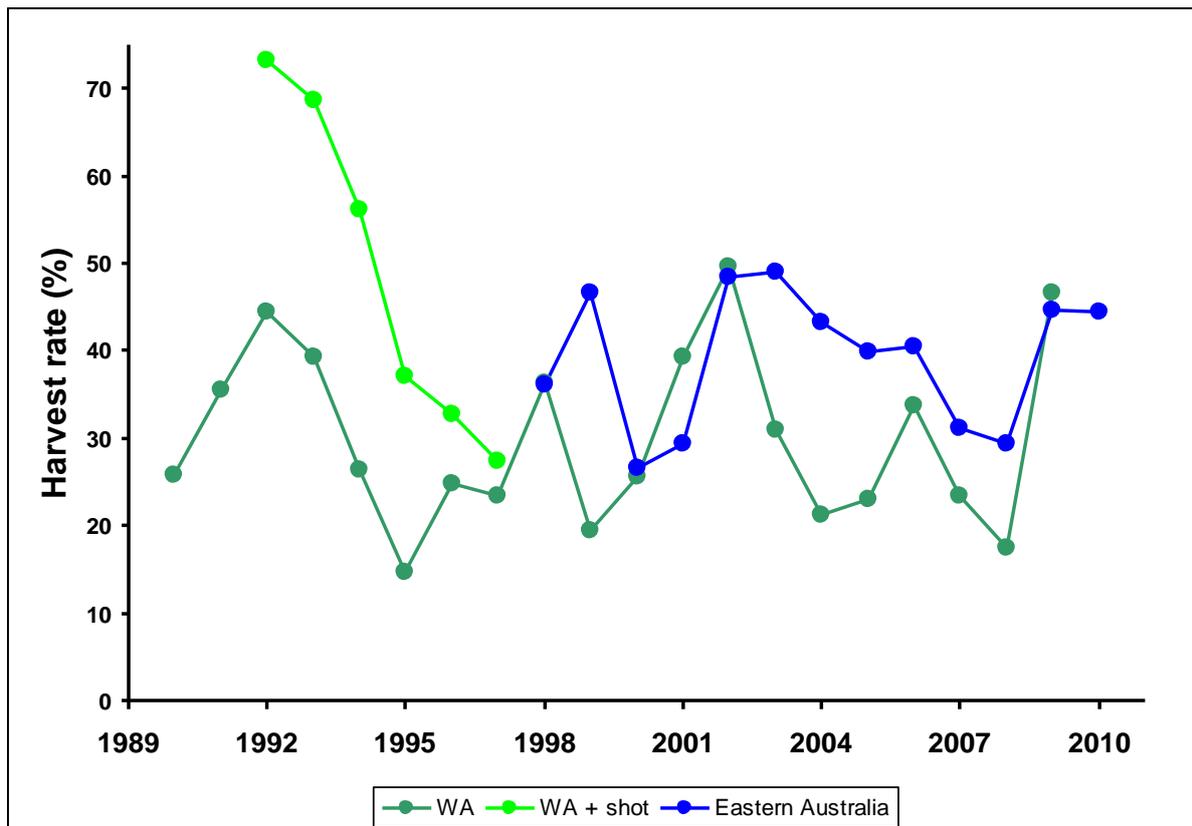


Fig. 4.7 Goat harvest rates 1990 to 2010, Western Australia (slaughtered, live export and shot) and Eastern Australia. (Source: Pople and Froese 2012)

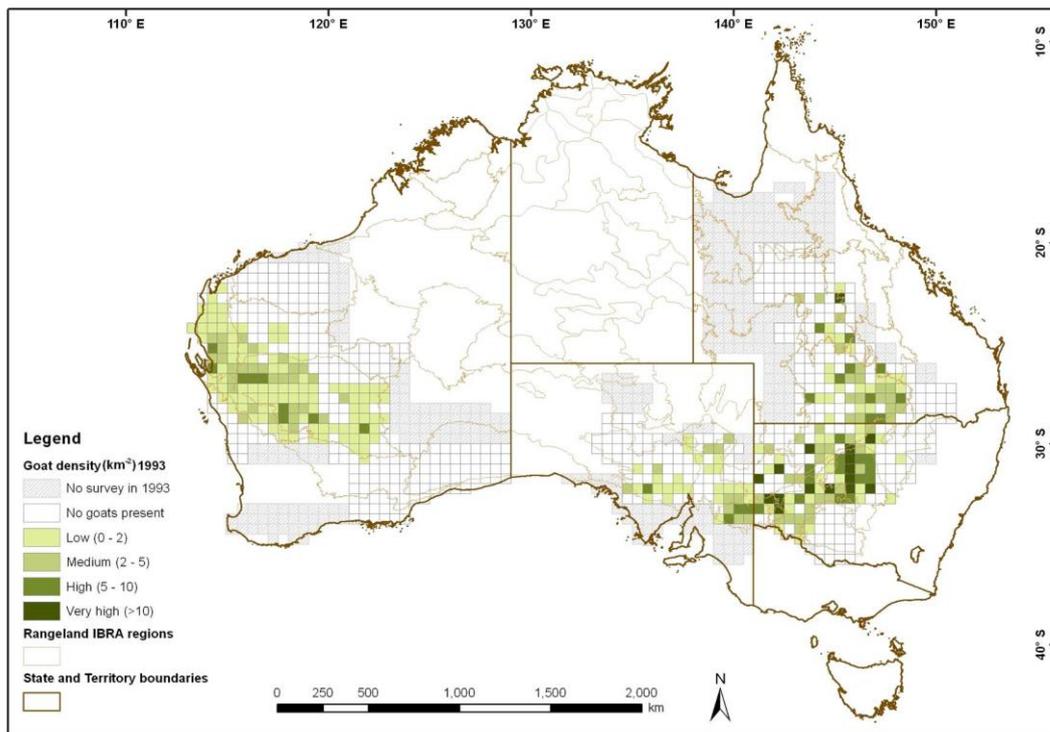


Fig. 4.8 Densities (km⁻²) of feral goats in half-degree blocks surveyed by fixed-wing aircraft in 1993 (1992 for Queensland). (Source Pople and Froese 2012)

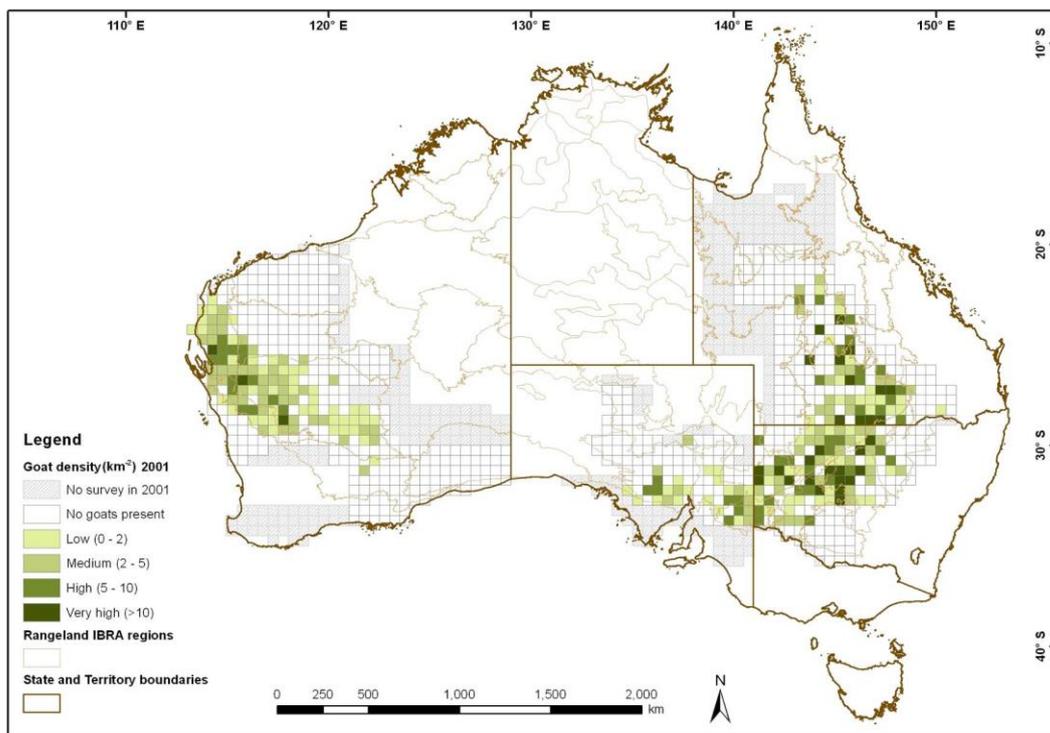


Fig. 4.9 Densities (km⁻²) of feral goats in half-degree blocks surveyed by fixed-wing aircraft in 2001. (Source Pople and Froese 2012)

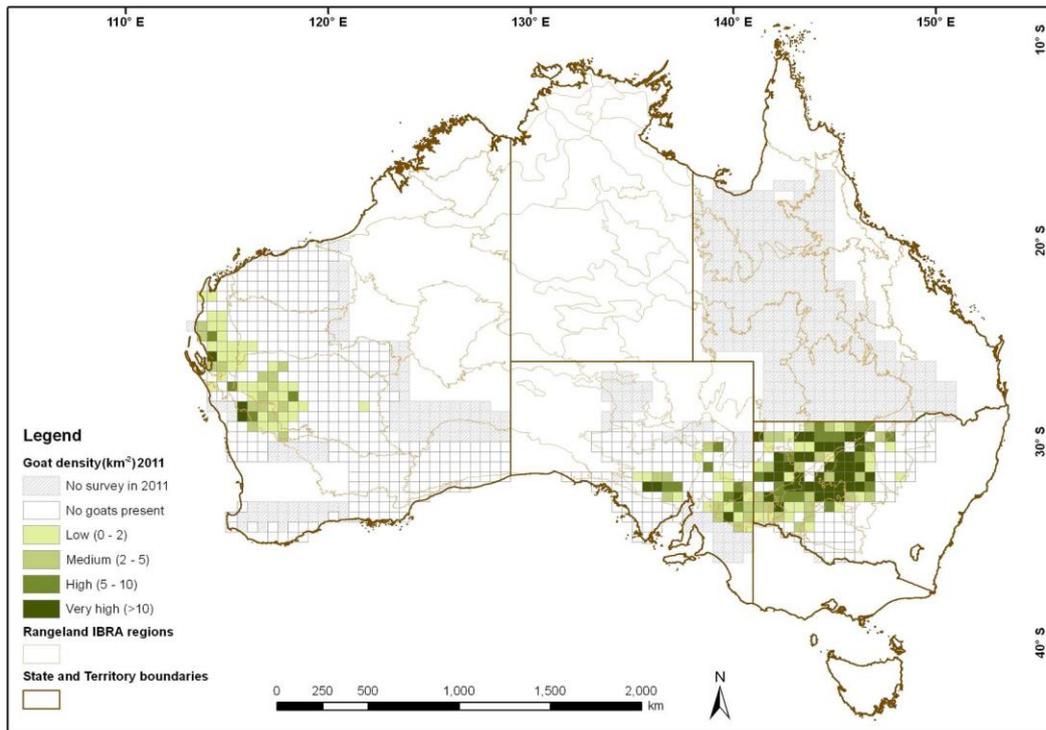


Fig. 4.10 Densities (km⁻²) of feral goats in half-degree blocks surveyed by fixed-wing aircraft in 2011. (Source Pople and Froese 2012) Note: no Queensland survey data for 2011.

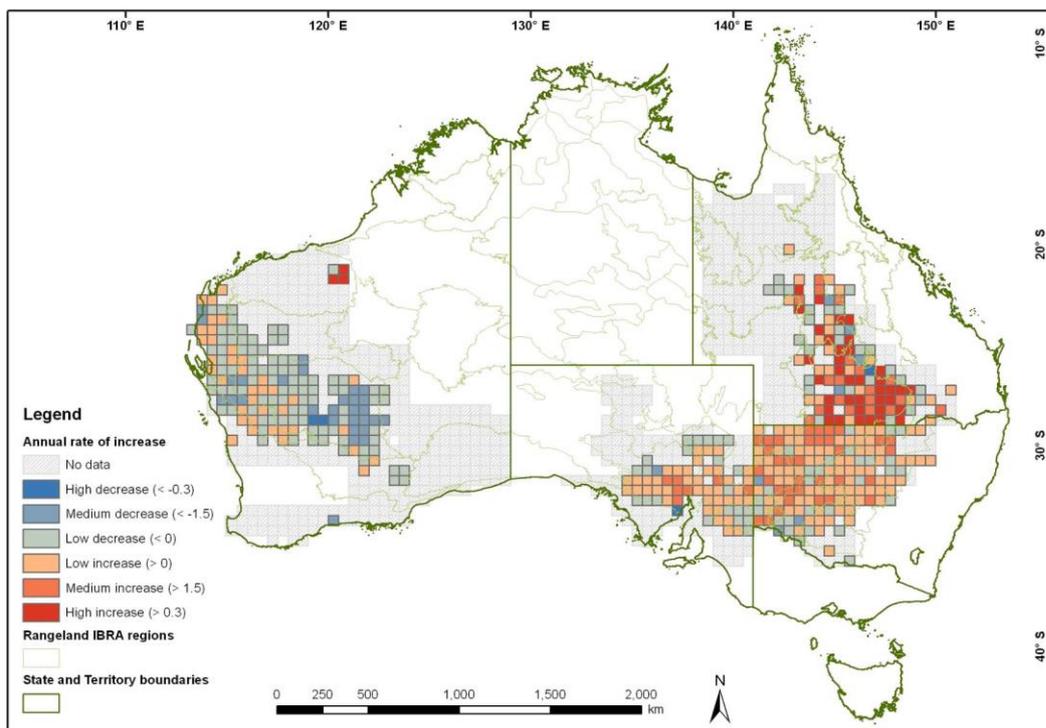


Fig.4.11 Annual exponential rate of increase of feral goats in half-degree blocks surveyed by fixed-wing aircraft across Queensland (1984-92, 2001), New South Wales (1993-2011), South Australia (1989-2011) and Western Australia (1987-2011).

Southwell and Pickles (1993) reported on the abundance, distribution and rate of increase of feral goats in Western Australia over the period 1987 to 1990. Interestingly, they noted a shift in population density from the inland goldfields to the Gascoyne and Murchison districts. Also, over those 3 years a 64% population increase was accompanied by harvesting rates of 54% in the first year measured, and ongoing harvest rates estimated to be between 34 and 40% (Table 4.15).

Table 4.15 Goat populations, harvest numbers and harvest rates Western Australia 1987-1991. (Sources: Southwell and Pickles 1993 and Pople and Froese 2012)

Year	Population (number)	Harvested (number)	Harvest rate (%)
1987	363,000		54
1987/88		195,792	
1988/89		165,498	
1989/90		199,990	
1990	596,500		37
1991		221,593	

4.4 Sheep population and production

As a co-grazing small ruminant it is of more than passing interest and relevance to consider the impacts of wild dogs on the sheep industry of the Southern Rangelands.

The documented population decline for sheep (Table 4.11) over the period 1990 to 2012 is very similar in magnitude to that for goats, albeit over a longer time interval. The earlier part of this period would have been in response partially to wool industry economics, but the introduction of shedding meat breeds was in response to their greater profitability. In fact in the analysis calculated by Young et al. (2002) the relative profitability, expressed on a Gross Margin per DSE basis, was similar for Damara sheep and rangeland goats. A Dorper sheep enterprise was also considerably more profitable than a medium wool Merino enterprise.

It would seem that the sheep (meat and wool) industry had stabilized by 2002/03; the Annual Reports to the Pastoral Lands Board for 2005/2006 (Department of Agriculture and Food 2006) and for 2006/07 (Van Vreeswyk S and Thomas P 2008) recorded an apparently stable population for the region over the interval 2002/03 to 2006/07 fluctuating around 430,000 with annual sales of between approximately 80,000 to 130,000 sheep. The relatively low turnoff rates (annual average 27%) very likely were caused by wild dog predation. Another contributing factor would be the inherently lower turnoff from the declining Merino sheep population. It is also interesting to note the slow increase and then decline in total cattle numbers, but their increasing contribution to domestic grazing animal pressure (Table 4.16).

Table 4.16 Sheep and cattle numbers and production, with grazing contributions for Gascoyne/Murchison regions combined 1999/00 to 2012/13. (Source and calculated from: Van Vreeswyk S and Thomas P 2008; Department of Agriculture and Food 2006)

year	Sheep population ('000)	Sheep sales ('000)	Cattle Population ('000)	Cattle DSE (7:1) ('000)	Sheep;cattle Dse ratio	Wool production ('000 kg)
1999/00	1024	na	127	889	1.2	5,366
2000/01	808	275	130	910	0.9	4,342
2001/02	650	275	132	924	0.7	2,997
2002/03	411	135	118	826	0.5	1,565
2003/04	419	82	137	959	0.4	1,211
2004/05	405	89	146	1022	0.4	1,391
2005/06	460	132	152	1064	0.4	1,455
2006/07	435	130	167	1169	0.4	1,093
2012/13	210		139	973	0.2	258

4.5 Wild Dog Data

4.5.1 Wild dog population

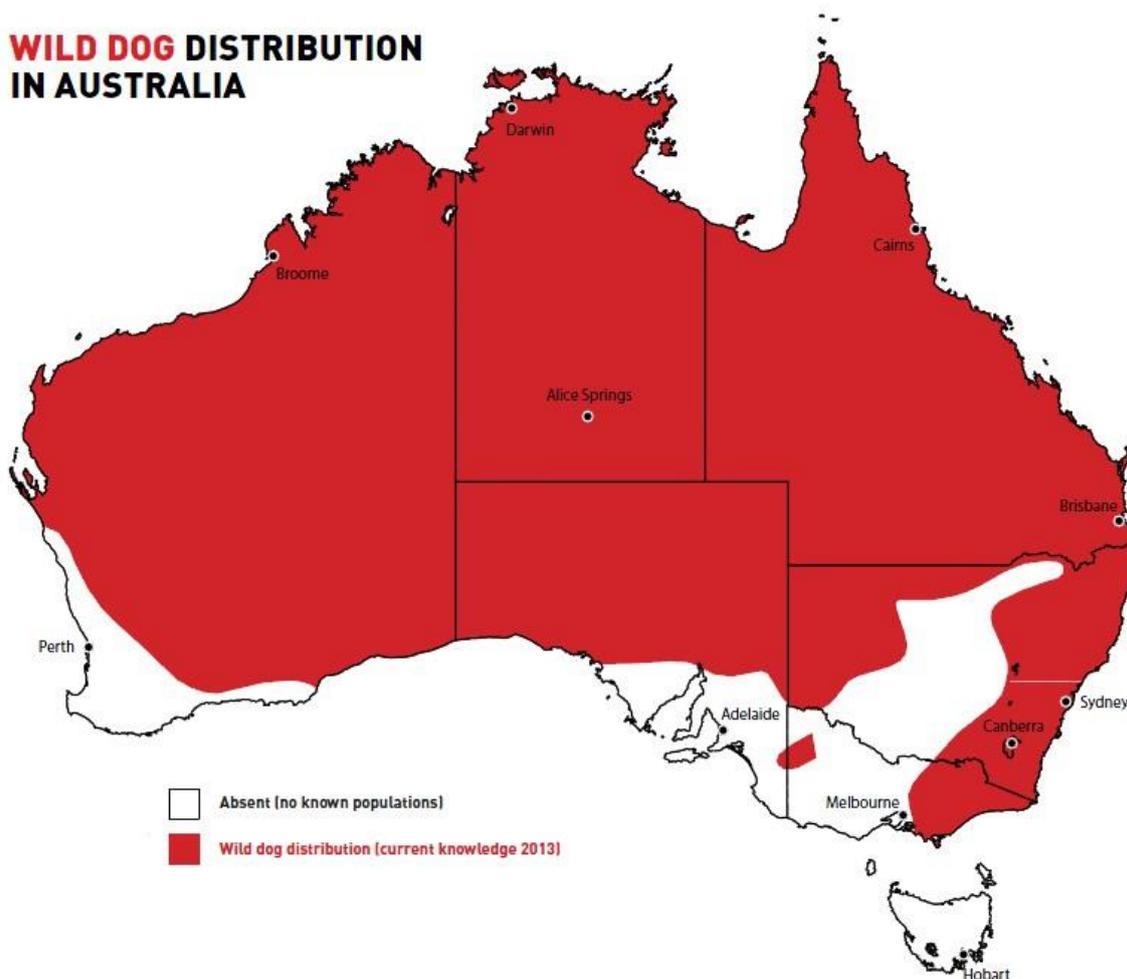


Fig. 4.12 Generalised wild dog distribution in Australia. Adapted from P. West 2013, *Invasive Animals Cooperative Research Centre*. (Prepared from data collated across 2006 to 2013).

Population estimates for wild dogs nationally and particularly for Western Australia prove difficult to quantify. As an overview, the most recent map of generalized wild dog distribution in Australia is included (Fig. 4.12), but this does not enable evaluation of populations or trends in any one area.

With regard to the WA Southern Rangelands, by 2002, following ongoing and escalating reports of wild dog problems, a panel was convened to evaluate existing wild dog control initiatives (Wild dog evaluation panel 2003). At that time, 10 years ago, the panel noted an overall lack of good information on dog numbers and dog movements, as being impediments to effective control. In looking for root causes as to why numbers of wild dogs may have built up within Western Australia, Panel Members concluded that landholder complacency, a scaling down in the amount of ground control work carried out, and a gradual over-reliance on aerial baiting, had all contributed significantly. There was agreement that the total effort and effectiveness of dog control had diminished in the preceding 10 to 20 years.

The escalation and seriousness of wild dog impact was recognized in the Duncan report (Southern Rangelands Pastoral Advisory Group 2009), noting that “the increasing presence of wild dogs was completely incompatible with a profitable small stock industry in the southern rangelands into the future”.

In the Annual Report of the Agriculture Protection Board of WA – 2004/05 (Williams and Thomas 2005) it was reported that the major focus and funding of both the Carnarvon and Meekatharra Zone Control Authorities was directed to minimising the impacts of wild dogs on livestock producers.

At the current time it remains not possible to obtain objective dog population trends, in spite of enhanced technology and communication. Wild dog-related events are reported onto a data base maintained by the Department of Agriculture. Doggers are encouraged to report in a number of categories: wild dog sighting, stock attack, trap capture, bait placement and shooting death (M Kennedy pers. comm.). However there are still inconsistent data reports, in varying formats, insufficient to monitor trends in dog numbers, locations and movements (M Stadler, Department of Agriculture). There exists no metric to record effort or activity with effect, and it was not possible to objectively confirm that current activities are achieving the desired impact. Anecdotally some doggers were of the opinion that there was less evidence of dogs, but this could not be supported by evidence. Interviewees referred to a “dog front”, implying a greater population adjacent to remaining goat and sheep populations, but this could not be verified.

The strong and unified anecdotal consensus obtained from interviewees in this study was that dog numbers and effects had built up slowly since the 1990's, the boundaries advancing south and westward from the desert and goldfields regions, to become very widespread with consequent observed impact on sheep and goats. At present only small isolated groups of small ruminants are found more than approximately 200km from the coast. This is supported by goat (and sheep) supply data from abattoirs. The author's observations concur with these data.

Events of intensive wild dog control efforts, principally ground and aerial baiting, seem to be effective locally as gauged by dog track observations, but this is typically a temporary population reduction as build up resumes as described from north and east (R Grindon pers. comm.).

4.5.2 Wild dog control costs

As an example of pastoralists' costs and total expenditure on wild dog control, district coordinated programs are funded through the recognized biosecurity groups (RBGs) . Major activities include ground and aerial baiting and dogger salaries.

For one group the 92 members contribute a total of \$190,750, representing an average individual contribution of \$2073. This amount is matched by state government for the group to fund its preferred plan. There is also the opportunity at present for groups to obtain additional funds to devote to wild dog control activities, for example the state government "Royalties for Regions" funding allocations.

In addition it is estimated that those members in the Southern Rangelands would spend on average between one and two days a week dedicated to wild dog control activities, baiting and trapping with the associated vehicle running costs. With a value imputed to the time, in all this individual effort is estimated to be an average amount per pastoralist of \$42,000 (A. Dowden pers. comm.)

Therefore on this basis the overall cost annually devoted to wild dog control by approximately 180 pastoralists would be in the order of \$8M. The costs incurred by 37 DPaW properties, 35 leases with predominantly mining interests and a proportion of destocked and lifestyle leases are not included.

4.5.3 Wild dog impacts post farm gate

The effects of a reduction in harvested livestock, although mainly impacting on pastoral enterprises, are felt in a number of not-insignificant areas, particularly in a local district. The main industries affected are abattoir and transport.

For an abattoir, with employment linked to throughput, the effect of the current reduction from the time of 2001 with annual slaughter numbers around 300,000, compared with the current situation, has been to reduce abattoir employees, mainly skilled slaughtermen, by up to 20 people. Part of this would be due to a slight reduction in sheep slaughtered, but minor as the abattoir processing the majority of rangeland goats over the time was primarily sourcing rangeland goats (P Jones pers. comm.).

With regard to transport operators, there is a direct correlation between stock regularly transported and truck units. Compared with the early 2000s the local livestock transport company has 6 trucks less. Part of this can be related to a general diminution of livestock, particularly sheep, partially replaced by cattle. It was estimated that at least 6 truck drivers were lost over the time due to loss of sheep and rangeland goat transport requirements. (R McPherson Hampton Transport pers.comm.).

Using the annual salary figures of \$50,000 for an abattoir employee and \$100,000 for a livestock transport truck driver (C Matthews Matthews Transport pers.comm.) it is estimated that the annual economic impact for the abattoir and transport industries is approximately \$1.6M.

4.6 Southern Rangelands Conditions

4.6.1 Climate and rangeland condition

See Appendices for data and figures from Novelty and Thomas (2014)

The most recent published report on the condition of the Western Australian pastoral land base (Novelty and Thomas 2014) provides information and comment on the current (to 2013) and historical southern rangelands situation.

The climate report acknowledged the near-record dry 2012 and 2013 winters as being particularly severe on seasonal quality with many Land Conservation Districts (LCDs) reporting many sites as being below average. This impacted on the rangeland plant resource base with a dependence on effective winter rainfall - being important for perennial shrub establishment and survival. As seasonal conditions declined there was a pronounced decline in shrub densities. Data to May 2014 showed a declining density of desirable perennial shrubs in the southern rangelands, with grazing pressure appearing to be the major factor responsible.

4.6.2 Grazing effects

With regard to livestock, grazing interaction with the rangeland feed sources was accomplished using an estimate of potential carrying capacity, the “Present Carrying Capacity” (Present CC) (Novelty and Thomas 2014). The Present CC is used as a measure of rangeland grazing capacity – the inherent capacity of the rangeland to run stock under the following circumstances:

- when the rangeland is in good condition
- all areas of the lease are accessible to domestic stock
- stock and seasonal conditions are average

If appropriate the Present CC is modified to account for current range condition.

Stock density as assessed at the LCD level was on the whole not unsatisfactory in the majority of cases (Table 4.17), when compared with the “Present Carrying Capacity” (Present CC). However the decline in shrub densities at a percentage of sites was considered as being evident of inadequate managerial response to adverse seasonal conditions in those localities. It was a concern that more than 50% of sites were recorded as losing desirable plants between 2005/2009 and 2010/2014. The grazing livestock in these cases is not recorded.

As discussed later neither goats nor sheep are likely to be implicated at present; cattle currently comprise approximately 75% of livestock grazing pressure, taking into account both sheep and goat numbers in latest population estimates (Table 4.16).

Table 4.17 Reported stock densities in selected LCDs of the Southern Rangelands Region, 2003-2013 (After Novelty and Thomas 2013).

LCD	Average Present CC (ha/DSE)	Stock density *(ha/DSE)	Stock density ha/DSE
		2003	2013
Binnu	25.2	40.6	89.8
Cue	18.7	29.9	62.2
Gascoyne Wooramel	11.4	16.8	13.2
Gascoyne Ashburton Headwaters	20.8	19.1	25.0
Meekatharra	22.2	30.8	28.6
Mount Magnet	17.1	24.1	44.5
Murchison	18.1	32.2	39.7
Shark Bay	12.8	18.2	20.1
Sandstone	19.2	77.5	136.5
Upper Gascoyne	19.2	23.0	11.1
Lyndon	9.5	10.8	9.0
Yalgoo	18.1	33.0	43.7

*Note the higher the figure, the more area available per livestock unit. Therefore the lower the stock density and the grazing pressure.

The grazing impact expressed as DSE is from the sum of livestock (sheep and cattle) recorded in the annual PLB Annual Returns of Livestock and Improvements. Seven sheep DSE are considered equivalent to one cattle unit. For the LCDs in Table 4.16 only the Upper Gascoyne and Lyndon areas as a whole have stocking rates higher than the assessed Present CC. However this can be misleading with regard to individual leases, as an increasing percentage have been destocked for conservation and other reasons, and these areas are included in the stock density figures.

With regard to the grazing contribution of rangeland goats over this period, the population data of Pople and Froese (2012) would indicate an overall reduction of the order of 80% with the spike in 2005/2006.

In the case of kangaroos, general population estimates indicate a relatively stable number (Kangaroo population estimates 2011). Kangaroo shooters can still operate with sufficient efficiency in spite of any possible wild dog predation throughout the region (A Dowden pers. comm.).

4.7 Local Initiatives

Together with the preceding information assembled, it is insightful to be aware of initiatives relevant to the southern rangelands within the timeframe of this report, which provide additional and pertinent background information to this study.

4.7.1 Southern Rangelands Pastoral Advisory Group 2009

Also referred to as “The Duncan Report”, referring to the committee chairperson, this group compiled a review of pastoralism in the Southern Rangelands of Western Australia. With regard to small ruminants, the report found that although it was less likely that Merino wool production would regain broad scale profitability in the region, meat sheep and managed goats had the potential to be profitable on the basis of their production characteristics (high reproductive and growth rates) and adaptability to the environment. However this was heavily conditional upon wild dog control.

“Wild dog predation of small stock has increased to unsustainable levels, particularly in the Goldfields, and the east and north of the Murchison. Most producers in these areas have abandoned small stock for cattle which are less impacted by wild dogs.

Wild dog numbers have increased as a result of diminished control efforts. This lack of control is directly a result of the diminished returns to sheep production and reduced government investment.” (SRPAG p.23)

The committee acknowledged that the increasing presence of wild dogs was completely incompatible with a profitable small stock industry in the southern rangelands into the future. The conversion to cattle production by some producers was considered to be motivated by the opinion that the effects of predation would be avoided rather than any advantages of enterprise profitability; the profitability of cattle enterprises in the southern rangelands was considered to be challenged by the nature of the feed resource, particularly the deficiency of perennial grasses, and the lack of appropriate infrastructure.

4.7.2 Murchison Vermin Cell Business Case Proposal 2014

There is currently under consideration the request for funds to erect 480km of vermin-proof fence, joining up with existing vermin fencing to create a cell enclosing 53 pastoral leases and 9 properties owned by the Department of Parks and Wildlife (DPaW.).

The pastoral lease owners have demonstrated their commitment to the concept to the extent of sharing the cost of the vermin proof fence with an annual indexed contribution of \$1800, over 23 years, combined with an agreed increase of up to \$1000 in annual vermin rates.

To support this proposal in 2012, a survey was sent to 73 pastoral stations in the Shires of Cue, Mount Magnet, Sandstone and Yalgoo to collect information regarding a range of wild dog impacts including stock losses. There were 24 respondents, running on average 9675 DSE comprising 2147 sheep, 446 cattle and 3125 goats (estimated).

The respondents reported average annual losses from wild dog predation of 313 sheep, 9 cattle and 1160 goats. Including control costs, the average estimated annual loss per respondent was of the order of \$90,000. In addition 55% had ceased to run sheep as a result of wild dogs.

81% would return to sheep and goats again if wild dogs were controlled.

From the survey it was concluded that 14.5% of all sheep, 2% of all cattle and 37% of all goats were being lost to wild dog attacks on an annual basis.

The business case document included a comparison of business performance between 2000-01 and 2011-12 for 7 of the properties, painting a picture of how station businesses have been affected by the changing circumstances of the industry. Notably there was a decrease in livestock productivity together with a decline in the numbers of domestic stock being managed - both largely brought about by the increasing presence of wild dogs. Combined with the inexorable increase in overhead costs common to all agricultural industries, there was shown to be a serious loss in profitability as measured by a number of indicators.

The change in selected financial performance indicators is shown in Table 4.18.

Table 4.18 Average selected financial performance indicators for 7 Murchison region station businesses, 2000/2001 and 2011/2012 (Source: Murchison Vermin Cell Business Case Proposal 2014)

KPI (Key Performance Indicator)	2000/2001	2011/2012
Return on capital (%)	7.5	-7.1
Profit *EBIT (\$)	57,037	-107,819
Cash flow (excluding off-station income) (\$)	25,576	-139,120
Off-station income (\$)	22,682	43,744

*Earnings Before Interest and Tax

5 Discussion

5.1 Overview

In addressing the topic of this report, namely assessing the impact of wild dogs on the Western Australian rangeland goat industry, it became apparent that many issues were at play over the few decades of what might be called the rise and threatened demise of the industry.

The original pastoral leases were stocked predominantly with Merino sheep, in recognition of the greater inherent suitability of the arid shrubland ecosystem for sheep rather than cattle. It remains a commonly accepted view that this is still the case, were it not for the critical issue of wild dogs (Southern Rangelands Pastoral Advisory Group 2009). As a small ruminant the goat is equally if not better suited to the environment, and so it is that the majority of goats in Western Australia have been located in the southern rangelands. Rearing goats is the best available livestock option for many pastoralists in this region (Western Australian Department of Agriculture 2015).

An impetus to the development of the rangeland goat industry was the decline in the wool industry, particularly since the 1990's when the impact of the declining price of wool reached a stage where wool production in the rangelands was becoming unsustainably unprofitable. Historically, until that time Merino sheep were the most common pastoral enterprise in that region. The introduction of alternative meat sheep breeds, specifically those not requiring shearing, was initiated by an increasing number of stations, but was an initially slow process being relatively expensive and constrained by availability, seasons and unavoidable

reproductive time intervals. Over this time there existed a significant annual rangeland goat harvest, often between 100,000 and 200,000 per year, including the period 1992-1997 when a culling campaign was in operation (Pople pers. comm.) with short-term fluctuations in response to goat price (Forsyth et al. 2009). Harvest rates over this period to 1999 were in the modest range of 15 to 44 % (up to 73% in the early years of the culling campaign).

It would seem that the goat as a resident animal species, whether considered as a resource or a curse, was an integral component of the Southern Rangelands.

5.2 The impact of wild dogs on Australian grazing livestock industries. A review of publications

The initial publication of McLeod (2004) attempted to address the “triple bottom line” of economic, environmental and social impacts of 11 species of pest animal, but in the admitted paucity of objective data for environmental and social effects the impacts calculated were mainly economic. For the sheep and cattle industries this was calculated simply by valuing losses from wild dog predation on calves (1% of national calf number) and on sheep (0.5% of national sheep flock). Valuing a calf at \$540 and sheep at \$30, the losses for the two industries nationally were \$32.4M and \$15.9M respectively. The cost of control measures by producers and of government and industry management and research was an additional cost, not allocated to individual industries but used to assess the total impact on the grazing industries of \$66.3M.

It must be noted that these are national figures, with losses to enterprises in high impact areas spread Australia-wide, across enterprises not impacted upon by wild dogs.

The report of Gong (2009) was commissioned by the Invasive Animals Cooperative Research Centre in an attempt to place pest animal impacts and costs in a classical economic framework. The report was confined to the impacts of foxes, rabbits, wild dogs and feral pigs. In doing this the economists’ standard concept of welfare was employed – that of “economic surplus”. The model was necessarily complex, including global as well as national flow-on effects of impacts and control measures. For wild dogs, the great majority of economic loss was born by the producer.

It is of interest that when the direct impacts on the sheep and cattle industries are expressed as cost per sheep equivalent, they are remarkably similar, in this report and that of McLeod (2004). See Table 5.1.

Following the earlier work of Rural Management Partners (2004) the Queensland Government report by Hewitt (2009) was commissioned in response to anecdotal reports that the impact of wild dogs on the grazing industries was rising. It was considered that the figures from the earlier report were conservative at the time and even more so currently.

This report, although confined to Queensland and using predominantly survey information on which to estimate State costs and impacts, is quite relevant to the Southern Rangelands in that it deals almost totally with a region and with producers directly influenced by wild dogs. The impacts are therefore not “diluted” by unaffected producers. As an example 91% of survey respondents reported experiencing sheep losses associated with wild dog predation in the previous year. The other reason for the report was to explore more fully the covert impacts of diseases associated with wild dog interaction on the cattle industry, not covered in the earlier national reports.

Although calf losses comprised the largest identified cost with wild dogs, the saleyard and processor losses associated with dog bites and processor losses from offal loss due to hydatids were identified. Wild dogs were considered the major carrier of the tapeworm responsible for hydatidosis in rangeland areas, and processors identified these losses.

Abortions in cattle due to the organism *Neospora caninum* were factored into losses from sero-prevalence data available for areas of Queensland, and this was conservatively estimated to be costing the cattle industry more than \$3M annually.

Not surprisingly, the relative economic impacts on the sheep and cattle industries in this report were considerably higher, particularly for sheep (Table 5.1).

The report discussed but could not quantify the cost of loss of enterprise flexibility resulting from wild dog impacts, referring to the ongoing trend towards pure cattle production leading to cattle being introduced into tracts of land that had long been acknowledged as being more suited to sheep.

With regard to the rangeland goat industry, due to the predominant browsing habits of goats they are far less likely to pick up hydatids or *Neospora* oocysts. Certainly loss of goat offal due to hydatids had never been a problem at a major goat-processing abattoir (P Jones pers.comm.). However the possible impact on cattle being introduced to the rangelands is unknown. In Queensland 90% of properties test positive with about 15% of cattle infected. There was some concentration in areas of higher rainfall and higher wild dog numbers (Landmann and Taylor 2003).

With the relatively small (32 grazier respondents) basis of The Rural Management Partners (2004) report the conclusions may be considered not as robust; nevertheless it did establish a comprehensive breadth on which to be expanded by the report of Hewitt (2009). Impact costs estimated are not out of line with other studies.

Table 5.1 Economic impacts of wild dogs on the sheep and cattle industries of Australia, expressed as \$/sheep equivalent. (Calculated from: McLeod 2004, Gong et al 2009, Hewitt 2009 and Rural Management Partners RMP 2004)

Publication	Cost (\$/sheep equivalent)*	
	Sheep industry	Cattle industry
McLeod (2004)	0.22	0.20
Gong et al. (2009)	0.20	0.16
Hewitt (2009)	3.85	0.37
RMP (2004)	1.25	0.25

*1 unit of cattle population equivalent to 7 sheep units; see Table 4.9 for industry costs and populations at the time.

The report of Wicks et al. (2014) does not permit of direct comparison, in that it uses an approach of three case studies in distinctly different areas of Australia. The model used is one developed to consider exotic disease control costs, and includes comprehensive non-market costs in creating economic returns to control programs in the face of a range of wild dog attack rate increases. As can be noted (Table 4.8) these non-market costs, though difficult to quantify, are considered as being much greater than the immediately apparent market costs.

In summary, the features of the national pest animal impact studies reviewed which can be considered relevant to this current report on the impacts of wild dogs on the Western Australian rangeland goat industry are:

- Losses expressed as the current value of the animals

- Impacts can be extrapolated nationally or confined to a defined locality
- There is some confidence in their relevance in that in spite of different approaches there exists some similarity in the calculated impacts
- On a livestock equivalent basis cattle are impacted to a similar degree to sheep
- Wild dogs are responsible for covert losses to the cattle industry; it is a mistaken belief that a cattle enterprise can replace sheep and that wild dog control is not as important

In addition to the methodologies of all the publications reviewed, this report introduces the concept of measuring the impact of a pest animal from the aspect of severely reducing or eliminating the industry, and being responsible for ongoing unreplaced income loss.

For example, all reviews of pest animal impacts reviewed measured impacts on industries as they existed at the time of their respective publication; with this approach measured total impacts diminish over time as the industry contracts. In fact the pest has so diminished the industry that, while pest impacts decrease on the existing industry, income foregone escalates as an industry contracts.

Wild dogs are not seen to have any measurable impact on livestock if there are no livestock remaining! But it is a very real effect, on people, a region and an entire industry.

For example, the Queensland study of Hewitt (2009) calculated dog impact costs at \$3.87 per head, and from that extrapolated to the state figure of \$16.95M, from the then sheep population of 4.4 million. A decade before, in the earlier stages of wild dog depredation of the sheep industry, the population was more than double and the cost would have been calculated as more than \$30M. Similarly, reported impacts of wild dogs in the Southern Rangelands, as recorded in the PLB Annual Reports, seemed to change little between 2005 (\$1.2M) and 2012 (\$1.4M). Over this period the sheep population halved, but the impact of this has not been captured as it really is: an ongoing annual loss of foregone income, not substituted for or replaced to any degree from livestock production.

It is of note that the economic impact of wild dogs on the Western Australian rangeland goat industry can be considered as being of similar order of magnitude as on the national sheep industry, in spite of the relative small size of the local industry; it is simply that dogs have not been controlled sufficiently, for the reasons outlined.

This study did not attempt to record pastoral lease incomes, but anecdotally this would support the contention that with wild dogs eliminating small ruminant production over much of the Southern Rangelands, pastoral production is increasingly being replaced, where at all possible, by alternative off-station sources.

5.3 Goat populations, turnoff and harvest rates

5.3.1 Overview

The data from Western Australia and the combined eastern states provides evidence of a growing fundamental difference between the two. It is clear that, influenced by NSW, the eastern states goat population continues to increase, at the same time supporting a harvest rate near the proposed maximum. In WA, with lower harvesting rates over the same period the population has declined, lately at an extraordinary rate.

To understand this it is pertinent to compare WA population and turnoff data with that for the eastern states combined (it is difficult and potentially inaccurate to estimate eastern states data per state, as goats often are transported interstate for slaughter; for example, most

goats recorded for slaughter in Victoria would have come from NSW and South Australia (Forsyth and Parkes 2004).

The data from Western Australia indicate that, in spite of lower harvest rates historically than NSW/eastern States (Table 5.2), the population and turnoff have been declining at ever increasing rates. It is hard to escape the conclusion that wild dogs are primarily responsible for this.

Table 5.2 Goat harvest rates Western Australia and combined Eastern States, 1999/2000 to 2010/2011. Calculated from the data of Pople and Froese 2012, WAMIA and ABS.

	Harvest rate (%) average 1999/2000 to 2010/2011
Eastern States combined	45.9
Western Australia	38.9

The data from the eastern states is amalgamated for the reasons given; however some comment can be made regarding the population trends in the states in which significant numbers of goats are found. In South Australia, total goat population has been relatively stable over the recorded time, although regions have displayed individual fluctuations. In Queensland there has been a pronounced decline starting around the same time as WA (Fig. 4.1). The report of Hewitt (2009) was instigated by AgForce Queensland in response to anecdotal reports that the impacts of wild dogs on the grazing industries were rising. Wild dogs may well be responsible for the Queensland goat population decline.

With regard to harvest rates and industry sustainability, the relatively high rates calculated for the eastern states indicate few and minor other influences on goat mortality apart from harvest for slaughter and export. In fact they are around a theoretical maximum if a goat population is to be maintained. Such theoretical figures have been derived from modelling studies inputting assumptions about goat reproductive biology, life span and mortalities apart from human capture interventions. For example Parkes et al. (1996) estimated that feral goats had the potential to double their population every 1.6 years in the absence of mortality caused by human control efforts and predation. Also rangeland goat density could rapidly increase after vigorous control programs: high levels of removal of rangeland goats from a population may increase survival rates and result in a faster than normal rate of increase.

For the western rangelands of NSW Ballard et al. (2011) estimated that with the recorded rate of population increase and similar conditions prevailing, and despite high commercial harvesting and culling on public lands, the goat population in the district would double by 2021.

Pople and Froese (2012) noted that the removal data estimated from their study suggested a commercial harvest rate that had fluctuated between 20% and 50% of the estimated population in Western Australia and eastern Australia (Queensland, New South Wales and South Australia combined) between 1990 and 2010. In Western Australia, non-commercial destruction increased the harvest rate to over 70% in 1992, but that declined to below 30% by 1997.

Earlier data from the Southern Rangelands in the late 1980s (Southwell and Pickles 1993) would confirm that in the absence of obvious wild dog impacts, rangeland goat populations could experience significant harvest rates (34 to 54%) and still increase by 64%.

In summary for the Western Australian industry, with the most recent population data published being for 2011, and 2012/13 and 2013/14 confirmed harvest numbers (51,000 and 84,000 respectively), recovery is at a critical state. For the industry to remain sustainable population would need to stabilize and increase with lower harvests and increased dog control efforts.

For the eastern states industry, there is much to be learned from monitoring the harvest rates, high by considered levels, and maintaining stringent wild dog control activities. The most recent population estimates and associated total harvest data, for 2009/10 and 2010/11 (Table 4.12), show harvest rates of 54 and 53% respectively. Subsequent harvests continue to increase, to 2,240,588 in 2013/2014. It would be reassuring for the industry to seek goat population estimates where available as soon as possible.

5.3.2 The influence of harvesting method

Throughout the 90s the more widespread adoption of trapyards certainly facilitated capture of rangeland livestock. In the latter part of the dry season, with natural water sources drying up, increasing proportions of animals could be captured for harvest or husbandry at yard-controlled watering points. It has been postulated that this could have led to excessive harvesting rates of rangeland goats and influenced population decline. Plausible as this may seem, that the increasing use of trapyards had contributed to the low current rangeland goat population and reduced distribution, it is most unlikely. Firstly, harvest rates as calculated have been modest by modeling and interstate comparisons. Secondly, the ability of the goat population to withstand and recover from human harvesting rates of 70%, as was the case for the years 1992 – 1997 with a vigorous culling campaign on top of commercial harvest, is testament to the recovering ability of goat populations. The impact of sustained wild dog predation, however, is well documented as being incompatible with goat or sheep populations.

5.3.3 The influence of goat prices

There are potentially a number of influences on the number of rangeland goats harvested, apart from population densities. For example, Forsyth et al. (2009) argued that economic and environmental factors determined the rate of goat harvest from Western Australian rangelands. They analysed data to show that the number of goats commercially harvested in Western Australia during July 1988–June 2003 was influenced by both environmental (i.e. rainfall) and economic (i.e. average price paid per goat) factors. They also showed that the harvest varied consistently with month.

With regard to price, from 1988 to about 1995 the CPI-adjusted average price paid per head for goats was relatively stable at about \$A9; thereafter it rose to be of the order of \$A18 by 2003. Over this interval price variations explained approximately 70% of the harvested goat number. There was support for the hypothesis that the number of goats harvested was a function of the average price paid per goat in the previous month, with a dollar increase in the price paid per goat associated with an increase of approximately 3.5–5.0% in the number of goats received by the abattoir in the following month.

The significance of this argument as it might apply over the more recent interval to 2014 can be evaluated by reference to the goat market prices over this time, paid by the major buyer (Table 5.3).

The price of goatmeat has risen steadily over these recent years, with one reduction in 2007/2008, but since then, with strong and positive outlook, there is widespread, strong motivation to harvest. However the reality is that there are no small ruminants, sheep or

goats, to be found in the eastern regions of the rangelands, and harvesting efforts yield few if any stock.

Table 5.3 Rangeland goat price trends Western Australia (Source: Geraldton Meat exports)

Year	Calendar year average price (\$/head)
2005	26
2010	31
2014	40
2015	51

It may well be the case that the reduced investment in wild dog management (Allen and West 2013) is a symptom rather than a cause of the declining profitability of sheep farming in Australia’s rangelands (Forsyth et al. 2014), but the same cannot be said about the role of the wild dog in the demolition of the Western Australian rangeland goat industry – nor for that matter the elimination of sheep from the shared rangelands.

5.4 Wild dog control and monitoring

It would seem clear that a number of causes, some unavoidable, some unfortunate, some brought about by ignorance, operated over the last 25 years to allow wild dog multiplication and spread and bring about the current extreme consequences of almost eliminating the traditional, recognized small ruminant industries of the Southern Rangelands. In listing these there is not the intention to apportion “blame” but to learn and move on, and, hopefully, not perpetuate the problem or waste resources into the future.

It is to be recognized that satisfactory wild dog control did exist throughout the rangelands probably till the mid 1980’s. The factors associated with this included an awareness by pastoralists as a unified group of land managers of the necessity for unwavering effort in maintaining a low wild dog population. With Merino sheep as the long-term enterprise, any escalation in wild dog impacts were quickly recognized and acted upon. Station staff were usually in sufficient numbers to be deployed for the necessary control activities. Communication between stations was facilitated by a combination of long-established social connections combined with locally based Agricultural Protection Board (APB) staff in government employ.

The factors of market and social change which subsequently transpired may not have individually had such catastrophic consequences, but acting together provided a situation where the recognized disciplines for wild dog control were eroded. These factors have been referred to:

- Reduction of profitability of conventional Merino wool enterprises, leading to less staff and funds to invest in dog monitoring and control
- Gradual reduction in government staff numbers and activities, combined with restructuring of the APB. Although the Biosecurity and Agriculture Management Act 2007 (BAM Act) did not come into effect until 2013, the changes were being experienced in remote rangeland areas from the early 2000’s.
- Government acquisition of a significant number of pastoral leases with subsequent management for conservation purposes. It is acknowledged that initial budgets were totally inadequate for wild dog control. Together with often inexperienced management the necessary time and commitment could not be deployed, and with

early government management structures the necessary communication and cooperation with neighbors was a weakness

- With increasing numbers of stations replacing sheep with cattle as a response to the wild dog problem a further patchwork of land did not always contribute the necessary wild dog control resources, This was a combination of staff inadequacy and lack of commitment to the urgency of wild dog control
- Gradual lease ownership change, with often locally inexperienced management. This included cases of smaller leases having absentee owners and used primarily for lifestyle attributes

With these issues operating to varying degrees at any one time, it is not surprising that wild dogs were able to multiply, initially in the inland and goldfields regions, to the extent that control activities increasingly became inadequate and the impacts on small stock escalated.

Whilst some of these issues have to some degree been addressed, others remain. The structure of RBG's does appear to facilitate the operation of wild dog control, although the enforcing of compliance on uncooperative managers remains a weakness.

There would still appear to be deficiencies in coordinated wild dog control activity where DPaW properties are involved. This is a contentious issue, but the issues of communication combined with a grossly inadequate personnel and economic budget for dog control are difficult to resolve.

As remarked upon, although wild dog control has received increasing resources and effort in recent years, it would be prudent to monitor the effect of this. There exist methodologies to accomplish this but there are not the resources to include them as a feature of control programs. Given the extraordinary expansion and impacts of wild dogs in the region under consideration this would seem a priority. The publication of Mitchell and Balogh (2007) provides a comprehensive description of candidate techniques for monitoring the presence of wild dogs.

Similarly, while there does exist a central state data repository, it does not permit of objective evaluation as to ongoing success or otherwise. Although in principle individual wild dog control actions would appear to be adhering to nationally accepted procedures, the inability to monitor effects over time would be seriously impeding success. Essentially the well-recognised necessity for coordination of activities could be better employed.

Much of the preceding would be achieved with support for increased Government Agency (Department of Agriculture and Food) regional staffing as pastoralists are increasingly having to deal with the consequences of policy which inevitably has interests and outcomes conflicting with pastoralism.

As an example of monitoring a trial in Queensland (Table 5.4) used dog track observations collected objectively to evaluate the impact of coordinated aerial baiting with 1080 over 3 shires. The data confirmed that the planned aerial baiting was demonstrably more effective in reducing evidence of dog activity than alternatives of trapping/shooting or doing nothing. It also showed that non-participating properties provided a reservoir of dogs to re-colonise the baited areas. This is well known but local confirmation of effectiveness would be stimulus to maintain and focus effort.

Table 5.4 Queensland Blackall project, wild dog activity August 2003-June 2004, including both pre-and post-baiting figures. Source: Pastoral Memo – Southern Rangelands 2005

Control method	Activity index*	No. of dog tracks	#Plot nights
Aerial baiting	0.04	68	1627
Ground baiting	0.03	16	498
All 1080 psg	0.04	84	2125
Other methods†	0.09	176	2002

*Average number of dog tracks per tracking over the year. † Includes trapping, shooting, guard dogs, doing nothing. # Number of nights for which plot assessments were conducted

It is heartening that a renewed Western Australian State wild dog strategy is being assembled, with extensive industry consultation and ownership. This will certainly be part of a return to satisfactory wild dog control.

Given the relatively recent introduction of cattle as significant enterprises in the Rangelands, a number of issues urgently need clarifying:

- What is the impact of wild dogs on cattle in an arid shrubland environment? The MLA report of Fleming et al. (2012) dealing with wild dog impacts in northern Australian cattle enterprises highlighted the existence of critical knowledge gaps that impede progress for both beef producers and the wider community. Priorities amongst a large list of recommended research were determining the part that wild dog predation plays in reproductive failure and enterprise profitability, abattoir survey of dog bites and hydatidosis and measuring the effect of wild dog presence on cattle weight gain, foraging patterns and maternal behaviour.
- With the widespread view that the Southern Rangelands are inherently less suitable for cattle than small ruminants, what is the difference in profitability, rangeland utilization and ecosystem biodiversity? Essentially, if pastoralists resort to cattle production as a fallback option in response to wild dogs, what is the ongoing income foregone? This would be in addition to the acknowledged but unquantified wild dog impacts on cattle.

With the extent of research acknowledged, government support for the proposed Murchison Vermin Cell Fence Project would seem of great benefit. It would enable the establishment of a permanent resource not only to indicate production potential for the rangelands but also to be a more controlled and manageable environment for a range of biodiversity outcome research, without wild dog impacts.

Included in such urgent research is the need for a comprehensive study into possible native wildlife losses associated with the considerable wild dog population; with the depredation of small ruminants and a modest kangaroo population there remains an unknown effect on a range of small wildlife species.

5.5 Economic impacts of wild dogs on the rangeland goat industry

Compared with the national and Queensland wild dog impact estimations on the sheep and cattle industries, part of the rangeland goat impact is quite simple to calculate.

Quite clearly, wild dogs as a major identified factor have reduced the goat population in number and distribution, from what was demonstrably a sustainable number and harvest rate, to the current levels. Over the period 1990 to 1999 the rangeland goat population was relatively stable, being of the order of 750,000 at beginning and end of the period falling and rising by 20% at the middle of the period. There was no change in contribution to rangeland grazing pressure. Harvest rates were modest – an average over the 10 years of 41%, this figure including removal rates of more than 70% in the early years of the organised culling campaign. The population withstood this. From 1999/2000 till 2005/2006 the industry matured with increasing population and harvest, again at modest and sustainable harvest rates (35.4%).

From this basis, it is not unreasonable to propose an industry with a stable and sustainable rangeland goat population of 900,000 with a harvest rate of 35%, or 315,000 annually.

The current harvest is of the order of 65,000 annually.

Using current 2015 goat prices (\$51/head) and a standardised transport cost per goat of \$7, the loss of potential annual income to rangeland goat producers in the rangelands would equate to a total of \$11M (Table 5.5).

Table 5.5 An estimate of the economic impact of wild dogs on the Southern Rangelands goat industry (K. Bell)

Rangeland goat population	Harvest rate (%)	Turnoff (number)	*Average goat sale return (\$)	Total regional return (\$M)
900,000 proposed	35	315,000	44	13.86
140,000 current estimate	46	65,000	44	2.86
Difference				11.0

*Farm gate price net of transport

From interview responses, with wild dogs controlled to a satisfactory degree, pastoralists would as a generalization plan to manage either a mixture of sheep and goats or a mixture of sheep, goats and cattle. Such a business plan was based on the desire to have diversity of enterprise with some protection from market price vagaries. A small number of producers would opt to have rangeland goats as a sole harvesting enterprise.

The considerable magnitude of the impact of wild dogs on the WA rangeland goat industry can be appreciated by comparison with the large-scale reports of dog impacts nationally on the sheep and cattle industries. For example, the economic impact (\$11M) calculated for the, by comparison, small WA rangeland goat industry is of the order of the estimated \$15.9M for the national sheep industry in 2003 (McLeod 2004) at which time sheep value as estimated by mutton and lamb real (2014) prices was remarkably similar to current prices, and national sheep population coincidentally the same (Donlan and Williams 2015).

Hewitt (2009) calculated an impact of \$16.95M on the Queensland sheep industry with a population at the time of 4.4M; at the current estimated sheep population of 1.5M this would equate to about \$5.8M.

5.6 Economic effects of wild dogs on the Southern Rangelands sheep industry

Although this report primarily estimates the impact of wild dogs on the rangeland goat industry, it is pertinent to include the impact on the sheep industry in the region, as in fact the initial increasing concerns over wild dog effects were in regard to sheep; this was because sheep were the long-term managed livestock enterprise of choice and with some degree of stock reconciliation the losses were more apparent. With the majority of rangeland goat producers also managing sheep the small ruminant losses were obviously not confined to goats. As expressed in interviews, typical history was the increasing evidence of wild dog attacks on both sheep and goats from 2000 onwards; often sheep (Merinos or more recently introduced meat breeds) had been discontinued some years earlier due to wild dog losses.

It is instructive to considering as a basis a current typical stock reconciliation for a rangeland Dorper sheep enterprise (Table 5.6), with an average sale sheep return net of freight conservatively of the order of \$60 at current prices. It is proposed that a sheep population of 420,000 as was apparently stable over the period 2002 to 2006 (Table 4.16) is sustainable. With a turnoff of 294,000 head (a conservative 70%), the farm gate return to Southern Rangelands pastoralists without significant wild dog impacts would amount to \$17.6M. Using as a point of reference the 2012 sheep population figure of 210,000 (Table 4.11), an estimated 200,000 sheep currently at turn off rate of the order of 30% (Table 4.16) would be returning \$3.6M.

On this basis the loss to the sheep industry, in addition to that experienced by the rangeland goat industry in the same region, is of the order of \$14M.

These figures are summarized in Table 5.7

Table 5.6 Dorper sheep annual reconciliation example Southern Rangelands (K. Bell)

Sheep class	Number start	Nat. increase	sales	losses	Purchase	Trans. in	Trans. out	Number end
Ewes	1000		150	100		250		1000
Ewe lamb		500	150	100			250	
Wether lamb		500	400	100				
Rams	50			10	10			50
Total	1050	1000	700	310	10	250	250	1050

Table 5.7 An estimate of the economic impact of wild dogs on the Southern Rangelands sheep industry (K. Bell)

Sheep population	Turnoff rate (%)	Turnoff (number)	*Average sheep sale return (\$)	Total regional return (\$M)
420,000	70	294,000	60	17.6
200,000 current	30	60,000	60	3.6
Difference				14.0

*Farm gate price net of transport

From the point of combined loss to sheep and goat producers in the Southern Rangelands, the economic impact of wild dogs as foregone income is seen to amount to a figure of \$25M

annually. This is a most significant impact, and would be supported in its order of magnitude by the data from the Murchison Vermin Cell Project survey.

It is recognized that a proportion of current sheep production comprises wool from Merino sheep; whilst no population figures are recorded for Merino sheep, it is considered that Merino wool production will continue to decrease in the Southern Rangelands on account of lower profitability than that from meat sheep breeds.

It is estimated from WSA wool receipts from the areas W04 and W05 (Southern Rangelands Wool Statistical Areas, Table 4.10), using an average greasy wool cut of 3.7 kg, that a current Merino population may be of the order of 60,000 confined largely to the coastal and adjacent areas. Reportedly this continues to decline.

It is of relevance to note the slow increase and then decline in total cattle numbers, but the increasing proportion by cattle of total domestic grazing animal pressure (Table 4.16). With the decline in sheep and goat numbers, cattle would now comprise an estimated 75 to 80% of grazing pressure in the rangelands. As has been reported the increasing proportion of cattle is seen largely as an attempt to mitigate wild dog impacts, accepting the inherently lower profitability of cattle enterprises in the region.

5.7 Wild dog impacts post farm gate

Post farm gate the impact of wild dogs is largely through abattoirs, with the loss of up to 20 employees or full time equivalent salaries over the period. This was considered to have a direct economic impact of the order of \$1,000,000 with community flow on.

The other direct impact is through trucking companies, the estimated reduction in truck driver salaries over the period being of the order of \$600,000. Both of these post farm gate economic impacts are in part due to the simultaneous reduction in rangeland sheep turnover. It is acknowledged that further community impacts would be experienced, for example in retail sales, school and services staffing, but these could not be reasonably quantified.

5.8 Rangeland condition and grazing pressure

Historically, for a variety of reasons, the southern rangelands have experienced transitional change with perennial grass loss and declining desirable shrub density (Novelly and Thomas, 2014). The timeframe over which this has been documented includes the past decade, over which time there has been an overall recorded reduction in domestic livestock, as reported in the PLB annual returns (Novelly and Thomas 2014). That there are exceptions with excessive stock grazing densities for individual sites within LCDs and for a number of LCDs as a whole is unfortunate. Also, these records cannot account for goat and kangaroo populations. With the data of Pople and Froese (2012) the contribution from goats can be estimated; as a summary the goat population had slowly risen until around 2005 followed by the dramatic and accelerated decline to be but 14% of the 2005 peak in 2011. Over this period sheep numbers declined dramatically and cattle numbers slowly rose. Kangaroo populations as documented are remaining relatively stable (Kangaroo population estimates 2011) with controlled harvest quotas (DPaW 2013).

Given the reduced livestock numbers reported (Novelly and Thomas 2014) it would appear that grazing pressure is slowly reducing. Certainly at the present time neither sheep nor goats are likely to be implicated in any ongoing rangeland degradation, as over the majority of the region their numbers have substantially reduced. Over the period 1990 to 2012 sheep numbers declined by 86% (Table 4.11) and goat numbers by 82% (Table 4.12).

The Present CC used has been an estimate for at least the past decade, when the rangeland was supporting up to 1,000,000 rangeland goats, as well as the kangaroo population estimates. However it cannot be used as an indicator for overall rangeland grazing pressure; leases are evaluated individually for carrying capacity.

It becomes important for the future productive health of the rangeland that the grazing contributions from all stock are recognised and accounted for, both the traditional “domestic” (but free-ranging) cattle and sheep and the rangeland goat and kangaroo numbers. These populations can be all managed to maintain their respective enterprise productivities together with the health of the rangeland herbage. For example, controlled grazing in particular areas to manage the return of desirable shrubs and perennial grasses. This has long been recognised as leading to the best long-term biodiversity outcomes, formally linking trends in biodiversity from monitoring to required changes in the total component of grazing livestock (Forsyth and Parkes 2004).

Pastoralists now have the tools and technologies to monitor and manage total grazing pressures across the landscape, to enable rangeland regeneration, and ultimately increase carrying capacity.

6 Conclusions/recommendations

It is concluded that wild dogs have been and continue to be the major reason for the dramatic, otherwise unexplained reduction in population and distribution of rangeland goats and sheep in Western Australia.

Documented rangeland goat populations, producer records and goat turnoff data supplied by industry indicate that this impact started around 2005 to 2006 with low harvest rates at that time. From 2009 the population experienced catastrophic reduction.

The trends for rangeland goats were preceded by similar trends for the population and turnoff of sheep from the same areas. Initially this was for the traditional Merino sheep industry but followed by impact on the meat sheep breeds introduced.

The decline in the rangeland goat population, for almost a decade, would indicate that any recent identified adverse trends in rangeland vegetation conditions are likely to be due to season and/or the past or present impacts of other grazing livestock.

Reports indicate that wild dog control reduced in effectiveness in preceding years, for a variety of reasons, leading to this imbalance. There are many improvements in wild dog control at present, with considerable effort and expense, but in WA no system or metric to monitor objectively the results of this has been implemented. If wild dog control is to be achieved this will be essential. It is considered that local implementation of the National Wild Dog Action Plan provides the guidance to reliably and demonstrably achieve the required control.

For the eastern states industry, there is much to be learned from monitoring the harvest rates, high by considered levels, and maintaining stringent wild dog control activities. The most recent population estimates and associated total harvest data, for 2009/10 and 2010/11 show harvest rates of more than 50%. The consequences of the subsequent increasing harvest numbers could be evaluated by reference to goat population estimates where available.

Given the relatively recent introduction of cattle as significant enterprises in the rangelands, a number of issues urgently need clarifying. Apart from the unknown impact of wild dogs on

cattle in this environment, the presumed foregone income from cattle as being inherently less suited by comparison to small ruminants requires investigation.

As a guide to actions which may eventuate from this report, the following recommendations are made in considered order of priority.

Recommendation 1

Maintain wild dog control activities coordinated within and between Biosecurity Groups, with ongoing association with the NWDAP. Without this there is no likelihood of a return to small ruminant production.

Recommendation 2

Implement a system or metric to objectively monitor dog numbers and therefore the success or not of control activities in WA and across other regions as necessary.

Recommendation 3

Compliance with wild dog control activities as enacted by Recognised Biosecurity Group's (RBGs) be legally enforced.

Recommendation 4

A strong and unified WA wild dog management strategy be developed and implemented.

Recommendation 5

With the current low population and restricted rangeland goat distribution there is a danger that excessive commercial harvest may impact upon population restoration in WA. Regional information regarding goat population numbers and harvest rates should be sought as a priority to better manage the impacts of commercial harvesting on populations. This recommendation would apply with equal emphasis to the eastern States.

Recommendation 6

The industry in the eastern States although buoyant at present, needs to be ever vigilant and maintain vigorous, coordinated wild dog control as recommended and facilitated within the framework of the National Wild Dog Action Plan. The Western Australian experience teaches that wild dog population growth and movement can be swift along with consequent impacts on small ruminants.

Recommendation 7

Overall grazing pressure at station and Land Conservation Districts (LCD) level should be regularly and consistently monitored so that the goat industry is and is seen to be a leader in rangelands biodiversity outcomes.

Recommendation 8

With increasing Southern Rangelands land ownership and management potentially in conflict with profitable pastoral production objectives, increase the presence and resources locally of appropriately skilled WA government department staff in order to actively support pastoralists.

Recommendation 9

Construction of a fence for the already planned WA Murchison Region Vermin Cell be commenced. As well as clear beneficial pastoral production outcomes, it would provide a resource of ongoing value for controlled research on livestock, native wildlife and rangeland vegetation/biodiversity.

Recommendation 10

In the absence of small ruminant prey and with modest kangaroo numbers, investigate and clarify native wildlife losses associated with wild dog predation. The fenced Vermin Cell (Recommendation 9) would facilitate this research.

Recommendation 11

On the assumption that the Southern Rangelands are less suitable to cattle than small ruminants, clarify what is the difference in profitability, rangeland utilization and ecosystem biodiversity. In relation to this, investigate the extent of ongoing foregone income from cattle enterprises, in addition to the acknowledged but unquantified wild dog impacts on cattle.

Recommendation 12

Clarify the impact of wild dogs on cattle in arid shrubland environments.

Recommendation 13

Progress the information gaps identified through the MLA report from Fleming et al. (2012) dealing with wild dog impacts in northern Australian cattle enterprises.

7 Acknowledgements

A lifetime history in the Southern Rangelands and unwavering passion for the potential of the rangeland goat industry characterised David Steadman, who was a continual source of information and stimulus to explore the many aspects surfacing during this study.

Also amongst the many pastoralists contacted special thanks to Ashley Dowden who was unfailingly generous in time and effort as a reference and source of information.

The author thanks the valuable inputs from present and past Department of Agriculture staff who generously provided of their considerable experience and contacts. Thanks especially to Tim Johnson, Matt Young, Tony Gray, Greg Brennan, Jim Miller, Paul Novelly, Malcolm Kennedy, Matt Stadler, and John James.

To Craig Walker from Primaries and Peter Burton from Australian Rangeland Meats, thanks for constructive guidance, information and advice. Thanks to Dave Saunders from WAMIA for always constructively responding to data requests for the WA goat industry and to Tony Pople From Biosecurity Queensland for the goat population data. Rashelle Levonian from MLA promptly accessed goat statistical data in response to requests.

A special thanks to Mike Edmiston from Geraldton Meat Exports, for his interest, information, patience and support.

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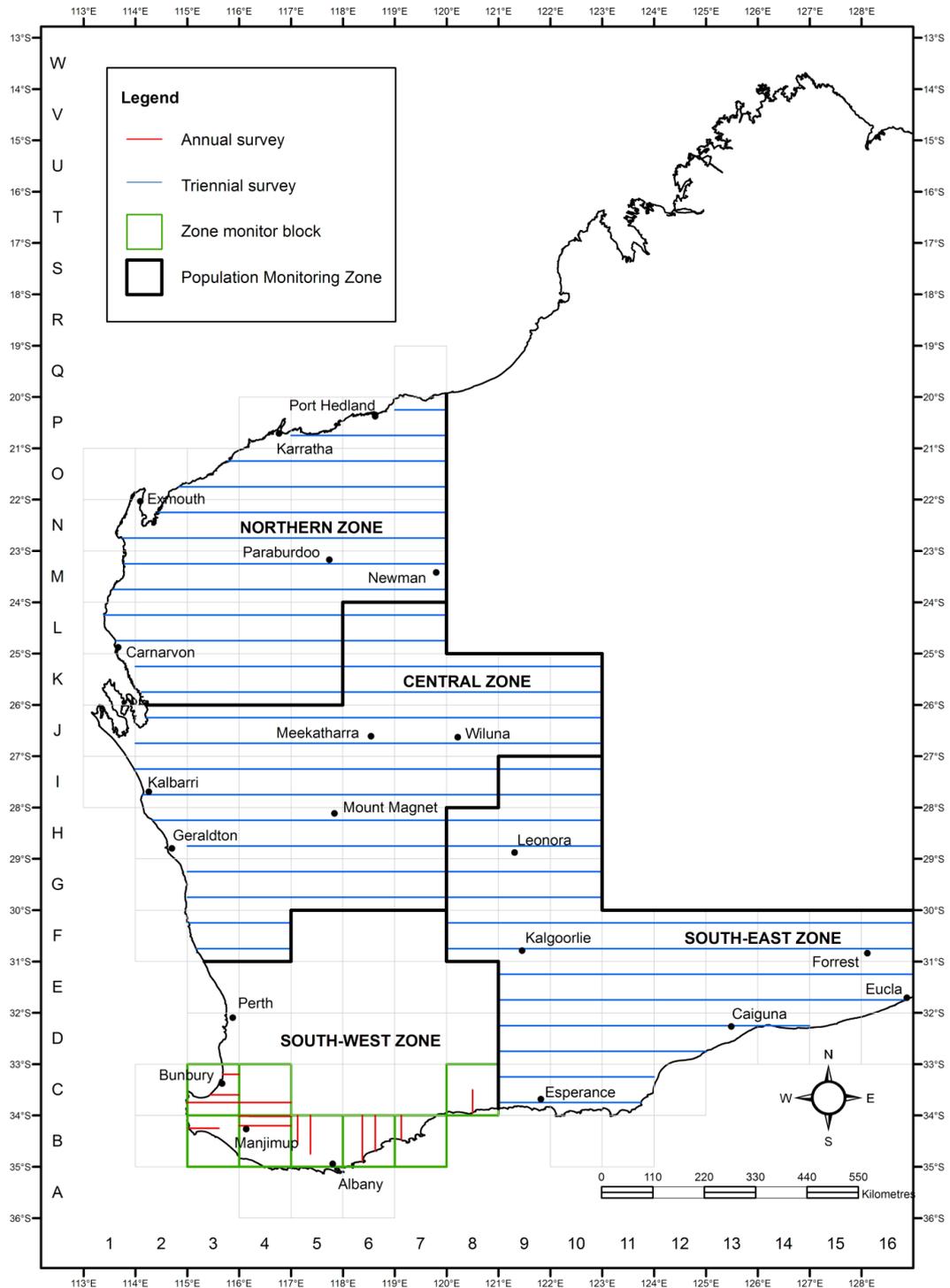
9 Appendices

9.1 List of Acronyms used

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABS	Australian Bureau of Statistics
APB	Agriculture Protection Board
DPaW	Department of Parks and Wildlife
DSE	Dry Sheep Equivalent
LCD	Land Conservation District
MLA	Meat and Livestock Australia
NWDAP	National Wild Dog Action Plan
PLB	Pastoral Lands Board
RBG	Recognised Biosecurity Group
SRPAG	Southern Rangelands Pastoral Advisory Group
WAMIA	Western Australian Meat Industry Authority
WSA	Wool Statistical Area
ZCA	Zone Control Authority

9.2 Area and Regional Maps

9.2.1 Kangaroo population monitoring zones Western Australia (Source: DPaW 2013)



9.2.2 Land Conservation Districts in the Western Australian Rangelands

(Source: Novelty and Thomas 2014)

Report on the condition of the pastoral resource base

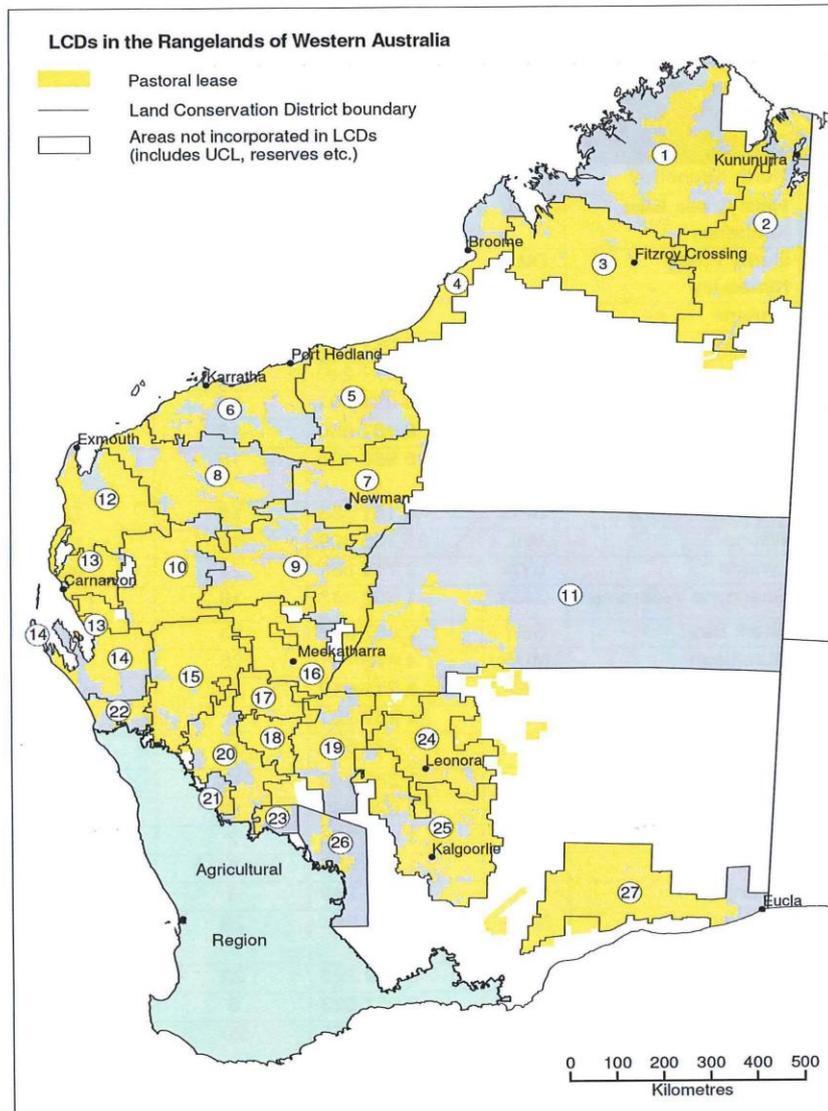


Figure 1 Land Conservation Districts in the WA rangelands

9.2.3 Western Australian pastoral Land Conservation Districts (Source: Novelly and Thomas 2014)

Report on the condition of the pastoral resource base

Table 1 Western Australian pastoral Land Conservation Districts (LCDs)

LCD NUMBER	LCD	LCD CODE	LCD area (ha)	Pastoral stations	% of LCD as pastoral lease
1	North Kimberley	NTK	11 276 364	14	33
2	Halls Creek East Kimberley	HAL	8 753 170	36	95
3	Derby West Kimberley	DWK	7 518 115	32	98
4	Broome	BRM	2 582 365	9	63
5	De Grey	DEG	5 082 429	15	76
6	Roebourne	ROE	5 177 240	18	59
7	East Pilbara	EAP	4 831 201	13	69
8	Ashburton	ASH	6 152 959	16	62
9	Gascoyne Ashburton Headwaters	GAH	6 906 425	16	72
10	Upper Gascoyne	UPG	4 181 585	18	78
11	Wiluna	WIL	33 705 599	18	13
12	Lyndon	LYN	3 715 081	21	90
13	Gascoyne Wooramel	GAW	1 653 843	16	117*
14	Shark Bay	SBY	2 667 947	13	56
15	Murchison	MUR	4 475 451	26	93
16	Meekatharra	MEK	3 211 619	20	112
17	Cue	CUE	1 257 263	8	71
18	Mount Magnet	MTM	1 223 568	17	135*
19	Sandstone	SAN	3 330 243	12	72
20	Yalgoo	YAL	3 020 649	19	81
21	Mount Marshall	MML	1 017 906	2	28
22	Binnu	BIN	1 216 520	5	17
23	Perenjori	PER	782 248	3	24
24	North-eastern Goldfields	NEG	3 936 601	29	161*
25	Kalgoorlie	KAL	6 092 703	22	73
26	Yilgarn	YLG	3 057 623	6	10
27	Nullarbor Eyre Highway	NUE	6 247 761	20	97

* Some parts or all of several stations are not aligned (or incorporated) with a particular LCD. However, for this report, they have been associated with the most relevant LCD. Therefore, for some LCDs the station area can exceed the registered LCD area.