Proceedings of the National Feral Deer Management Workshop

Canberra, November 2005

Australian Government
Bureau of Rural Sciences

NSW DEPARTMENT OF PRIMARY INDUSTRIES

Invasive Animals CRC

Edited by Dr Steven McLeod

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Invasive Animals Cooperative Research Centre

"Together, create and apply solutions"

Workshop Proceedings:

What are the issues for the management of wild deer in Australia?

November 2005, Canberra

Australian Government

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Edited by: Dr Steven McLeod,
Vertebrate Pest Research Unit,
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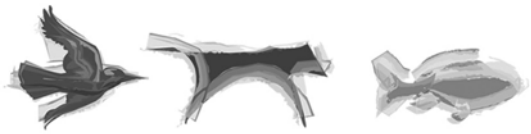

Foreword

Wild deer are an emerging pest management problem in Australia. Unfortunately there is no consensus on how best to manage deer as they continue to expand their range and increase in density.

Recreational hunters and deer farmers view them as a highly valued resource and commodity. Other groups (such as primary producers, disease management agencies, conservation agencies, horticulturalists) view them as a potentially serious pest. The conditions under which wild deer are either a valuable resource or a pest are not clearly understood. The implications of such differences in perceived resource value also require investigation for effective coordinated management.

Pest management agencies have been slow to react, probably due to the fact that the issues surrounding the management of deer in Australia are not clearly understood.

A workshop, held in Canberra on 9 and 10 November 2005, brought stakeholders together to openly discuss their goals for the management of deer in Australia. The participants were invited to submit both spoken presentations and written papers explaining their position on, aspirations and goals for, the management of wild deer. The proceedings of the workshop will form a useful and unique reference document for the development of understanding, and for policy development and research agendas.

Aims and Objectives

1. To record the aims, objectives and aspirations of the main stakeholder groups that have an interest in the management of wild deer in Australia.
2. Identify knowledge gaps in the management of wild deer in Australia.
3. Use this information to provide direction for research.
4. Promote communication between stakeholder groups.

Stakeholder groups that participated included:

- recreational hunters, various hunting organisations, Sporting Shooters Association
- deer farmers
- government (state) pest management agencies (including Livestock Health and Pest Authorities <LHPA> and Game Council of NSW)
- R&D corporations and government funding agencies (RIRDC, DEH, BRS),
- scientists (with in depth knowledge of the management of deer, from the UK and NZ, and also Australia)
- animal welfare agencies (RSPCA)
- disease management agencies (DAFF)
- government conservation agencies (state NPWS)
- government policy developers
- local government (eg councils)

These proceedings have been published to provide a permanent record of the aims, objectives and aspirations of each stakeholder group. The proceedings will be a useful reference for the development of research priorities.

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Workshop Summary: The Big Issues

A number of themes emerged from the workshop. They were:

- prevention of new populations
- sustainable opportunities for cultural and heritage valued hunting
- cost effective control techniques
- sound understanding of behaviour and ecology of deer
- relationships between density and impacts
- management needs to be informed by targets and impacts
- policies fail due to lack of technical knowledge

Project Proposals

Workshop participants suggested the following list of potential projects as worthy of investigation (the list is not in order of priority).

Project title

Develop a risk assessment tool to make decisions on keeping deer in new areas.

Background

There is a need to assess the risk of keeping deer in new areas so regional groups can make a decision to issue licences for deer or to set appropriate conditions based on risk.

General Approach

- needs to be done with the support of the deer industry
- use current Goat Risk Assessment tool in South Australia as a guide
- look at risk factors for deer
- develop decision tool.

Project title

Understanding the values and motivations of deer releasers.

Background

- need to understand: i) who/how many; ii) why.
- understanding will lead to development of effective education/regulation/incentives.

General Approach

Interviews with known/admitted deer releasers (conducted or supervised by a social scientist). Important that there are no negative consequences for participants.

Project title

Investigating the notion of ‘‘traditional/historic/heritage’’ range

Background

- is this ecologically valid?
- has equilibrium been achieved?
- accept that there needs to be some hunting areas.

Project title

Benchmarking attitudes to deer and deer management

Background

- to set a benchmark for/understanding of current attitudes
- to be in a position to compare attitudes within 5–10 years.

General Approach

Review previous studies in Australia
Take a quantitative approach:

- focus group
- case studies
- national survey

Consider the pros and cons of identifying attitudes towards deer in the context of other species (both native and introduced).

Project title

New deer populations: fingering the suppliers

Background

Deer species are rapidly dispersing across many areas of Australia. Nothing is known about the dispersal characteristics (spread from current populations, escapes from farms, deliberate release).

General Approach

Review methods for identifying new populations:

- DNA
- stable isotopes
- tagging schemes

Test these methods for rusa deer in Queensland.
Work with agencies and industry to assess how information can be linked to regulatory frameworks.

Project title

How to manage new deer incursions

Background

Need a rapid response strategy to prevent new incursions from becoming established populations.

General Approach

- consult with all stakeholders
- desktop study to develop a response strategy
- implement a number of assessment sites
- monitor outcomes
- refine response strategy

Project title

Eradication of isolated deer populations: ‘‘Go For Broke Approach’’

Background

Pick one or two herds in high priority areas that are not too easy to eradicate (but possible) and use this as a demonstration.

General Approach

Feasibility study: aimed at funders (where are they; risks and constraints)
Island approach
Time frames
Operational plan: aimed at the people who do the work. Technical details/time frames.
Stop rules/exit strategies:

- are there survivors?
- are there risks of new invaders?

Detection probabilities and search theory
Review and audit

Project title

The economic, heritage and cultural value of deer and deer hunting in Australia

Background

The economic, heritage and cultural values of deer have been under recognised and overlooked. Wild deer hunting generates significant dollars for the Australian economy.

General Approach

Develop questionnaire
Mail out survey to target recipients
Identify:

- all cost and expenditures
- equipment purchased
- deer consumption
- ancillary equipment costs

Project title

Identify areas that should remain deer free

Background

Deer are an alternative land use.
Acknowledgement that deer can be an invasive species and at high densities can have negative impacts, therefore, deer distribution and abundance needs to be regulated and managed to achieve positive outcomes and reduce the potential for negative impacts.

General Approach

- develop protocols to demonstrate impact
- manage established herds to minimise impacts
- identify emerging herds for elimination

Project title

Environmental responses to different deer densities

Background

Establishing relationships between reductions in deer density (by management) and biodiversity.

General Approach

Multiple pairs of closely matched sites with different deer species in different states selected for conservation value. Within each pair of sites, toss a coin to determine which one gets control. Deer densities are reduced as quickly as possible in the control site. Monitoring of deer and environmental values (habitat structure, biomass, vegetation (including weeds) and

invertebrates). Project may need to run for up to 20 years. Approach would enable a meta-analysis to be performed.

Project title

Management tools for urban areas

Background

- limited options
- public perception and interference

General Approach

- literature search for suitable options
- delivery systems
- community consultation at the beginning
- marketing
- community based mitigation, repellents, fencing
- increase control options for urban deer including fertility control, lethal and repellent options.

Workshop papers

How can research contribute to the management of wild deer in Australia?

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Summary

Current management of deer in Australian States/Territories ranges from game species (with little or no consideration of impacts on other values) to declared pests (because of their actual or likely impacts on agriculture and environmental values). Most research on wild deer in Australia has been conducted by volunteers and university students rather than by state or federal government agencies. A framework for managers interested in understanding the consequences of their management actions on the deer environment system is outlined. Some practicalities of monitoring and thus learning about this system are briefly discussed: for example, it is not possible to estimate reliably the absolute abundance of deer in forests and evaluating the impacts of deer on native species and ecological communities in Australia is difficult because of the presence of sympatric mammalian herbivores. Finally, it is suggested that adaptive experimental management may be a useful means of reducing uncertainty about the outcomes of different management actions.

Introduction

Wild self-sustaining populations of introduced deer have been present in parts of Australia since the 1860s (Bentley 1967, 1998). The geographic ranges of all six deer species are increasing through both the expansion of existing ranges and the establishment of new populations, with the latter often human assisted (Moriarty 2004a).

The legislative status of wild deer in Australia varies according to state/territory. In Victoria, deer can be legally harvested only by people possessing a hunting licence (for which a fee is charged) and there are seasons and bag limits (Department of Sustainability and Environment 2006a). In contrast, deer are 'declared pests' in Western Australia (see Woolnough *et al.*. this issue). Legislation in other states/territories varies between these two ends of the continuum.

In this paper, I briefly discuss the meaning of research and what research has been conducted on wild deer in Australia. I then briefly discuss how research can contribute to the management of wild deer in Australia.

What is research?

Research can be broadly defined as 'the constellation of facts, theories, and methods collected in current texts' (Kuhn 1970). It is generally accepted, at least in the biological sciences, that the most reliable (or 'best') research is published in peer-reviewed journals. However, other important outlets for research are theses (which are usually available to anyone after an 'embargo' period), book chapters and books. Much research work, particularly in government agencies, is described in reports, which are often subject to less rigorous peer review than journal papers: reports are often not available to people outside the agency, or need special approval before release. Conferences and workshop proceedings (like these) are sometimes outlets for original research, but may be difficult to obtain. However a large amount of work never finds its way into any of these outlets, instead remaining in the researcher's 'file drawer'.

A brief review of research on wild deer in Australia

I conducted a brief review of the research pertaining to wild deer in Australia that has been published in scientific journals, theses, books, reports and conference/workshop proceedings. My search included ecological studies but not veterinary (eg serological) studies. I located

research by: (i) checking standard ecological texts describing deer in Australia (ie Menkhorst 1995; Strachan 1995; Bentley 1998); (ii) searching the SCOPUS (http://www.scopus.com/scopus/home.url) and ISI Web of Science (http://portalisiknowledge.com/portalcgi?DestApp=WOS&Func=Frame) abstracting services using the keywords 'deer AND Australia'; (iii) searching a database (http://librariesaustralia.nla.gov.au/apps/kss) of theses held in Australian universities using the keyword 'deer'; (iv) searching my library of literature pertaining to deer in Australia and; (iv) searching the literature cited in any articles identified through the above methods. I do not claim this to be an exhaustive review; rather, its purpose is to identify trends in the types of questions that researchers sought to answer and the organisations that conducted the research.

Published papers

The earliest relevant article published in a peer-reviewed science journal was an overview of the distribution and status of wild deer in Australia (Bentley 1957). Roff (1960) described the range of wild deer in Queensland. However, I could find nothing else published in peer-reviewed science journals until this decade. Yamada *et al.* (2003) used expert knowledge to construct a habitat model for sambar deer (*Cervus unicolor*) in Lake Eildon National Park (Victoria). Moriarty (2004a) described largescale patterns in the distribution of deer in Australia and Forsyth *et al.* (2004) included deer in their analysis of the factors influencing the establishment of exotic mammals in Australia. Two papers were published on rusa deer (*Cervus timorensis*) in Royal National Park: Webley *et al.* (2004) investigated the genetics of this population and Keith and Pellow (2005) described observations of browsing on plants. Hall and Gill (2005) discussed some issues in the management of deer in Australia. Peel *et al.* (2005) described observations of the ecological impacts of sambar deer in part of Victoria. Ray and Burgman (2006) investigated how variation in expert opinion could be represented in habitat suitability maps for sambar deer in part of Victoria.

Much research on the ecology of wild deer in Australia has been reported in *Australian Deer*, the journal of the Australian Deer Association (ADA). Articles in this journal are not peer-reviewed. Most of the work reported in this journal was conducted by ADA members. Some of the research reported for sambar deer in *Australian Deer* is from the enclosure managed by the ADA at Bunyip (see Harrison 1986). However, studies by ADA members into physical characteristics (eg Draisma 1976; Slee and Presidente 1981a,b), hunting (eg White *et al.* 1991), and the diet (Burke 1982) of sambar deer have also been reported in that journal. Philipps (1986) summarised the results of her B. Nat. Res. Research project, on the diet of habitat preferences of fallow deer in north-east Victorian pine forests, in *Australian Deer*.

Books

Two books reporting at least some research have been published on wild deer in Australia (Bentley 1967, 1998). The second edition (Bentley 1998), published by the Australian Deer Research Foundation, reported data on many aspects of the biology of sambar deer living in an approximately 13-hectare enclosure at Bunyip, Victoria. The Bunyip enclosure was established in 1986 by the Victorian State Executive of the ADA, to study the ecology of sambar deer and, since that time, has been managed by a subcommittee of the executive (G Moore, Australian Deer Research Foundation, pers comm). The Australian Deer Research Foundation is a non profit organisation that was established in 1978 to promote research into the biology, ecology and management of wild deer in Australia, and to publish the results of that research.

Mayze and Moore (1990) report research on hog deer (*Axis porcinus*) from penned and wild hog deer on Sunday Island, Victoria. Sunday Island was purchased in 1967 by the Para Park Cooperative with the purpose of managing the island for the hunting of hog deer (G Moore, Australian Deer Research Foundation, pers comm).

Theses/university projects

My search identified two completed PhD theses, four Masters theses and 11 Honours theses, one Diploma, one Master Qualifying Thesis and two undergraduate projects (Appendix 1). I do not claim this to be an exhaustive list, but it indicates a substantial amount of work by University students on the topic of 'wild deer'. A wide variety of topics were investigated, ranging from the economic value of recreational deer hunting (Cause 1990) to monitoring (eg Lewin 2002; Houston 2003) and habitat modeling (Yamada 2001; Lucas 2002).

Reports

M Draisma (pers comm), representing the Australian Deer Association, submitted a substantial article entitled 'Some aspects of the biology of wild sambar in Victoria, Australia' for publication in the proceedings of the New Zealand Deerstalkers' Association International Wildlife Forum, which was held in Wellington, New Zealand, in July 1978. However, the proceedings were apparently never published and the article remains an 'unpublished report' that is available from the author.

Downes (1983a-c) investigated aspects of sambar ecology, habitat use and condition and hunting opportunities in two state forests in Victoris forest: his work was funded by the Forests Commission of Victoria. Statham and Statham (1996) estimated the home-range sizes and daily movements of 20 fallow deer in Tasmania. The response of the animals to a simulated shooting campaign was also evaluated. The work was funded by the Bureau of Resource Sciences Wildlife and Exotic Disease Preparedness Program and the Tasmanian Department of Primary Industry and Fisheries.

Murphy (2001) and Hall (this volume) summarised the history, distribution, population size and value of fallow deer in Tasmania, and the implementation of Quality Deer Management in that state: much data on harvest size, composition and body condition/antler characteristics are also summarised in those publications. Zerger *et al.* (2001), in collaboration with Parks Victoria, summarised work in Lake Eildon National Park (Victoria) aimed at validating a predictive model of sambar deer habitat quality. Forsyth (2006a), commissioned by Parks Victoria, designed a monitoring program for sambar and fallow deer at six sites in Victoria.

Conference/workshop proceedings

There was a conference on 'deer management' at La Trobe University in November 1974, and three papers concerning wild deer in Australia were published in the proceedings. Cowling (1975) provided a brief overview of the history, distribution and management of wild deer in Australia. Bentley and Moore (1975) outlined the history of deer hunting in Victoria and how recreational deer hunters would like the deer-environment system to be managed. Wapstra (1975) described the distribution, abundance and recent management of fallow deer in Tasmania: the results of some research were also presented, including the results of a hunter survey and a fallow deer tag and release program. Keep (1979) also provided a brief overview of the distribution of wild deer in Australia.

Four papers were published in the proceedings of a 1994 conference on 'Conservation through sustainable use of wildlife', held in Brisbane in 1994. Murphy (1995) outlined fallow deer management in Tasmania; Cause (1995) summarised the results of an economic survey of recreational deer hunting in Australia; McGhie and Watson (1995) outlined a vision for the management of deer in Queensland; and Slee (1995) described the recreational hunting opportunities provided by sambar and hog deer in Victoria. Both Cause and Slee represented the ADA; McGhie and Watson were private consultants; and Murphy was employed by the Tasmanian Deer Advisory Committee, a body that advises the Tasmanian State Government.

One paper pertaining to wild deer was published in the proceedings of a recent conference on urban wildlife. Moriarty (2004b), a student at the University of Western Sydney, used the example of rusa deer in Sydney to illustrate how wild deer can be a feature of suburban Australian.

Summary

The bulk of the research published on wild deer in Australia has been conducted by university students (Appendix 1) and by volunteers in the ADA, the ADRF and Para Park Cooperative. Relatively little work has been published by people employed by state or federal (eg CSIRO) research agencies. This contrasts with New Zealand, where most research on wild deer has been conducted by government agencies (review in Caughley 1983; see also the chapters on each deer species in King 2005).

It is worth noting that research is sometimes deliberately *not* published because the researcher is either unhappy with some aspect of the way the work was conducted, or because the result does not match his or her view of the world. Researchers sometimes change career (either voluntarily or not), or become sick or die before they can publish their work. Research not

published in a way that is accessible by library interloan within the country of origin is effectively lost to the scientific (and wider) community.

How has research shaped current management in Australia?

One end of the continuum of current management treats deer as a resource to be managed for hunting, with little or no consideration of impacts on agriculture or other environmental values. There is a large international literature describing the optimal harvesting of temperate ungulate populations, but nothing for the tropical deer species (ie sambar deer) that dominate Victoria. Although Downes (1983a) recommended such work, I am unaware of work conducted to identify the optimal management strategies for recreational harvesting of sambar deer in Victoria.

Deer management in Tasmania is based on the Quality Deer Management (QDM) that was originally developed for white-tailed deer (*Odocoileus virginanus*) in the United States (Murphy 1995, 2001; Hall 2004; Hall and Gill 2005). QDM aims to set regulations that reduce the abundance of deer (eg by encouraging harvest of females rather than males), thus increasing the body condition and trophy characteristics of males in the population because there is more food available per capita (Miller and Marchington 1995). Apart from transplanting the QDM concept from North America, research does not seem to underpin current management in Tasmania.

At the other end of the spectrum is the treatment of deer as a pest to be controlled or, if possible, eradicated. However, I am unaware of any management actions with the aim of controlling l*et al.*one eradicating deer populations in Australia. Given that many populations of deer in Australia can probably *not* be eradicated (*sensu* Bomford and O'Brien 1995), the key question becomes, at what abundances do the environmental impacts of deer become tolerable? To my knowledge, no research has attempted to answer this question.

Some theory and reality for understanding deer/environment interactions

A large body of theory (eg Beddington and May 1977) has developed around the aim of optimally harvesting mammal populations. For ungulates, the simplest model involves assuming that the population grows according to logistic growth: the population grows most rapidly (per capita) at lowest abundance but then slows as the amount of per capita food resources declines until an equilibrium (K) is reached and the population stops growing. This model is appealing because it is mathematically tractable, and it can be shown that the maximum harvest (in terms of number of animals) occurs at K/2 (ie when the population is at half its maximum density). Unfortunately, it has recently been shown that most introduced ungulate populations appear not to grow in the way this theory predicts, but rather they exhibit eruptive dynamics (Forsyth and Caley 2006). Eruptive dynamics can be characterised by four stages (Caughley 1970; review in Forsyth 2006b): the 'initial increase' stage represents the period between establishment and the initial population peak; the 'initial stabilisation' lasts from the population peak until the start of the decline; the 'decline' continues until the population's rate of increase changes from negative to zero, and; the 'postdecline' is characterised by small fluctuations around an equilibrium density. Riney (1964) suggested that the postdecline density is lower than the initial peak because the quantity and/or quality of available per capita forage has been greatly reduced.

Many studies have shown that deer with access to large amounts of high quality food will be larger bodied and fatter than those with access to smaller amounts of lower quality food; females will reproduce at a younger age and their offspring will be larger and survive better (eg Challies 1978; Gaillard *et al.* 2000; Cook *et al.* 2004); males will be larger bodied and fatter (eg Challies 1978) and with larger antlers (Fennessy and Sutttie 1985). It is this theory that partly determines the principles of QDM (see Miller and Marchington 1995).

Another body of theory and data indicates that a deer will grow larger and fatter and survive better, and have more time for social interactions, if it eats the food resources with the greatest nutritional value (review in Belovsky *et al.* 1999). This explains why deer often travel long distances to feed on preferred foods (eg fallow deer feeding on crops and pasture a long way from cover in Tasmania; Statham and Statham 1996). Of course, native plants and crops and pasture are interchangeable. In some areas, deer will have only access to one or the other, in

other places both. The key point is that the same framework applies to agricultural and conservation impacts.

Linking the three theories outlined above provides a broad framework for understanding the links between deer abundance, individual deer size, body condition, antler characteristics, and survival and conception rates, fawn survival and growth rates, and impacts on agriculture and native biodiversity. The eruptive dynamics typical of introduced deer populations arise because of the interaction between deer and their food supply, with substantial declines in the abundance of both deer and their preferred and browsing-intolerant foods (Riney 1964; Caughley 1970; Forsyth and Caley 2006). From a conservation perspective these changes may not be reversible (eg see Coomes *et al.* 2003 for the case of New Zealand forests). In intensive agricultural systems, irrigation, fertiliser and replanting may frequently 'reset' the system.

The framework (Figure 1) can be applied to the continuum of deer management in Australia. At the 'pest' end of the continuum, if the population cannot be eradicated then the interest is in the relationship between deer abundance and impacts: there would be no interest in how the abundance of deer affects attributes of the deer population and hunting opportunities. At the game management end of the continuum there would be interest in the abundance of deer and the attributes of the population (eg size and number of trophies, number of females) and their interaction with hunter satisfaction. There may be interest in the per capita availability of food. On Sunday Island there is a system of annually monitoring hog deer abundance (using spotlight counts along a network of tracks), deer body condition (through measurements of all animals harvested in the hunting season) and hunter satisfaction (through feedback from the cooperative's members, most of whom hunt on Sunday Island). Crops have been planted and are fed to deer using break fences during the dry summer months, when animals are thought to experience the greatest nutritional stress. The abundance, key carcass characteristics and hunter satisfaction have all increased following the planting of crops (G Moore, Para Park Cooperative, pers comm).

Between the ends of the continuum are agencies that wish to manage deer as both a hunting resource and a pest. The framework above enables the costs and benefits of different management actions to be evaluated. In other words, reducing the abundance of deer may reduce both the number of animals a hunter sees and some of the environmental impacts, but the increased per capita food availability may lead to larger and fatter deer, and males with larger antlers. However, research is required to parameterise the above model. Of course, alternative management can be applied in different places.

The realities of research on deer

Having outlined a conceptual framework for understanding deer management in Australia (Figure 1), I now briefly address some issues in the conduct of research in this system.

Abundance of deer

A population is the sum of animals in age-sex classes. The age-sex classes are important because they contribute differently to population growth (Gaillard *et al.* 2000) and to the aims and satisfaction of hunters (eg Miller and Marchington 1995).

However, although it may be desirable to know the number of animals in key age-sex classes for some management goals, abundance is not always an important parameter to measure, and trends in abundance may be more relevant. Moreover, estimating the abundance of deer is likely to be problematic in many parts of Australia.

Methods for estimating the abundance of deer can be classified as either 'direct' or 'indirect' (Thompson *et al.* 1998). In a direct survey, deer are likely to move away from the observer before being detected, a bias that is likely to be acute in hunted populations. Indirect surveys measure variables that are unaffected by the observer.

Direct counts (eg from helicopters or fixed wing aircraft) and distance sampling may well be useful for some species in some situations: the technique is used for both kangaroos (*Macropus* spp.) and feral goats (*Capra hircus*; eg Pople *et al.* 1998) but, to my knowledge, has not been tested on deer in Australia. Direct counts are unlikely to be useful for sambar because this species spends most daylight hours in heavy cover (Bentley 1998; Mayze and Moore 1990). Raines (1982) described a drive count to estimate the number of hog deer, swamp wallabies

Figure 1. A conceptual framework for understanding the deer environment system in Australia. The arrows show the main direction of the effect. Note that 'extrinsic' factors such as rainfall and fire are not shown for simplicity.

(*Wallabia bicolor*) and eastern grey kangaroos (*Macropus giganteus*) on the 260-hectare Rotomah Island (Gippsland, Victoria).

Indirect counts are likely to be more useful for deer inhabiting heavy cover. Dividing the number of deer harvested (D) by the time expended harvesting (*E*) generates a Catch Per Unit Effort (CPUE) statistic, C (eg Forsyth *et al.* 2003):

$$C = \frac{D}{E}.$$

If it is assumed that there is a linear relationship between C and true abundance, then changes in C can be interpreted as changes in true abundance. However, there is evidence that C may be biased at high animal density because of shooting saturation (hunters kill proportionally fewer animals because time becomes limiting) and at very low animal density because animals become much harder to find. However, large changes in C within management areas are likely to reflect real changes in the abundance of animals. In Victoria, a form of CPUE is calculated annually as the number of deer seen per hunting hour based on returned hog deer tags (Department of Sustainability and Environment 2006b).

Internationally, faecal pellet counts are one of the longest used indices of deer abundance. The density of pellet groups on the ground at any one time is a result of three factors: the number of animals present, the rate at which these animals have been defecating, and the rate at which their defecations have been disappearing. Forsyth *et al.* (2007) examined the relationship between three faecal pellet indices ('total pellets', 'pellet groups' and 'pellet frequency') and the density of deer (primarily red deer; *Cervus elaphus scoticus*) in 20 enclosures in the north and south islands of New Zealand. The slopes of the relationships between the three indices and deer density were approximately linear. A method was presented for estimating the proportional change in deer abundance between two surveys, and this is the method that Parks Victoria has adopted (Parks Victoria 2005) for estimating changes in deer abundance at six sites containing sambar and/or fallow deer (Forsyth 2006a).

Faecal pellet counts have sometimes been used to estimate the absolute abundance of deer. Estimating absolute abundance relies on estimating defecation and decay rates. Both defecation and decay rates are likely to be influenced by a number of factors, the most important being habitat and season (eg Rogers 1987). Defecation rates of wild deer (c.f. penned deer) are difficult to reliably estimate. Two studies have estimated the absolute abundance of sambar deer in Victoria using faecal pellet counts (Lewin 2002; Houston 2003, 2005): However, neither study incorporated uncertainty in the estimates of standing crop, defecation rate and decay rate into their estimates of deer abundance. If those uncertainties are properly accounted for, then the resulting precision of estimates of deer abundance will be so poor (ie will have very wide confidence intervals relative to the mean) as to be of little management value. However, one future area of promise is the use of faecal and hair-based DNA to estimate the absolute abundance of deer in forests. Because absolute abundance cannot be sensibly estimated in most large forested areas, one must rely on indices of abundance. Research into the ability of faecal pellet counts to estimate known changes in the abundance of deer in enclosures is being conducted in Victoria (DM Forsyth, Department of Sustainability and Environment, unpublished data). The question, at least in forests, becomes 'what is the change in the *index* of deer abundance?'

Carcass parameters

Commonly measured parameters of carcasses include length and eviscerated weight, (eg Challies 1978), jawbone measurements (eg Nugent and Frampton 1994) and hind foot length (eg Morellet *et al.* 2007). Age can be estimated from either the sequence of tooth eruption or from layers in cementum annuli of molars (eg Fraser and Sweetapple 1993). Antlers can be measured in a variety of ways. Hog deer shot in Victoria must be presented at a checking station where the following parameters are measured: shoulder height, length, girth, and antler length. The reproductive condition of females is also assessed (Department of Sustainability and Environment 2006b).

Survival and reproductive rates

The best methods of estimating survival rates involve monitoring uniquely marked individuals (Gaillard *et al.* 2000; Williams *et al.* 2002). Reproductive rates can be estimated using the ratio of females:offspring (Williams *et al.* 2002), although there is uncertainty about the reliability of this method.

Abundance of food

Estimating the quantity and quality of food is difficult in forest systems. In New Zealand forests, the abundance (g m^{-2}) of food is estimated by clipping all potentially edible food within randomly located three-dimensional quadrants assuming a maximum browse height that differs among deer species layer (eg see Nugent 1990). Methods for estimating the biomass of pasture and crops have been available for many years. For example, Short (1985) showed how to estimate the biomass of pasture available to kangaroos. Measuring food quality is likely to be more problematic, particularly over large scales.

Impacts of deer on food

Numerous methods have been used to estimate the impacts of deer on the plants that they consume (review in Côté *et al.* 2004). A common technique is to construct exclosures and compare changes in plant abundance inside and outside the exclosure (eg Wardle *et al.* 2001). However, because mammalian herbivores co-exist with deer in many parts of Australia, differential exclosures are required to tease out the effects of the sympatric species. Browse on plants may be subjectively scored (eg light = 1, moderate = 2, and heavy = 3) and an index of browsing constructed for species at a site (eg Wardle *et al.* 1971). Again, although deer may browse to a greater height than many of the sympatric mammalian herbivores, attributing browse on plants to deer (eg Burke 1982) will be tenuous at lower heights: the method will also obviously not detect plants that have been completely removed by browsing.

Sweetapple and Nugent (2004) used the ratio of species richness of tall seedlings/saplings (30–200cm) and short seedlings (<30cm) in different ungulate preference classes (high, moderate and low) to examine the impacts of deer (and feral goats and feral pigs) in New Zealand and Hawaii. Individual plants can be tagged and periodically remeasured to estimate growth and survival rates.

Stakeholder satisfaction

There is a large North American literature on quantifying stakeholder viewpoints and satisfaction in the management of deer (eg review in Decker *et al.* 2001). Although hunters are an obvious and potentially large stakeholder group for many deer populations in Australia (eg Cause 1990), other important stakeholders might include botanists, birdwatchers, and adjoining landowners. Economic valuation would be important for landowners who lease hunting rights and/or lose production to deer.

Most of the components of the framework outlined in Figure 1 can be enumerated and monitored in a way that can inform management. However, both the constraints and uncertainties in these methods must be acknowledged. Morellet *et al.* (2007) describe the pros and cons of indicators of animal performance, population abundance, habitat quality and animal impacts used for monitoring and managing hunted populations of roe deer (*Capreolus capreolus*) in France. A key constraint on observing the system in Figure 1 is the inability to usefully estimate the abundance of deer by age-sex class in large forested areas, although methods are available for estimating temporal changes in abundance at the population level. Although many techniques are available for estimating the impacts of deer in forests, applying these will be problematic where there are sympatric mammalian herbivores, as is the case in much of the deer range in Australia. Identifying and enumerating stakeholders for areas with public access may also be difficult.

Dealing with uncertainties in the system

Managers of complex biological systems, such as that outlined in Figure 1, have to cope with uncertainties that result from three main sources:

(a) natural variability imposed on the species or processes being managed by largely unmanageable environmental factors (eg climatic variation, catastrophic disturbances).
(b) uncertainty about how the managed components within the system actually behave and interact.
(c) intrinsic uncertainty in the monitoring used to measure the system and effects of management.

Hence, there is large uncertainty about the best way to manage the system. Failure to include these uncertainties in management may often lead to overly optimistic estimates of management benefits.

Adaptive management is one approach to dealing with uncertainty in the benefits of a management approach. At its simplest, adaptive management involves monitoring the effectiveness of changes in management to see whether such changes give better results. This 'trial and error' or 'learn-by-doing' approach can be constructive when it encourages managers to measure outcomes, but it is often at best inefficient and at worst counter productive if the before and after outcomes cannot be validly compared (Wilhere 2002). However, such an approach may be the only possibility when there are competing ideas about how best to manage one site (eg management of mallard ducks in North America; Johnson *et al.* 1997).

When there are multiple sites and competing ideas about how best to manage the system, then the tenets of classical experimental design (replication and random allocation of management options) can be applied in order that the results or change in outcomes can be attributed with more certainty to the changes in management (Walters 1997). The latter approach has been termed 'Adaptive Experimental Management' (AEM).

AEM involves formulating predictions about the outcomes of alternative management options: these predictions may come from verbal hypotheses or, preferably, from mathematical models. The experiment uses management areas as the independent experimental units: thus, the different management options should be randomly assigned to multiple management areas (ie replicated). The predictions are monitored in each management area and these data are used to update the original predictions in an iterative process. Such an approach has been used to evaluate the costs and benefits of controlling brushtail possums at various intervals in a sample of New Zealand forests (Parkes *et al.* 2006) and is being used to evaluate the effects of deer control in four New Zealand forests (Department of Conservation 2006).

Adaptive experimental management appears particularly well suited to evaluating the outcomes of different deer management policies in Australia. A key component of AEM is identifying the competing management options and incorporating them into an experimental framework. However, it is unclear how the agencies that manage deer in Australia would themselves adapt to AEM. For example, Caughley (1983) suggested a management experiment to determine the optimal harvesting rate for wild deer in New Zealand: this corresponds to the game management end of the continuum evident in Victoria. However, different stakeholders (eg stalkers, hound hunters and hunting guides) would have different ideas about what the 'optimal' outcome might be (eg many smaller bodied and smaller antlered deer versus few larger bodied and larger antlered deer). Hence, even supposedly 'simple' management aims can have multiple stakeholders with competing objectives. Furthermore, accepting suboptimal short-term outcomes at some management sites for the sake of more optimal long-term management at all sites appears to be difficult for stakeholders (eg see Parkes *et al.* 2006).

Conclusion

I have presented a framework for managers and researchers to use to understand the consequences of management on the deer environment system in Australia. Some practicalities of monitoring and thus learning about this system are discussed: in particular, it is not possible to reliably estimate the abundance of deer in forest habitats, and evaluating the impacts of deer on native species and ecological communities in Australia is difficult because of the presence of sympatric mammalian herbivores. Adaptive experimental management (AEM) may be a useful means of reducing uncertainty about the outcomes of different management actions. AEM involves incorporating potentially competing stakeholders in management in an iterative

process, but the willingness of Australian management agencies to engage in such a process is yet to be demonstrated.

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Appendix 1.

Completed theses investigating ecology and management of wild deer in Australia. Theses are listed in ascending year of completion.

Author	Year	Title	University	Degree
Taylor, PG	1971	Aspects of the biology of the hog deer (*Axis porcinus* Zimmerman 1780)	Monash University	PhD
Tuck, M	1971	Javan rusa deer (*Cervus timorensis*) in the Royal National Park - habitat utilisation and distribution	University of Sydney	BSc (Hons)
Hamilton, CA	1982	Rusa deer in Royal National Park: diet, dietary overlap with *Wallabia bicolor*, influence on the vegetation, distribution and movements	University of Sydney	MSc
Philipps, MJ	1985	Studies on Fallow Deer (*Dama dama*) in the Koetong Pine Plantations in North-eastern Victoria	University of New England	BNatRes (Project)
Duncan, AMR	1987	A dietary study of two sympatric herbivores: fallow deer (*Dama dama*) and Forester kangaroos (*Macropus giganteus tasmaniensis*)	University of Tasmania	BSc (Hons)
Cause, M	1990	Economic values of recreational deer hunting in Australia	Griffith University	MSc
Millington, SJ	1991	Identification and monitoring of the impact on species of *Exocarpus cupressiformis* (Cherry Ballart) by *Cervus unicolor* (Sambar Deer) within Mount Buffalo National Park	Charles Sturt University	Parks and Recreation Project 1 (RMG 3614)
Moore, IA	1994	Habitat use and activity patterns of Sambar Deer, *Cervus unicolor*, in the Bunyip Sambar Enclosure	The University of Melbourne	MSc
Boyle, BG	1995	Aspects of the biology of fallow deer (*Dama dama*) in eastern Tasmania	Charles Sturt University	BApplSci (Parks, Recreation and Heritage) (Hons)
Bovill, L	2000	Bunyip Deer Study: the presence, movement and environmental impact of deer within Bunyip State Park	Institute of TAFE, Holmesglen	Diploma
Finch, N	2000	The performance and condition of wild red deer in Queensland	University of Queensland	BApplSci (Hons)
Calleja, M	2001	Evaluation of rapid census methods on wild Fallow deer populations within NSW and economic impacts of these herds	University of Western Sydney	B Lands Manage Cons (Hons)
Vincent, S	2001	Aspects of the behavioural ecology of the European Fallow deer (*Dama dama*) in NSW	University of Western Sydney	BSc (Hons)
Yamada, K	2001	The integration of expert knowledge and GIS for wildlife habitat modeling	The University of Melbourne	MSc
Bennet, A	2002	An assessment of sambar deer (*Cervus unicolor*) browsing on tree ferns in Victorian wet sclerophyll forests	Monash University	MSc Qualifying Thesis
Eyles, D	2002	Sambar deer (*Cervus unicolor*) as a potential seed vector for the spread of the environmental weed Himalayan Honeysuckle (*Leycestria formosa*) at Mount Buffalo National Park	The University of Melbourne	BSc (Hons)
Lewin, J	2002	The application of faecal accumulation surveys to estimate densities of wild sambar deer (*Cervus unicolor*) in Victoria	The University of Melbourne	BSc (Hons)
Lucas, PR	2002	A population model and habitat management for Sambar Deer (*Cervus unicolor*) in Lake Eildon National Park	The University of Melbourne	BSc (Hons)
Houston, E	2003	The use of faecal counts to estimate	Monash	BSc (Hons)

		sambar deer (*Cervus unicolor*) population abundance in Victoria	University	
Roberts, C	2004	Population, diet, and movement of red deer (*Cervus elaphus*) in the Victoria Valley, Grampians National Park	University of Ballarat	BSc (Hons)
Moriarty, A	2004	Ecology and environmental impact of Javan rusa deer (*Cervus timorensis russa*) in the Royal National Park	University of Western Sydney	PhD

The Australian Government Department of the Environment and Heritage and the management of deer in Australia

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Abstract

The Australian Government Department of the Environment and Heritage ('the Department') has over time expanded its engagement on the environmental management of deer impacts within Australia. The Department's approaches to the management of wild deer have evolved as more has become known about the potential impacts of these species in Australia. The Department will continue to be involved in issues associated with the importation of deer species into Australia under the *Environment Protection and Biodiversity Conservation Act 1999* ('the EPBC Act'), and will continue to approach wild deer management issues within Australia from a threat abatement planning perspective. The Department recognises that wild deer have significant socio-economic values that need to be considered in the process of developing constructive ways to manage wild deer within Australia.

Introduction

The Department's early view on wild deer

During the late 1980s to early 1990s the Department's involvement in issues associated with deer species was focused primarily on managing the importation of deer genetic material into Australia to meet the demands of an expanding deer farming industry (RIRDC 2000; AGDAFF 2003). The Department's role in this process was defined under Commonwealth legislation via the then *Wildlife Protection (Regulation of Exports and Imports) Act 1982*. Ramsay (1994) notes the observation made by Ramsay and English (1991) that at approximately this point in time the deer farming industry decreased its dependence on captured wild deer for use as breeding stock, choosing instead to use imported breeding stock.

Groves and Bishop (1989) noted that wild deer had the potential to have a negative impact on Australia's biodiversity. They noted that at that time Australia had not experienced the same degree of wild deer related negative impacts that New Zealand had and was trying to abate. Groves and Bishop (1989) also acknowledged that hunting was a significant socio-economic driver in the management of wild deer, particularly in southeastern Australia. Ramsay (1994) notes that at that time it was difficult to get accurate estimates of wild deer numbers in Australia and refers to a rough estimate provided by Cribb (1991) of approximately 48 200 head.

At the same time the Department's public position on wild deer suggested a low risk that wild deer species would become a potentially significant threat to Australia's biodiversity. The assignment of a low risk was based on a view that environmental factors would limit the abundance of wild deer species within Australia (ANCA 1993). The Department noted the potential for sambar deer (*Cervus unicolor*) to increase its range in Australia. The Department also believed that wild deer were more likely to be viewed as a desirable socio-economic resource and that recreational hunting pressure would keep species such as sambar deer from becoming a pest (ANCA, 1993).

The Department's view on wild deer evolves

Wild deer were discussed in the 2001 Australia State of the Environment Report (Williams *et al.* 2001). This report notes the work of Clarke *et al.* (2000) who included chital deer (*Axis axis*), hog deer (*Axis porcinus*), red deer (*Cervus elaphus*), rusa deer (*Cervus timoriensis*), sambar deer, and fallow deer (*Dama dama*) as a single group among 29 terrestrial species that were

causing, or had the potential to cause, severe damage to natural and agricultural systems within Australia.

Clarke *et al.* (2000) noted the lack of data available to determine the level of environmental threat that wild deer posed in Australia. However, they noted that wild deer, particularly at high densities, have the potential to cause the following environmental impacts:

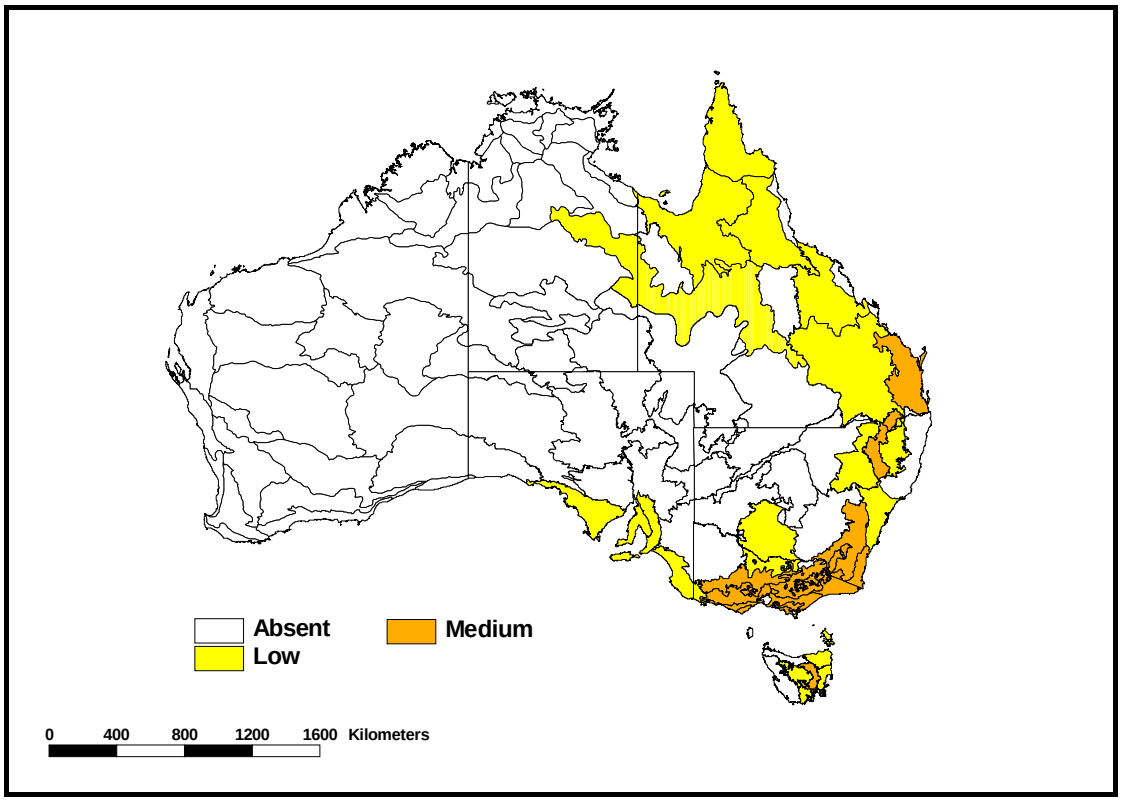
- competition with native species for food and other resources
- damage to native vegetation caused by grazing and the rubbing of antlers
- a combination of the points above to change the physical structure and composition of native vegetation communities
- to act as a carrier of wildlife diseases

Clarke *et al.* (2000) also used the Interim Biogeographic Regionalisation for Australia (Thackway and Cresswell 1995) to map the distribution and abundance of deer species (see Figure 1). Clarke *et al.* (2000) also noted that shooting was the main technique use to control wild deer, although this was not done as a pre-emptive threat abatement measure.

By this stage the EPBC Act had replaced the *Wildlife Protection (Regulation of Exports and Imports) Act 1982.* This change had little impact on the nature of the Department's involvement in the management of deer species within Australia.

The Department was involved in the consultation process undertaken by Biosecurity Australia as part of the generic import risk analysis (IRA) of deer and their genetic material. The *Technical Issues Paper* prepared in 2003 for the IRA process notes that Australia had an estimated 200 000 wild deer, most of which had arisen from original releases made by acclimatisation societies (AGDAFF 2003; see also Moriarty 2004).

Figure 1. The combined distribution and abundance of deer species in Australia as developed by Clarke *et al.* (2000) and based on the Interim Biogeographic Regionalisation for Australia.



The Department's current view on wild deer

At the time of the Invasive Animals CRC workshop on the management of wild deer in Australia (November 2005) the following species of deer could be imported into Australia under Part 2 of the live import list established under the *EPBC Act* – Live specimens requiring an import permit:

- Philippine spotted deer (*Cervus alfredi*): has conditions for import (eligible non-commercial purpose only, excluding household pets. High security facilities only.).
- elk (*Cervus canadensis*), red deer, sika deer (*Cervus nippon*), and fallow deer: have no specific conditions of import other than meeting the requirements of the *Quarantine Act 1908*.

The potential negative impacts of sika deer within Australia were highlighted by a number of the workshop participants. As a result, in December 2005 the Vertebrate Pests Committee applied to the Department to review the risk from importing sika deer into Australia.

The terms of reference outlining the reporting requirements for assessing the potential impact on the environment of amending the 'List of Specimens Suitable for Live Import' for the purposes of the EPBC Act, to delete sika deer, were published by the Department on 11 January 2006. A report by Braysher Consulting (2006) for the Department concluded that sika deer should be rated as an extreme risk both in terms of (i) becoming established, and (ii) of becoming a pest should they become established in Australia.

The report by Braysher Consulting (2006) was made available for public comment on 1 June 2006 with comments due by 28 July 2006. It is anticipated that the Department will provide a recommendation concerning this review to the Australian Government Minister for the Environment and Heritage in the near future.

A number of recent publications further highlighted the emerging threat that wild deer may pose to Australia's biodiversity (Moriarty 2004; Norris and Low 2005; House of Representatives Standing Committee on Agriculture, Fisheries and Forestry 2005). Parker and English (2004) also note that we still have much to learn about the ecology of wild deer in Australia and the nature and extent of their socio-economic and environmental impacts.

From a threat abatement planning perspective, wild deer have not been nominated as a key threatening process under the EPBC Act. At a national scale, managing the threats that wild deer may pose to Australia's biodiversity needs to be considered against the listed key threatening processes relating to other wild introduced species including rabbits (*Oryctolagus cuniculus*), goats (*Capra hircus*), foxes (*Vulpes vulpes*), cats (*Felis catus*) and cane toads (*Bufo marinus*).

However, the Department does not require wild deer to be listed as a key threatening process to enable Natural Heritage Trust funding to be provided to projects that address the management of wild deer. The Natural Heritage Trust has funded a small number of wild deer control projects in recent years.

Concluding remarks

The Department will continue to be involved in issues associated with the importation of deer species into Australia under the EPBC Act. The Department will also continue to be actively engaged on wild deer management issues from a threat abatement perspective. This includes issues surrounding the contrasting nominations to list the environmental impacts of wild deer under the relevant New South Wales (nomination successful) and Victorian (nomination unsuccessful) legislation (New South Wales Scientific Committee 2004; Parker and English 2004; Victorian Scientific Advisory Committee 2005).

The Department recognises that wild deer have significant socio-economic values that will need to be considered in developing constructive ways to manage wild deer within Australia. Failure to include socio-economic values in the management of wild deer in Australia has the potential to threaten:

- the effectiveness of any control activities and/or related recovery planning actions undertaken by agencies over the long term;

- the development of cooperative management approaches between agencies and key external stakeholders;
- the ability of agencies to access a significant amount of knowledge concerning wild deer species in Australia (eg Bentley (1998) and the resources of the Australian Deer Association and the Australian Deer Research Foundation).

The Department also recognises that there is much for Australia to learn from New Zealand's experiences on the management of wild deer species (eg Department of Conservation 2004; Speedy 2005). The issues concerning the management of wild deer in Australia present an opportunity for further development under the Australian Pest Animal Strategy that is currently being developed.

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Bureau of Rural Sciences / National Feral Animal Control Program (NFACP) perspective on wild deer management

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Overview of the wild deer 'issue'

Wild deer are increasing in profile as a state and national pest animal management issue. From a national perspective, the concern is that climate matching maps (and intuition) would suggest that the respective deer species in Australia have considerable potential to increase in range and density. Although the agricultural and environmental impacts of wild deer are poorly defined at present, it is inevitable that any herbivore that reaches high densities will have some detrimental impact on pasture production and endangered native plant communities. However we need to determine if these impacts are significant enough to justify:

- Research into control techniques – recognising that there are very limited pest animal research funds relative to the large suite of exotic pests that Australia has to contend with.
- Control measures – once again, recognising the 'opportunity cost' of managing deer relative to other pest animal and land management issues.
- Animal welfare and rights concerns – few pest animal control techniques are completely humane, and there is usually a trade-off between benefits and animal welfare in pest animal control; it is therefore important to be able to justify any killing of animals in terms of *defined* benefit.
- Impact on recreational hunting – the workshop made it clear that there is a significant recreational deer hunting industry in Australia, with many enthusiastic and passionate participants. Apart from the social amenity value of deer to the hunters themselves, the hunters undoubtedly make a significant economic contribution to some regional communities.

Therefore, further research into deer impacts and benefits should be our starting point for guiding State and National action.

Government involvement

There is a case for adopting the 'precautionary principle' for some wild deer management scenarios because the risks of waiting for complete information on impacts may be unacceptable. Such decisions may be taken by local, state or federal governments, and include:

- local council action to address social concerns such as the impact of deer on gardens and the potential for vehicle accidents.
- state government decisions to attempt local eradication of isolated populations of deer (eg Kangaroo Island).
- state and federal government concerns about the potential role of deer in animal disease outbreaks.

In terms of formal policy relating to wild deer, it became clear at the workshop that there is an extremely variable approach by different state governments, ranging from a fairly high degree of acceptance of the 'heritage' and recreational value of wild deer in the environment, to a degree of intolerance towards wild deer in certain areas, including local eradication objectives in some cases.

Wild deer do not currently have formal recognition as an unacceptable threat to biodiversity at the national level. That is to say that they are not currently recognised as a 'Key Threatening Process', although it should be pointed out that only five (feral cats, foxes, rabbits, feral goats

and feral pigs) of more than 30 exotic pest animals in Australia have been formally recognised in this way to date.

Wild deer are on the national agenda in terms of animal disease threats, and are also likely to be identified as an 'animal family of concern' under the Australian Pest Animal Strategy (draft available at: http://www.feralorg.au/content/policy/VPCcomment.cfm) that is currently being developed. In particular, this Strategy will emphasise the importance of not adding to our already extensive list of exotic pest animals. Whilst the focus of this will be rigorous risk assessment (such as that which is currently being conducted to potentially remove Sika deer from the permitted import list), quarantine and post-entry keeping standards to prevent new species from becoming established in Australia, there is also scope to reduce the spread of existing exotic species. The latter issue is particularly relevant for the deer family, where local eradication of newly established isolated populations should be considered by state agencies.

National Feral Animal Control Program

The National Feral Animal Control Program (NFACP) is a Natural Heritage Trust Program administered by the Bureau of Rural Sciences in Canberra. We produce extension materials promoting improved approaches to pest animal management and fund research projects to develop and promote improved monitoring and control techniques.

The November 2005 workshop was partly funded by NFACP and was probably largely responsible for the fact that we received four wild deer management applications from four states in our February 2006 funding round:

- investigation of wild deer monitoring (DNA analysis with some incidental use of track indices and remote cameras) and control techniques (use of feeders to increase the efficiency of shooting), Kangaroo Island, SA
- relative cost-effectiveness of helicopter-based and coordinated recreational shooting for reducing the abundance of wild deer, Victoria
- cooperative wild deer control in the Illawarra, NSW
- coordinated management of wild deer in the Esk Shire, Queensland

Interestingly, one of the applications was withdrawn as a major collaborator had received pressure from recreational deer hunters (and even some farmers) about being involved in a project that considered wild deer to be 'pests' that would be subject to non recreational control activities. This highlights the difficulties in developing regional management programs, and the importance of tailoring approaches to local situations following extensive consultation with stakeholders.

The one project that ended up being funded from the above list was the one working towards wild deer eradication on Kangaroo Island. In contrast to the project that was withdrawn, there is a high level of agreement amongst stakeholders about the approach being taken on Kangaroo Island, and a deer management team is in place that includes all major landholders within the deer distribution. Two public meetings had been held before the project proposal was developed, and there was also consultation with government and non government deer experts. However, it could be argued that an island situation is much simpler than a mainland situation for wild deer management, given that there are well-defined boundaries and eradication is a feasible and simple objective with a defined time period.

The status of wild deer as a 'pest' relative to other exotic species

The policy and management situation for wild deer is complex relative to that for more universally accepted pest animals such as rabbits or cane toads. There is considerable evidence that rabbits pose a major threat to agricultural and environmental values, and they are of little commercial or recreational value. Many urban people keep rabbits as pets, but the killing of wild rabbits occurs out of the spotlight (so to speak) and there is little public outcry about it. Therefore there is little dispute about whether rabbits should be controlled, and the focus is on research to improve our suite of control techniques, and extension to encourage landholders to keep rabbit numbers low. The other advantage with managing rabbits compared to other exotic animal species is that they are relatively easy to census – that is, in areas where they are

dependent on warrens, we can get a reasonably good estimate of their population based on active warren entrances. It is therefore possible to formally declare them a pest animal, oblige landholders to control them, and assess landholder performance in this regard.

In the case of cane toads, there is little agricultural impact, and we have limited evidence of significant environmental impact; ie they undoubtedly compete with some native species and individual native predators have certainly died from eating cane toads, but there is no evidence that they have threatened the long term survival of a native species at the population level. Unfortunately for cane toads, they are an unattractive animal and dare to venture into urban areas. The general public distaste for them combined with their impact on public amenity and lack of 'value' has made them a highprofile pest species. Therefore it is a relatively simple and socially acceptable decision for Northern Territory, Western Australian and Federal governments to put money into developing control techniques and reducing their rate of spread.

Deer management is a much more complex matter. Even more so than for cane toads, there is little information on negative impacts. A significant proportion of the general public is likely to view deer favourably and most would consider encountering deer in the wild as a positive experience. If a 1997 attitudinal survey of pest animals by the Victorian Institute of Animal Sciences is anything to go by, there is probably a low awareness amongst the urban public that wild deer may be considered a pest in some situations, or in fact, that wild deer even exist in Australia. It is only when urban people have a personal negative experience with deer (eg impact on gardens, knocking over infrastructure, vehicle accidents) that their attitudes are likely to change.

There is also a very significant and vocal recreational hunting industry associated with deer. There is a small deer farming industry that has a variable attitude towards government regulation of deer keeping, although most accept the undesirability of wild deer around their own properties. Many non deer farmers also value deer for aesthetic or recreational hunting opportunities. Countering the positive attitudes towards wild deer, there are some government agencies, conservationists and farmers who believe that the presence of obvious wild deer populations is unacceptable in some situations.

As with cane toads, wild deer are still spreading, and therefore we have the opportunity to manage this spread. However, wild deer do not have the same public and political profile and do not spread as rapidly as species such as cane toads, carp and starlings. Managing their spread has therefore attracted little attention and resources. The situation is also complicated by having to manage a number of deer species that are spreading on many fronts.

The other issues complicating wild deer management relative to that of other species is the lack of cost effective and socially acceptable control and monitoring techniques. For example, whilst there is little public concern about the shooting of feral pigs, shooting wild deer has the potential to be as unpopular as shooting wild horses. However, the experience of the Royal Sydney National Park has shown that culling wild deer in a peri-urban area is possible, particularly where: the local community has experienced negative impacts from wild deer; the need for control is well communicated to the local and broader community; and, the control program is conducted professionally and humanely.

Even if a control technique is socially acceptable, it may not be affordable, and the lack of cost-effective broad scale control techniques for wild deer is currently a major limitation to their effective management in particular areas. The other problem is that it would be very difficult to oblige landholders to suppress wild deer populations or contribute to any local eradication objectives, due to the mobility of deer and the difficulty in monitoring them compared to a species such as rabbits.

Options for addressing the needs of all stakeholders in wild deer management

Given the clear conflicts in opinions about wild deer outlined above, approaches to management are going to have to be much more tailored to local situations than they are for other exotic species.

Even if it was to become a general objective, there simply aren't the control techniques or resources available to eradicate or even achieve significant population reductions of the

respective wild deer species across their range. Therefore there will always be wild deer available for recreational hunting as long as hunters have access to the land. Many farmers (particularly in Tasmania) are happy to have wild deer on their properties as they attract recreational hunters who can take deer under formal game management plans in exchange for the hunters also targeting other wild animals and providing other services to the farm enterprise. Deer hunters may also have legal access to some public land (eg NSW Game Council access to state forests).

At present, there is limited information on the impacts of wild deer on agriculture and the environment, so it is difficult to justify control effort and the potential removal of a recreational hunting amenity in some areas. Nonetheless, where there is good evidence (and in some cases even just reasonable intuition) that wild deer are having a significant impact on a valued resource, local control should take precedence over recreational hunting amenity – particularly where there are alternative hunting opportunities within the region. There is no doubt that in the case of an emergency animal disease outbreak, or fatal motor vehicle accident, knockdown of the local deer population would take precedence over other factors.

The 'precautionary principle' should apply where wild deer establish in new areas – if the population is sufficiently small and isolated, local eradication should be considered.

With regard to policy on deer farming, there is a case for tightening government regulation of fencing standards and stock identification. The Deer Industry Association has been proactive in developing such requirements, but unfortunately only about half of deer farmers are members of the Association. There may even be local areas where new (and even existing) deer farming should be discouraged or banned. As an example, it would be inappropriate to expend considerable resources on eradicating wild deer from Kangaroo Island in South Australia unless the keeping of deer is also prohibited.

Management of deer: RSPCA Australia perspective

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Introduction

Although some deer species have been present in Australia for over one hundred years, other species have only been introduced more recently. In addition, escapes of deer from farms and translocation of deer by hunters mean that new populations of wild deer are being established and will continue to do so unless these sources of new populations are managed. Different sectors of the community perceive the place of deer in Australia differently and this is reflected in the differences in the status of deer in legislation across Australia. Some consider deer to be a wildlife species, a resource, a nuisance, or an introduced pest.

As an animal welfare organisation, RSPCA Australia accepts the need to control wild populations of introduced animals, provided it is both justified and humane. Therefore, where deer need to be controlled due to their impacts on biodiversity this should be conducted as humanely and strategically as possible. RSPCA Australia supports a deer management program that prevents new populations of deer occurring. It also supports the control of deer populations when they occur at low levels and, if discrete and isolated, that may have the potential to be eradicated. If new incursions and populations are able to increase unchecked, this not only increases the potential impact on Australian ecosystems but also increases the population size of deer that may need to be killed through control in the future.

Objectives of RSPCA Australia

The main objectives of mainstream animal welfare organisations, such as the RSPCA, are fundamentally the same across the world and have changed little from the original intent of the movement's founders. They are:

- to prevent cruelty to animals by enforcing existing legislation
- to work towards improving such legislation for the protection of animals
- to educate the community about the humane treatment of animals; and
- to encourage and sustain public debate on animal welfare.

RSPCA policies relevant to deer management

Each year RSPCA Australia publishes its Policies and Position Papers, which provide the public with a guide to the position of the RSPCA on a wide range of animal welfare issues (see www.rspca.org.au). The policies relevant to the management of deer can be found in the 'Wildlife' and 'Humane Killing' chapters.

RSPCA Australia acknowledges that in certain circumstances it is necessary to reduce or eradicate populations of some introduced animals provided that it is justified and humane, is under direct supervision of government authorities, does not cause suffering to non target animals, and is effectively monitored and audited with resulting data made available for public information (see policy E1.3 for further details).

When an animal is killed it must be either killed instantly or instantaneously rendered insensible to pain until death supervenes (see G1 and G2 for further details). The most appropriate method will vary according to the species and circumstances but death should be without panic, pain or distress and the method should be able to consistently achieve a humane kill. Skill of the operator is also critical to achieving a humane kill, therefore RSPCA Australia encourages training and accreditation programs that improve the skills of operators and provide an understanding of welfare issues, animal behaviour and physiology.

Although RSPCA Australia recognises the need for the control of introduced animals in certain circumstances, RSPCA Australia is opposed to the hunting of animals for sport. This opposition is because:

- some practices are inherently cruel, especially where hunting dogs are used;
- there are difficulties in enforcement;
- there is variability in the skill of hunters;
- hunters are a diverse group and have different motivators;
- gun-shy animals hinders the effectiveness of control programs.

RSPCA recommendations regarding deer management in Australia

As there are many feral species of deer within Australia the impacts of deer will depend on the species, population density, location, environment and habitat. However, as deer are feral grazers they have the potential to compete with native animals for food, can impact on the species richness and abundance of flora and can cause environmental degradation (eg overgrazing, erosion, ringbarking, weed dispersal etc). Impacts of feral deer on indigenous flora in Australia have been studied to a some extent but some more adaptive management projects would be worthwhile for different species and in different environments to better inform control programs; ie flora and deer population surveys before and after control programs to determine what levels of control are required to mitigate impacts.

Although some may perceive benefits in the hunting of deer, RSPCA Australia is opposed to the hunting of animals for sport for those reasons already stated, and therefore believes that the recreational hunting of wild deer should be banned. If control of deer is to occur it should be conducted as a fully regulated and government supervised management program. As with the control of all feral animals it should be both justified and humane. 'Best practice' techniques and methods should be used and the control program conducted at such a scale that there is an effective outcome. Programs must be properly evaluated and refinement and improvements to control methods should be conducted wherever possible, to make control programs more humane, efficient and effective.

As deer are an emerging pest species it is critically important that there is a coordinated approach to manage and control wild populations now, rather than wait until the populations increase to unmanageable levels. Incursions of populations into new areas or by new species of deer should be prevented wherever possible through regulation and onground monitoring and, when new incursions do occur, they should be quickly managed to prevent establishment of the population. Every effort must be made to prevent escapes and deliberate releases from deer farms or introductions of deer by hunters.

Like all wildlife management, social issues and impacts are fundamental to the successful management of deer in Australia. The effectiveness of any control programs will be severely compromised if escapes and deliberate releases are also occurring in an area. Management of the sources of new populations is fundamental to the management of deer in Australia. Therefore focused social science studies and consultation with the deer industry and those keeping deer is also required to determine the most effective risk management strategy to try to prevent new incursions.

Wild deer in Western Australia: A review of the current issues

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Abstract

There are at least three species of deer at large in Western Australia: red, fallow and rusa. Each of the three species was originally introduced to WA in 1899, but whether these original introductions succeeded is unclear. More recently, wild deer issues have become increasingly urgent, with populations increasing. Nearly all populations of wild deer occur in the agricultural region of the state. Links can generally be made between deer at large and deer farms and/or hunting. Using the Bomford (2003) risk assessment model, these three species of deer, and the yet to be introduced (or detected) Sambar deer, all represent extreme risks to WA. Fittingly, all species of deer are declared under the *Agriculture and Related Resources Protection Act 1976* in categories A1 (entry prohibited), A2 (subject to eradication in the wild) and A3 (keeping prohibited), with the exceptions of red and fallow deer which are in categories A5 (numbers will be reduced/controlled) and A6 (keeping under permit and/or conditions) because of the large numbers being kept in captivity in the state.

Introduction

Three species of deer (red [*Cervus elaphus*], fallow [*Dama dama*] and rusa [*Cervus timorensis*]) have established free-ranging populations in Western Australia (WA; Long 2003). Red deer were introduced to Australia as early as 1860 and liberated in WA around 1899 (Long 2003). At the same time (1899) fallow deer were also liberated in WA (Long 2003). Rusa deer, a native of the Indonesian archipelago, were also released in WA in 1899, but Long (2003) suggests that they failed to become successfully established. Recent evidence (*Sporting Shooters Magazine*, November 2003) suggests that wild populations of rusa deer are present in the southwest of WA, though their origins are unknown. Generally, the three species of deer in WA are collectively referred to as 'deer' rather than individually, as similar management issues apply for all wild populations.

In the last decade there has been increased concern about wild populations of these three species becoming more widely established in WA because of escapes from deer farms and deliberate releases for hunting (Long 2003). Currently, the agricultural and environmental impacts seem to be less than other populations of wild deer in eastern Australia and New Zealand, but this may be because of their low density and relatively restricted distribution in this state.

Legislation and policy of wild deer in Western Australia

Legislation

All members of the Family Cervidae are on the List of Declared Pest Animals, under the provisions of the *Agriculture and Related Resources Protection Act 1976* (Section 37). This Act defines different categories of declaration, depending on the species and circumstances. Red deer and fallow deer are declared under categories A5 (numbers will be reduced/controlled) and A6 (keeping under Department of Agriculture and Food [DAFWA] permit and/or conditions), because these species are present in the state in large numbers primarily for private production purposes. Under the Act, minimum standards must be met for keeping deer, including specific requirements for fencing, handling yards and identification marking. All other members of the family *Cervidae* are in categories A1 (entry prohibited), A2 (subject to eradication in the wild) and A3 (keeping prohibited).

Under the *Agriculture and Related Resources Protection Act 1976*, it is an offence to liberate or attempt to liberate declared animals or to fail to prevent them being at large. This Act also directs the landholder to undertake control work of a declared animal on their land. For deer at large, it is therefore the responsibility of the landholder to control and reduce the numbers on their land. This applies to all types of land tenure (leasehold, freehold and government managed lands). To date, the DAFWA has taken most of the responsibility for their control.

Under the *Wildlife Conservation Regulations 1970* administered by the Department of Environment and Conservation (DEC), it is also illegal to abandon or release most animals, including deer, without the permission of the Executive Director. Under the *Conservation and Land Management Regulations 2002*, also administered by DEC, it is illegal to bring non indigenous animals onto lands managed by DEC, and it is illegal to destroy such animals without authority.

Like other stock animals in WA, deer are subjected to the *Stock (Identification and Movement) Act 1970*. Deer can only enter WA with the correct health certifications and must be branded, earmarked or tagged appropriately. In addition, deer that are imported into WA must also be accompanied by a licence issued by DEC under the *Wildlife Conservation Regulations 1970*.

Deer are also covered under the *Animal Welfare Act 2002* and the *General Regulations*, where they are covered in two codes of practice (Deer–Code of practice for farming deer in Western Australia 2003 [Department of Local Government and Regional Development 2003a]; Feral Animals – Code of practice for the capture and marketing of feral animals in Western Australia 2003 [Department of Local Government and Regional Development 2003b]).

Policy

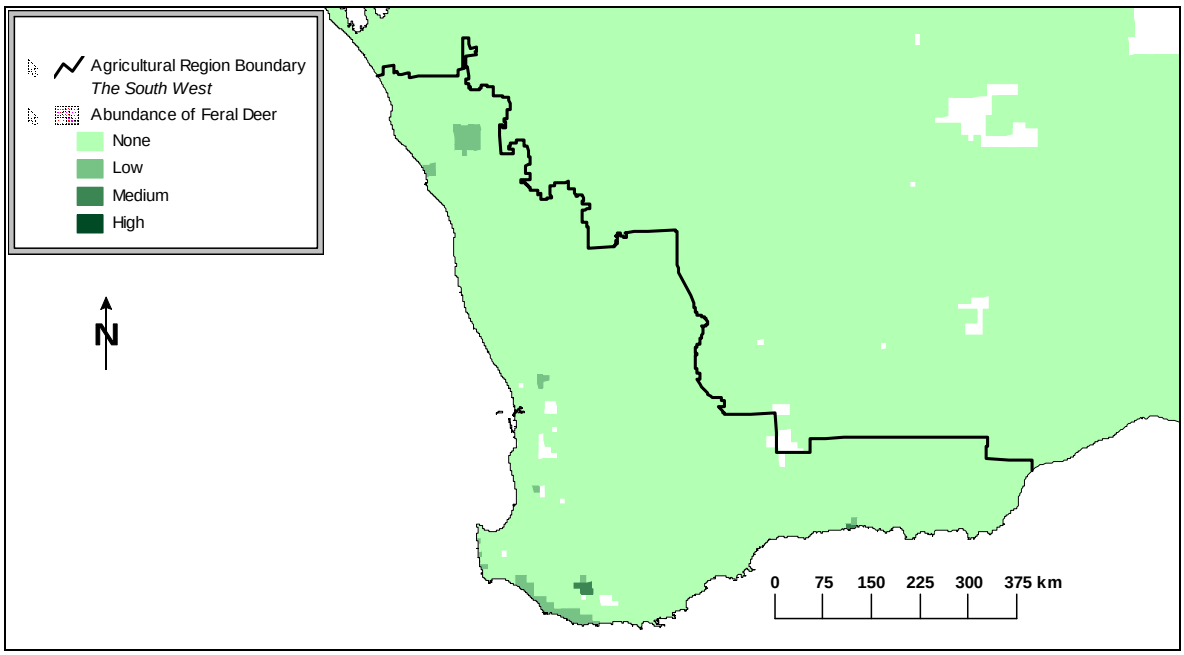
There are no *specific* policies relating to the management of wild deer in Western Australia, either for DAFWA or DEC. At this stage DAFWA officers record reports of wild deer and any evidence of damage caused, and sometimes attempt to shoot animals or encourage others to do so, but there are no resources specifically allocated to deal with deer. The previous lack of support for continued declaration of deer as pests has also contributed to the current situation. Consequently, there are issues associated with resources (people, time and money), technical knowledge and lack of expertise to deal with the deer at large. There is an urgent need for information on options for controlling deer at large in WA.

Distribution and abundance of wild deer in Western Australia

A pest animal survey was conducted by DAFWA to determine the distribution and abundance of selected pest animals in WA (Woolnough *et al.* 2005). In a series of face-to-face interviews, over 100 staff from DAFWA and DEC across the state were asked questions about pest animals, including wild deer. Most survey respondents indicated that wild deer were absent from their area of responsibility. Where wild deer did occur, their abundance was generally considered low. However, the low abundance may be a consequence of the fact that they are notoriously difficult to detect and quantify and there may be more populations in the wild that remain unknown by agency staff. Ground truthing is needed to verify the existence and size of these populations.

As described, wild deer can be considered an emerging pest in WA. Areas of infestation are generally restricted to the southwest of the state (Figure 1). From the pest animal survey, red deer are assumed to be the most common species of wild deer, followed by fallow deer. Wild populations of rusa deer are less common and management agencies have little idea of the current distribution and abundance of this species. Key areas where wild deer are found include the Mount Frankland National Park, Fitzgerald River National Park, the Perth hills, Harvey hills and parts of the Greenough and Northampton Shires.

Figure 1. Reported distribution and abundance of wild deer in the south west of Western Australia. See Woolnough *et al.* 2004 for definitions of abundance and how the data were collected. Patches of white represent gaps in our knowledge.



Risks and impacts of wild deer in Western Australia

Risk Assessment Model

The Bomford (2003) model is designed to estimate the threat (social, economic and environmental) posed by exotic vertebrates in Australia. This decision making model was applied to the three species of deer with wild populations in WA (red, rusa and fallow deer). The model was also applied to sambar deer, a species of deer found in Victoria and the Northern Territory and that are known to have been imported into WA in the past. Sambar deer are highly regarded by hunters as trophy animals. Extensive literature reviews examining key aspects of the biology of each species and a climate match using the software CLIMATE were used to provide information for input into the model (see Appendix 1 for more detailed information).

All four species assessed were placed in the highest threat category of 'extreme'. Under national guidelines set out by the Vertebrate Pests Committee, if such extreme threat species were assessed today for introduction into Australia, they should be prohibited.

In WA, management strategies for dealing with extreme threat species include:

- effective legislation to allow action to be taken to prohibit, regulate, extirpate and prosecute as required;
- cross-agency decision making using assessment results and prevention of entry into WA of such species not already present;
- captive animals already present in the state only to be kept under permit and high security conditions;
- increased public awareness of the potential problems associated with such species (using information collected during the assessments) to encourage secure keeping and early reporting of any found in the wild;
- rapid response by Agency staff and private contractor teams to eliminate animals found in the wild.

Even though these strategies may be in place and are very effective for prevention of potential new incursions, there is no specific plan to take action against the three species of wild deer currently at large in WA.

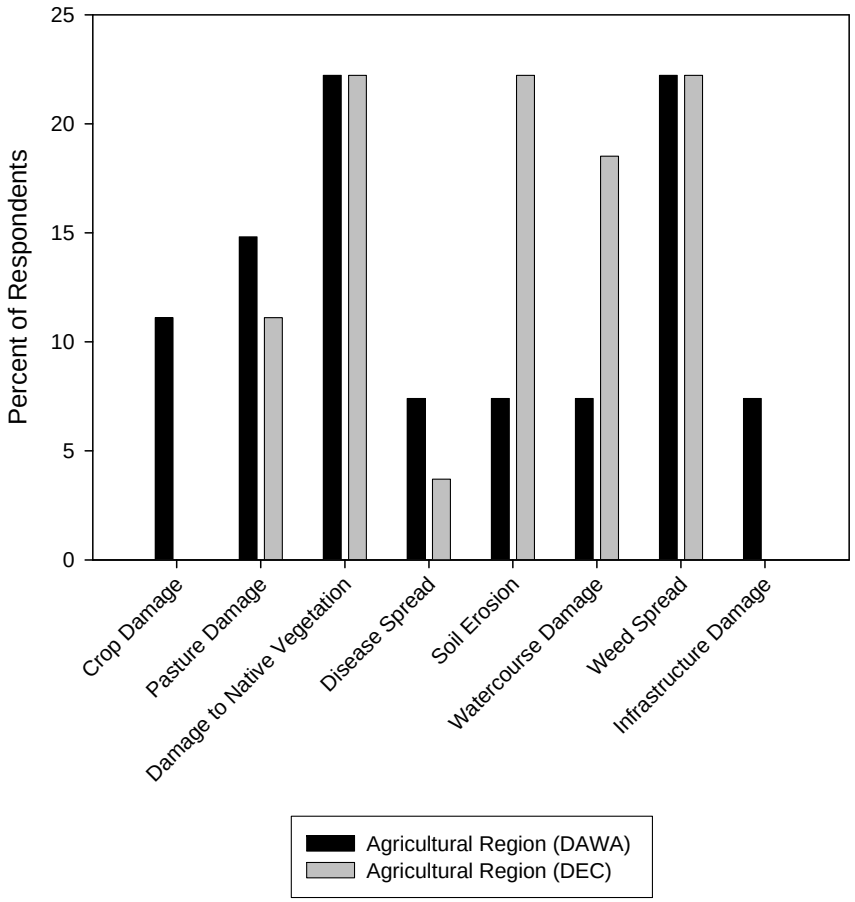
Environmental and agricultural impact

Wild deer can significantly impact on vegetation communities and agricultural practices (Moriarty *et al.* 2001). In the WA pest animal survey (Woolnough *et al.* 2005), respondents suggested that the key impacts of wild deer were damage to native vegetation, the spread of weeds and soil erosion (Figure 2). The maximum impact of wild deer was perceived to occur in late spring and summer, when damage and deer may be more visible because of seasonal differences in food and water availability.

Disease

From an exotic animal disease perspective, wild deer pose significant risks for the maintenance and transmission of non-endemic diseases such as foot and mouth (AUSVETPLAN 2000). Wild deer also pose risks for the maintenance and transmission of endemic diseases, including footrot. The cryptic habits of deer make them difficult to detect, which may be a major problem in managing a disease outbreak. Interestingly, respondents in the WA pest animal survey (Woolnough *et al.* 2005) perceived that the role wild deer could play in the spread of animal diseases (and the plant disease, dieback *Phytophthora* spp.) was low, possibly because of perceived low abundance of wild deer. However, many survey respondents suggested that wild deer have the potential to be in close contact with domestic stock. The mobile yet cryptic nature of wild deer, combined with their propensity to inhabit farmland/bush-edge habitats, increases the risk of transmission of endemic and exotic animal diseases.

Figure 2: Perceived impacts of wild deer in the agricultural region of WA, reported by staff from the Department of Agriculture and Food (DAFWA) and Department of Environment and Conservation (DEC). Figure from Woolnough *et al.* (2005).



Methods to control deer in Western Australia

There is a great need for agencies involved in the management of wild deer to have a clear understanding of what methods are available to detect and control free ranging populations. At present, the control of wild deer in WA is almost exclusively dependent on shooting. There is a strong perception that shooting is the best form of control (Woolnough *et al.* 2003) but it may actually complicate control efforts through persecution. The observed perceptions of the benefits of shooting may also be reflective of lack of knowledge about alternative techniques. It may also be a symptom of the current lack of resources and strategic planning to address the wild deer issue in this state. Areas that need to be explored for WA include the development of clear policy directions, allocation of appropriate resources to support these policies, and gaining a better understanding of situation specific control tools.

Wild deer issues for Western Australia

There are many issues that need to be considered with respect to wild deer in WA. In this paper, we present the viewpoint from an agricultural protection, conservation and disease management perspective, which may not adequately cover the concerns of the recreational hunting or deer farming groups. However, the issues that we raise are not necessarily mutually exclusive or exhaustive.

Table 1: Key issues regarding deer management in Western Australia. These issues represent personal opinions from employees of the Department of Agriculture and Food, Department of Environment and Conservation and the Agriculture Protection Board, but not necessarily the opinions of the authors.

Area	Issue
Policy	• Recognising that wild deer may be a problem and having specific policies to address the issue, including support for regulatory activities. • Recognising that wild deer populations have the potential to expand at a rapid rate. • Recognising that wild deer may pose a significant threat to the environment and agriculture.
Regulation	• The deer ''industry'' is regulated through effective identification and marking of deer kept under permit. Is this enough or working well? • Does marking of animals need to be more effective (eg DNA register – effective but expensive), since other methods of marking may be unreliable? • How can the issues of deliberate or accidental releases from captivity be managed? • Keeping deer under permit requires special enclosures (expensive to establish and maintain) and requires periodic inspection (ongoing regulatory cost). • Who pays for the control of escaped animals, especially when their origin cannot be established with certainty? • With reduced staff numbers, how do we become aware of illegal keeping, releases or escapees?
Industry	• The economics of deer farming do not appear to have lived up to initial expectations. • During periods of industry decline or tough climatic conditions (low prices for meat/velvet/ decline in the number of abattoirs able to process venison), there is an ever-present risk that would-be deer farmers become insolvent/withdraw from the industry and choose to release captive animals rather than see them killed. • Poaching presents a risk of approved enclosures being breached and captive animals escaping. • Anecdotal evidence would suggest that recreational hunters have deliberately released breeding pairs obtained from farmed herds into bushland. • Interactions between government and the WA Deer Association can be improved to facilitate better cooperation.

Agriculture & Conservation Protection	• Having good information about the available methods to detect and control wild deer. • Having resources to deal with deer at large. • Having specific policies to deal with deer at large. • Ensuring that staff are experienced in the safe use of effective methods to detect and control wild deer.
Public Involvement	• Potential for shooting/hunting groups to become powerful lobby groups to encourage wild deer hunting (eg creation of deer hunting reserves). • Potential for the deliberate movement of deer to 'seed' new areas for hunting. • Potential for responsible hunting to assist with detection and control of wild populations. • In the absence of a profitable and sustainable farming industry, would seem to be little reason to keep deer, except for recreational hunting – does the community at large really want them, having regard for their pest potential? • Any established hunting enterprise would need to be fully enclosed ''safari park style'' to avoid escapes into the wild and impacts on agricultural production in the vicinity. This has the same risks as deer farms such as enterprises that go broke, animals being released to avoid destruction and deer fences in disrepair. These risks should be minimised. • Public perception of deer may not represent the reality (eg the 'Bambi' issue). The actuality is that deer in captivity are unpredictable and difficult to handle. Education is required to address this. The public are also the greatest asset in reporting of wild deer activities and populations. • Public expectation is that the management of both captive and wild deer meet high standards of animal welfare (ie compliance with the *Animal Welfare Act 2002* and associated regulations).
Other Issues	• Wild deer seem to persist and expand in numbers in areas where 1080-bearing plants (*Gastrolobium* spp) occur.

The key issues for WA (outlined in Table 1) have been suggested by a panel from DAFWA, DEC, and the Agriculture Protection Board. The issues raised by the panel specifically relate to how to quantify the problem and how to deal with the problem before wild deer become more widely established pest animals.

Even though the general issues are essentially common across agencies, the unmentioned issue of cross department ownership of the wild deer issue may be one of the biggest current impediments to meaningful management. However, the recent success of initiatives such as the State Wild Dog Management Strategy (Anon 2005), where all levels of government (national, state, local and NRM Groups) were stakeholders and participants, may be the blueprint for formulating a ''state wild deer strategy''. Furthermore, because WA is essentially starting from a low knowledge base, national and international guidance on how to address our wild deer problems becomes increasingly important. It is hoped that the national workshop can provide the necessary guidance and momentum to move in the right direction.

Acknowledgements

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Appendix 1: Assessing the Risk: Example of the rusa deer.

Overview of the Risk Assessment Model

The risk assessment model (Bomford 2003) is based on scientific knowledge about invasive species of mammals and birds obtained from analysis of available data on past successful and unsuccessful introductions into Australia and overseas. The model considers the consequences of species establishing populations in the wild and becoming pests. Risk assessments of exotic vertebrates in Australia, using the Bomford model, have been carried out by DAFWA since 1999 when early (pre-publication) versions of the model were used. The model was first published in 2003 and then refined and recalibrated in 2006. The risk assessment for rusa deer, excerpts presented here, was completed more recently (2005) than the assessments for red, fallow and sambar deer (2002) and was signed off by the Vertebrate Pests Committee (VPC).

Climate match

An important aspect of the model is the level of climate match between a species' overseas geographical range and Australia. The level of match is assessed using the software package CLIMATE (Pheloung 1996; Duncan *et al.* 2001). The level of establishment risk and potential geographical distribution of a species in Australia is influenced by the amount of similarity or climate match between the species' overseas range and Australia.

Risk scores

The model is used to calculate three scores of risk to determine an overall threat category for the species being assessed. The three risk scores are: risk to public safety; the risk of a species establishing feral populations; and the risk of any feral populations becoming a pest of agriculture or the environment.

Significant factors in the rusa deer assessment included:

1) A history of establishment overseas outside of the species' normal distribution on large islands (<50 000 km^2) and anywhere on a continent.

There are introduced populations of rusa deer in the Lesser Sunda Islands, Moluccas, Sulawesi and Timor, Kalimantan, Papua New Guinea, New Britain, Aur Islands, Mauritius, Comoro Islands, Madagascar (possibly now extinct), New Zealand, New Caledonia, Borneo, Obi Island, Ambon Island, Hermit Islands, and Horsburgh Island in the Cocos group (Figure A1; Lever 1985; Nowak 1999; O'Brien and Kinnared 1996; Strahan 1995; Fraser *et al.* 2000; Long 2003). Also, feral populations of rusa deer have established on a continent (Australia), where wild populations can now be found from northern Queensland to South Australia (Moriarty 2004).

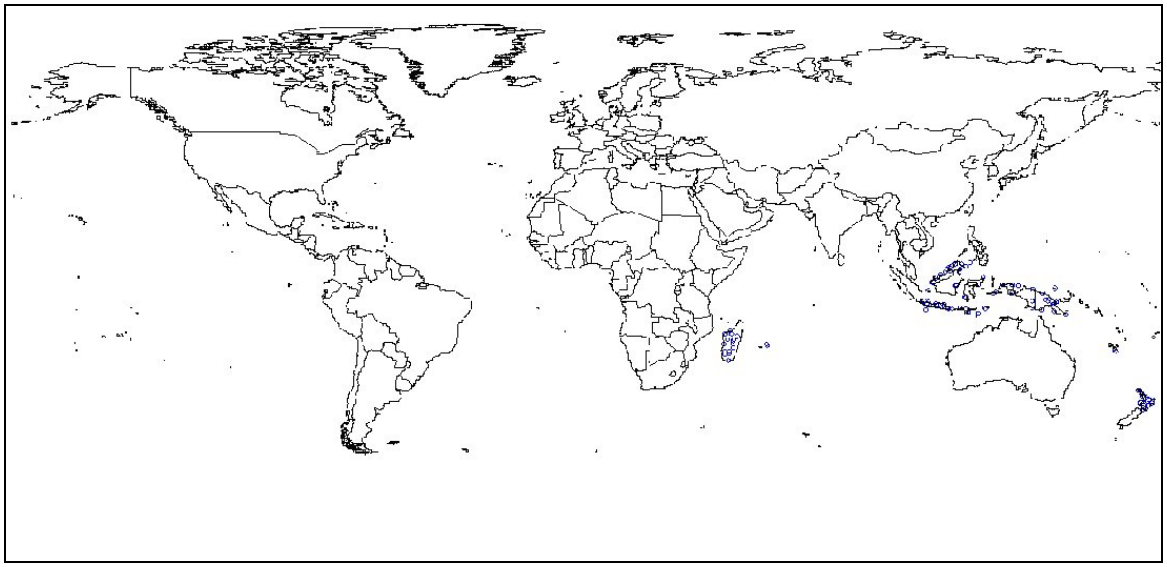
2) The species is in a taxonomic group that has demonstrated detrimental effects on primary production.

Rusa deer are members of one of the mammalian orders that have been demonstrated to have detrimental effects on habitat degradation — *Artiodactyla* — as well as a member of a family particularly prone to causing agricultural damage — *Cervidae* (Wilson and Reeder 1993).

3) The species is a grazer/browser.

The rusa deer is a generalist herbivore, consuming a broad range of food types. It eats grass, shrubs, herbs, leaves, young shoots (including sugarcane) (Nowak 1999; Long 2003). It also eats farm pasture, root crops (such as carrot and swedes), tips of bracken fern and flax, clover and new growth of stinging nettle and hook grass (King 1990).

Figure A1. Worldwide distribution of rusa deer (Cervus timorensis), excluding Australia, generated using CLIMATE software.



[Note: these Australian populations were not included in the distribution data used for CLIMATE analysis as the risk assessment was done for Australia.]

4) The species is considered a pest of the environment overseas.

There are reports of rusa deer being an environmental pest in Madagascar and Mauritius, where they contribute to non-regeneration of native vegetation and subsequent invasion of weeds (Ministry of Environment and National Development, Mauritius, 2006). Likewise, in New Caledonia the rusa deer is considered to be a major environmental pest (De Garine-Wichatitsky *et al.* 2004). In the New Caledonia archipelago, rusa deer damage forest by grazing and by creating tracks through vegetation. Also, local people encourage new shoots through the use of fires to attract deer, thus making them easier for the villagers to hunt. However, this results in increased grazing pressure on the indigenous plants by the deer (Ecott 2002). In the Western Province of Papua New Guinea (Tonda), overgrazing by rusa deer causes damage to river floodplains (Ramsar 2004) by changes in herbaceous species and through soil compaction (Chatterton 1996). In Irian Jaya (Indonesia) and Papua New Guinea, rusa deer have caused habitat changes and degradation of swamplands (Hitchcock 2004). This has resulted in negative impacts on native plant and animal species in the ecologically sensitive areas around the Torassi (or Bensbach) and Fly Rivers on the border areas between these two countries (Hitchcock 2004).

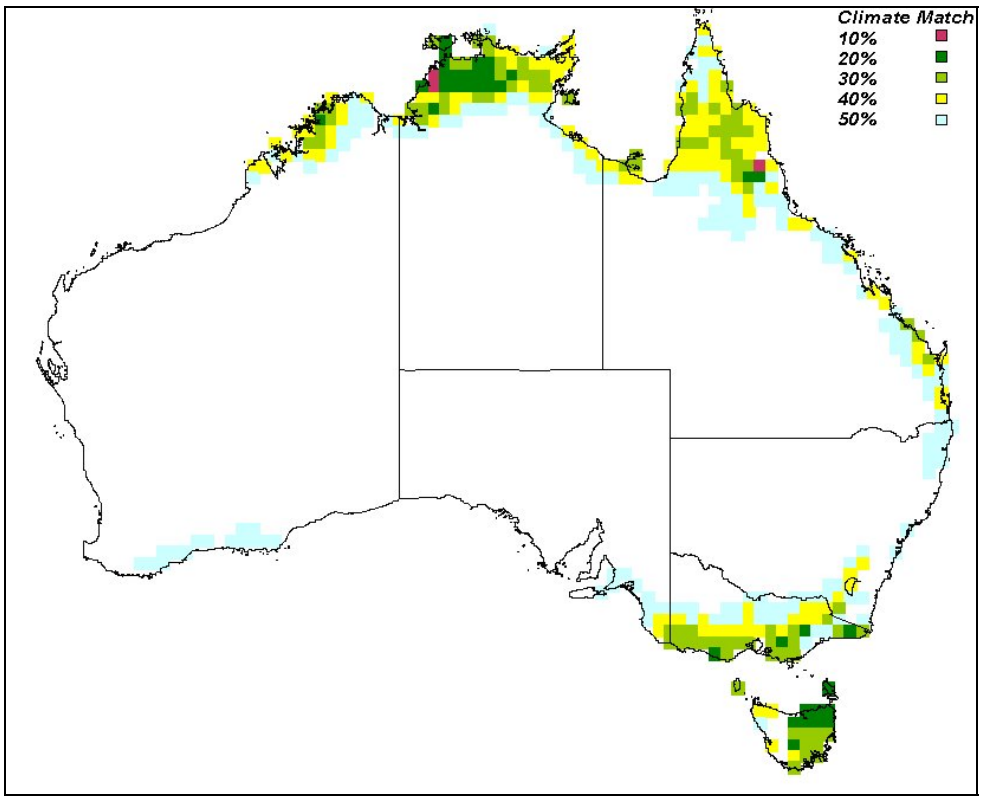
It has been widely reported that rusa deer play an important role in changing the structure and composition of native plant species (Lever 1985; Wilson *et al.*;1992; Reid *et al.* 1999; *The National* (PNG) 2001; Ramsar 2004). For example, Allen (1976) found that rusa deer over browsed an ecologically sensitive three-tiered forest habitat type. Likewise Hamilton (1981) showed that rusa deer altered the structure, species abundance and composition of grassland communities. In New South Wales, rusa deer have been attributed to a reduction of biodiversity in the sandstone heath, woodland and littoral rainforest habitat types (National Parks Wildlife Service 2002; Adam 2004). Similarly, in South Australia rusa deer have been reported to have the potential to cause more damage in sensitive conservation areas than red or fallow dear (Department of Water, Land and Biodiversity Conservation, South Australia, 2000). The browsing pressure of rusa deer also contributes to the non-regeneration of native vegetation (Mungroo 2004) and the altering of the composition and structure of some forests in New Zealand (Coomes *et al.* 2003).

5) There is a significant degree of climate match or similarity between the species' overseas range and areas in Australia where susceptible native species and/or communities occur (may be a prey item or be harmed from competition for resources).

The rusa deer climate match (Figure A2) significantly overlaps the distribution of *Petrogale concinna* (Narbarlek). This species feeds on grasses *Cyperus cuspidatus*, *Eriachne sp* and

Fimbristylis sp. During the wet season these grasses grow on the areas of the blacksoil plain not covered with floodwater (Strahan 1995). Because of the high habitat specificity of this rock wallaby, potential dietary overlap with rusa deer may put it at risk of competition pressure. Other species that may be at risk from habitat destruction/alteration may include ground nesting birds and swampland plant species (National Parks Wildlife Service 2002; Hitchcock 2004).

Figure A2. Climate match (50%) map for rusa deer demonstrating similarity in climate between the overseas distribution and Australia. The map was generated by CLIMATE software.



6) The species is considered a pest of agriculture overseas.

Rusa deer are reported to damage crops, pastures, cultivated plants and native flora in New Caledonia and elsewhere (Moriarty *et al.* 2000; Long 2003). They also harass livestock and compete with stock for pasture (Glover 2000).

7) There is a significant degree of climate match or similarity between the species' overseas range and areas in Australia of susceptible primary production. A commodity damage score is estimated using commodity value index scores derived from Australian Bureau of Statistics data for any primary production that the species is capable of causing damage to. Information from the climate match analysis is used to match susceptible primary production areas of Australia with potential distribution of the species.

Rusa deer scored the maximum for this factor.

8) As a mammal the species is a potential vector of endemic diseases.

Rusa deer have potential to spread *Tryanosoma evansi* (a tick) (Reid *et al.* 1999) in Australia.

9) The species poses a significant risk that if it is established in the wild, it could cause harm or annoyance to people. Harm could come from aggressive behaviour (including protection of young) plus the possession of organs capable of inflicting harm, such as sharp teeth, claws, antlers or toxin-delivering organs. Some species are a social nuisance and the risk of the species being a reservoir or vector for parasites or diseases that affect people is considered.

Wild populations of rusa deer can potentially cause injuries or harm. The risk of this happening is considered moderate but unlikely to be fatal and with few people at risk.

Summary of Risk Assessments

Threat Categories

The summing of the three risk scores (risk to public safety posed by captive or released individuals, risk of establishing a wild population and risk of becoming a pest following establishment) is used to assign the species to one of four threat categories: EXTREME, SERIOUS, MODERATE or LOW. These categories are used and endorsed by the Vertebrate Pests Committee.

Rusa deer assessment (for Australia):

A. Risk to public safety posed by captive or released individuals – Moderately dangerous.
B. Risk of establishing a wild population - High establishment risk.
C. Risk of becoming a pest following establishment - Extreme risk.

Threat Category for rusa deer is EXTREME (endorsed by VPC).

Red deer assessment (for Western Australia):

A. Risk to public safety posed by captive or released individuals – Highly dangerous.
B. Risk of establishing a wild population - Extreme establishment risk
C. Risk of becoming a pest following establishment - Extreme risk

Threat Category for red deer is EXTREME (result not yet presented to VPC for endorsement).

Fallow deer assessment (for Western Australia):

A. Risk to public safety posed by captive or released individuals – Moderately dangerous.
B. Risk of establishing a wild population - Extreme establishment risk.
C. Risk of becoming a pest following establishment - Extreme risk.

Threat Category for fallow deer is EXTREME (result not yet presented to VPC for endorsement).

Samba deer assessment (for Western Australia):

A. Risk to public safety posed by captive or released individuals – Highly dangerous.
B. Risk of establishing a wild population - Extreme establishment risk.
C. Risk of becoming a pest following establishment - Extreme risk.

Threat Category for samba deer is EXTREME (result not yet presented to VPC for endorsement).

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Appendix 2 - Other Department of Agriculture and Food information on deer

(see www.agric.wa.gov.au and search for 'deer')

- Introduction to deer farming (Farmnote 69/91)
- Feeding Deer (Farmnote 45/91)
- Livestock identification and movement: deer, camelids and ostriches (Farmnote)

Management of Deer in Victoria

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Deer in Victoria

Deer were first introduced into Victoria in the mid to late 19th century for purposes including hunting and agriculture (Bentley 1978). At least six species of deer are known to have established populations: however two of these species; chital (*Axis axis*) and rusa (*Cervus timorensis*), have not been recorded since the 1920s and 1940s respectively. The remaining four species — hog deer (*Axis porcinus*), red deer (*Cervus elaphus*) sambar (*Cervus unicolor*) and fallow deer (*Dama dama*) persist in the wild (Menkhorst 1995). Anecdotal reports of sightings of other deer species exist, but the existence of viable populations remains unconfirmed (S Toop, pers comm).

Current deer populations are the result of original introductions, as well as illegal releases and escapees from deer farms and private collections. Anecdotal information, including sightings reported to the Atlas of Victorian Wildlife (DSE 2005), suggests numbers and range of deer are expanding, particularly for sambar and fallow deer. Deer occur in much of the forested and woodland habitat in the eastern half of the state, with scattered populations in various areas throughout western Victoria (Figure 1), however the distribution of each species differs.

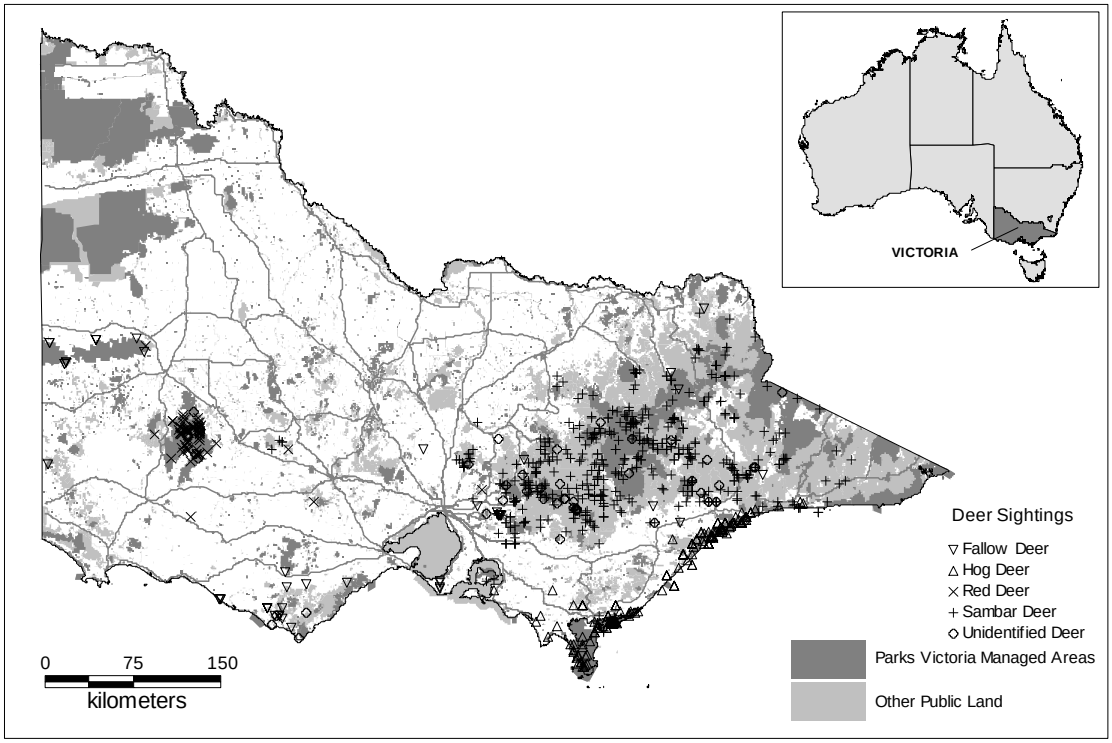
Hog deer occur in low-lying coastal areas in eastern Victoria, with sightings reported from the western shores of Western Port through to Marlo in the far east of the state (Figure 1).

Red deer, although once distributed across the western area of the state (Menkhorst 1995), do not have a widespread distribution throughout Victoria, with most records concentrated in the Grampians area in western Victoria (Figure 1). More recently, sightings of Red Deer have been made in widespread areas of the state (Parks Victoria, unpublished Data) suggesting possible illegal releases or escape from deer farms.

Sambar is the most abundant and widely distributed deer species in Victoria. Sambar occur in forested areas throughout the central and eastern areas of the state (Figure 1), as well as swampy areas on French Island (S Coutts, Parks Victoria, pers comm).

Fallow deer have a patchy distribution throughout Victoria (Figure 1). From those original releases, only small, isolated herds persisted beyond the 1920s. A joint effort between the Victorian Government and hunting interests in the 1970s established a trial population in pine plantations near Koetong, in the north east of the State. The increasing numbers of fallow deer in Victoria is mostly likely the result of widespread illegal releases after a decline in the deer farming industry in the 1990s (S Toop pers comm).

Figure 1. Distribution of deer in Victoria. Data sources: Atlas of Victorian Wildlife (DSE 2005) and Parks Victoria's Environmental Information System.



Legislation

Deer are recognised as 'protected wildlife' under the Victorian *Wildlife Act 1975* and are afforded the same level of protection as native wildlife. No person may take or destroy protected wildlife, except where authorised under that Act. Authorisation may be given to take protected wildlife for a range of purposes, including human health and safety, research and education, Aboriginal cultural purposes and conservation, protection or control of wildlife.

Deer are also classified as 'game' under the *Wildlife Act 1975* and, as such, may be taken by licensed hunters in accordance with the regulations specified under that Act. These regulations apply to things such as hunting methods and equipment, areas in which hunting may or may not be undertaken, time of day and open seasons. Regulations vary among species (Table 1).

Table 1: Summary of some of the regulations relating to hunting of deer in Victoria. See the *Victorian Wildlife (Game) Regulations 2001* for further information.

Species	Closed season	Hound hunting	Bag limit
Hog	Yes	No	Yes
Red	Yes	No	No
Sambar	Yes (using scent-trailing hounds). Stalking permitted all year.	Yes	No
Fallow	May not be hunted, except on private land	No	No

While deer are recognised as protected wildlife under the *Wildlife Act 1975*, land managers, such as the Department of Sustainability and Environment and Parks Victoria, must act in accordance with a range of other legislation.

Victoria's *Flora and Fauna Guarantee Act 1988* provides a legal framework for the conservation of Victoria's native flora and fauna. This requires land managers and owners to comply with action statements and management plans and to protect listed species and communities. Areas listed under the Victorian *National Parks Act 1975* are managed primarily for the protection of natural values. The Act requires that all national and state parks be preserved and protected in

their natural condition, that all indigenous flora and fauna are preserved and protected, and that exotic fauna are controlled and managed.

Many other pieces of state and commonwealth legislation, as well as international conventions, also apply to the management of land and biodiversity conservation in Victoria. Management of deer must be undertaken with due regard to the requirements of all relevant legislation and conventions.

Management objectives for deer in Victoria

Management of deer in Victoria is undertaken in accordance with the provisions of the *Wildlife Act 1975*. In doing so, the state seeks to manage populations that have persisted since their original release in a sustainable manner, while reducing or eliminating illegally established populations. The state also seeks to minimise or manage the impacts of deer on natural values, primary production and private property.

For species that have persisted since their original introduction by the Acclimatisation Society in the 1800s, the state seeks to manage the recreational hunting of deer in a sustainable manner and to ensure protection of animal welfare, compliance with legislation and co-existence with other recreational pursuits and land management objectives. For illegally established species, such as fallow deer, hunting is seen as a tool that may assist in efforts to reduce or eliminate these populations.

In parks and reserves, Parks Victoria's (the agency responsible for managing the state's protected area network) goal is to ensure deer management is based on sound science and reliable information. Priorities for management include improving understanding of the distribution, abundance, and impacts of deer populations. While the current focus of deer management is on recreational hunting, it is recognised that management intervention may be required where areas of high conservation value are at risk from impacts of deer. Consistent with the state's objectives, a major aim of Parks Victoria is to work co-operatively with stakeholders in the management of deer.

Current management of deer in Victoria

Most of the current effort surrounding the management of deer in Victoria is directed towards recreational hunting and compliance with regulations under the *Wildlife Act 1975*. In limited instances, permits are issued to landholders for site-specific destruction where deer are having adverse impacts on agricultural, property or conservation values. However, while destruction permits may be issued, little work is currently undertaken to actively manage the abundance of deer or impacts they may have on natural values on public land.

Generally, recreational hunting is permitted in areas of state forest, other unoccupied Crown land and private lands with the permission of the landowner/manager. Hunting is generally not permitted in parks and reserves, although some areas, including seven areas managed under the *National Parks Act 1975*, as well as some State Game Reserves and Coastal Parks, have been formally set aside for deer stalking of specified species.

Because Parks Victoria wishes to ensure that its management of deer is based on reliable and accurate information, increasing effort is being made to improve understanding of the ecology of deer in parks and reserves. Recently, Parks Victoria established programs to monitor deer abundance at seven sites around the state and plans to increase the number of sites where monitoring is undertaken in future. In addition, a small number of research projects are being supported to examine aspects of deer ecology, including diet and impacts on vegetation. In terms of managing impacts on natural values, some short term localised action, such as fencing small areas where deer are impacting on high priority natural values, are being implemented.

In recognition of the importance of stakeholder involvement, Parks Victoria and the Australian Deer Association (Victoria) (ADA) signed a memorandum of cooperation in 2004. The memorandum seeks to improve understanding and cooperation between the two groups. Under the memorandum, both parties will work together on matters such as hunter and public education, sharing information of common interest and facilitating opportunities for funding joint research, conservation and training programs. The memorandum supports the establishment of

a structured process for the ADA to provide input to development of park management plans. It also recognises that there may be opportunities for cooperation on matters such as signage, management and research.

Environmental impacts of deer

The impacts of deer on natural values in Victoria have not been widely studied and, hence, are not well understood. Despite limited local research, the small body of work that has been undertaken in Victoria, as well as long term observations in various areas of the state and research from overseas, give some understanding of the potential impacts of deer.

Research overseas has shown browsing or grazing by deer can influence the structure and composition of vegetation communities (eg Veblen *et al.* 1989; Mark *et al.* 1991; Rooney and Waller 2003; Côté *et al.* 2004). Selective browsing may reduce abundance or prevent regeneration of preferred species, while favouring less preferred species.

Feeding preferences of deer in Victoria are not well understood, but some preferential feeding behaviour has been reported. Recent research in the Central Highlands (Stockwell 2003) found that, while the extent of browsing by Sambar on many plant species reflects their abundance, some species are browsed preferentially and others are avoided. At Wilsons Promontory, the major components of the diet of Hog Deer are shrubs and forbs (N Davis U unpublished Data).

Whether feeding behaviour of deer is influencing vegetation composition and structure in Victoria is not clear at present and further research is needed. However, a recent observational study (Peel *et al.* 2005) reported that browsing by sambar was reducing regeneration of several species of plants in East Gippsland. Although the result of a high-density captive population, changes in vegetation due to preferential browsing have also been observed in the Australian Deer Association's sambar enclosure in Bunyip State Park, near Gembrook (Moore 1994). Similarly, in areas of the Yarra Ranges where sambar density is high, reduced understorey cover and a clear browse line in the vegetation about 2m above ground are evident (I Roche, Parks Victoria, pers comm).

Antler rubbing may also affect the condition of vegetation. Recently, areas on the Snowy River in East Gippsland have been fenced to protect Buff Hazelwood (*Symplocos thwaitesii*), an endangered plant of warm temperate rainforest, being damaged by sambar rubbing. In their East Gippsland study, Peel *et al.* (2005) report that antler rubbing by sambar is affecting the health and survival of trees of many species, and that particular species seem to be targeted. This is consistent with observations of field staff in the Central Highlands of Victoria, where Shiny Nematolepis (*Nematolepis wilsonii*), a vulnerable species listed under the Commonwealth *Environment and Biodiversity Conservation and Protection Act 1999* and the Victorian *Flora and Fauna Guarantee Act 1988*, is often rubbed and sometimes ringbarked by Sambar antler-rubbing.

Deer may also contribute to the spread of weeds. In a study at Mt Buffalo (Eyles 2002), it was found that seeds of Himalayan Honeysuckle (*Leycesteria formosa*), which is frequently browsed by sambar, remain viable in their faeces. Parks Victoria staff at Mt Buffalo have also observed Himalayan Honeysuckle seeds germinating in sambar faeces in the field (K Cosgriff, Parks Victoria, pers com).

Revegetation programs can also be affected by deer. Browsing by fallow deer resulted in the need for Parks Victoria to erect deer-proof fencing around areas revegetated in Yellingbo Nature Conservation Reserve in Victoria's Central Highlands. Wallowing and creation of tracks through vegetation are other impacts reported by field staff around the state (Parks Victoria, unpubl. Data).

It is acknowledged that with limited research undertaken in Victoria to date, the impacts deer have on natural values, and how these impacts vary with deer abundance and among locations and species, are not well understood. Further research is required to address these knowledge gaps so that management decisions can be made on the basis of sound information.

Implications for management

Apparent increases in the abundance and distribution of deer in Victoria, coupled with the impacts that deer may have on natural values, means that deer present potential implications for land managers in Victoria under certain circumstances.

Where deer are having unacceptable impacts on natural values, particularly in areas of high conservation value, land managers may need to undertake actions to minimise these impacts. Currently however, the ability of land managers to address impacts of deer is constrained by limited knowledge of the distribution and abundance of deer and the level and significance of any impact poor understanding of the relationships between impacts and deer abundance and of appropriate techniques to manage any impacts.

Addressing these knowledge gaps is a priority for land managers if the ability to manage the impacts of deer is to be improved. Knowledge gaps, however, do not preclude land managers from undertaking actions to prevent or minimise impacts, especially in areas important for biodiversity conservation. Current understanding can be used as the basis of an adaptive management approach, whereby the results of any management undertaken can be used to improve our understanding, and hence, the effectiveness of management in future.

Future

Deer have been established in Victoria for over one hundred years. Different sections of the community value deer for a range of reasons, including hunting opportunities and aesthetic values. On the other hand, deer can impact negatively on agricultural activities, by competing with stock, damaging infrastructure and crops. The extent and significance of any impacts on conservation values is yet to be determined, however, under certain circumstances, some impact is probable.

The major focus for management of deer in Victoria in the immediate future needs to be on collecting information and improving understanding, particularly in relation to abundance and impact to mitigate risks associated with increasing and expanding deer populations. However, deer are widespread across the Victorian landscape. Hence, considering limitations on resourcing, management intervention, where required, needs to be targeted to areas where risks associated with the impacts of deer are greatest.

As with virtually all landscape level conservation and wildlife management issues, successful management of deer impacts will rely on the involvement of all interested stakeholders, recognising and understanding the different attitudes towards deer and focussing on common goals. Educating stakeholders on the issues will result in a more informed debate on appropriate management responses in an effort to maximise public value.

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Deer management in Queensland

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Introduction

Wild deer have been present in some parts of Queensland for well over 100 years. For most of that time they have been hunted (both legally and illegally) and in the 1970s a deer farming industry developed. More recently, wild deer populations have increased in density and range, due likely to a combination of natural spread, escapes from deer farms and deliberate releases for hunting. These new populations, in particular, have the potential to adversely affect the environment, primary production and human safety and calls for the declaration of deer as pests have increased. Declaration would enable control of deer impacts to be enforced as well as restrict the movement and keeping of these animals.

However, declaration is opposed by a number of stakeholders in Queensland, including hunting groups, landholders, particularly those in areas where deer have long been established, and some local governments. This opposition cannot be ignored as many of these groups play an important role in deer management. Declaration alone is unlikely to be a solution to the problem. Clear management guidelines need to be drafted with public consultation and implemented with an education and training program. As part of the process, the Department of Natural Resources and Water (NRW) published a review of the status of wild deer in Queensland (Jesser 2005). The following discussion is largely drawn from that document.

Distribution of wild deer in Queensland

Current and historical distribution

Four species of deer are established in Queensland: chital (*Axis axis*), red (*Cervus elaphus*), rusa (*C. timorensis*) and fallow (*Dama dama*). While there are established wild populations of sambar deer (*C. unicolour*) and hog deer (*A. porcinus*) in the southern states and a population of sambar deer on the Coburg peninsula in the Northern Territory, there are no verified records of these species in Queensland. However, there are anecdotal reports of releases and individuals in the wild in the state and sambar deer are present in safari parks and perhaps deer farms in Queensland. There are also anecdotal reports of sika deer (*C. nippon*) being released in Queensland.

Populations of chital, red and fallow were established in Queensland by the Queensland Acclimatisation Society in the late 1800s (Figure 1). The populations of red and chital deer in these historic ranges now number in the 10,000s, while the fallow deer population in southern Queensland is likely to be a few thousand. Rusa deer were introduced to Friday Island in the Torres Strait in the early 1900s and have since dispersed to other islands and are most abundant on Prince of Wales Island. The overall population is now likely to be several hundred animals.

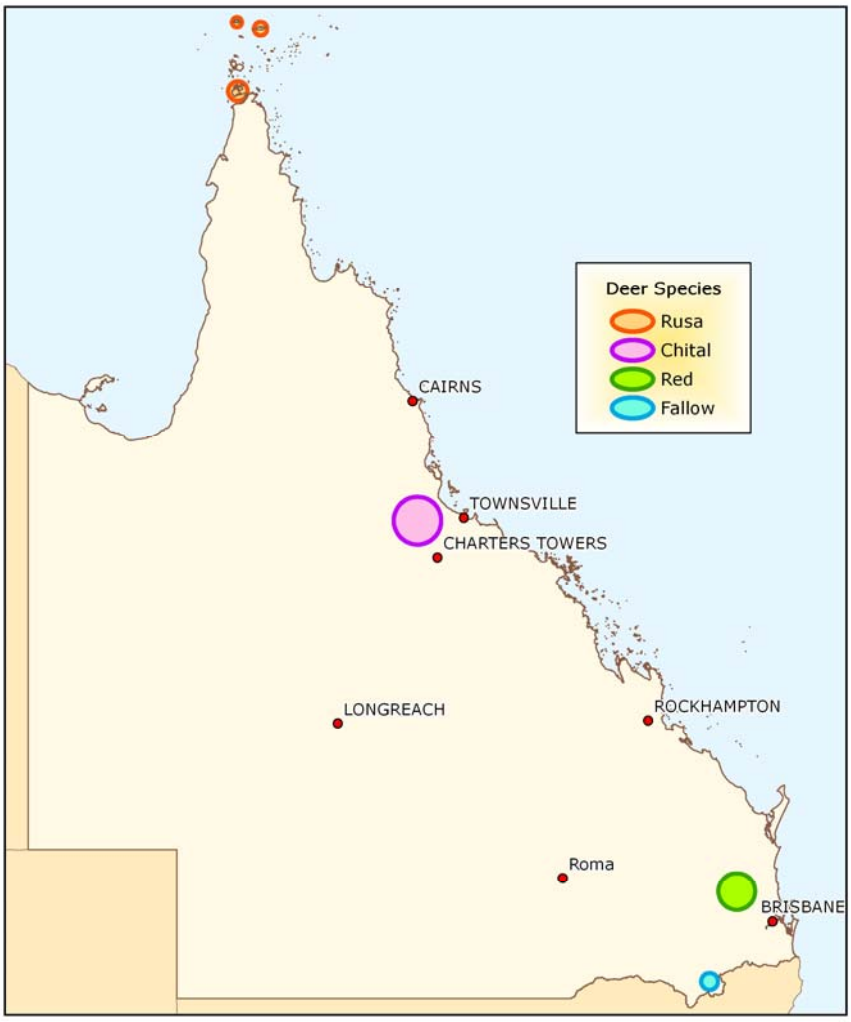
Not surprisingly, the growth in size of these populations has been accompanied by an expansion in range through dispersal. However, the expansion has been extremely limited compared with the spread of other large mammals introduced to Australia such as goats, pigs, horses, donkeys and camels. Of all the deer populations introduced in Australia, only sambar deer in Victoria have substantially expanded their range; moving northwards along the Great Diving Range (Moriarty 2004). New populations have appeared across Queensland that are disjunct from these historical ranges, indicating deliberate translocation or deer farm escapes as the source. Most have appeared since the 1990s coinciding with a decline in the profitability in deer farming and relaxation of legislative restrictions on farming (see below).

Annually since 2002, NRW has interviewed NRW Land Protection Officers and local government pest officers throughout Queensland to determine the state-wide distribution and density of >40 species of pest animals and weeds (http://www.nrw.qld.gov.au/pests). Since

2004, deer were included in the survey and the results for 2006 are shown in Figure 2. Not all populations have been identified in the survey and some records still require verification. Nevertheless, the survey suggests both an expansion and a likely cause. Notably, no additional species to the original four were recorded in the NRW survey.

Most populations of the four existing species outside the historic ranges are small and localised, suggesting they could be eradicated. An exception is the chital deer population on Rita Island at the mouth of the Burdekin River in Central Queensland, which, while localised, is likely to be >2,000 animals. There are also numerous populations of chital deer in the Gulf and in central, coastal and inland Queensland. Other, notable, new populations of deer include semi-urban populations of red and rusa deer in the outer suburbs of Brisbane, on the Sunshine Coast and Gold Coast. Rusa and chital deer have now been reported in a number of locations in the Wet Tropics where they are recognised as a major threat to the environment (Hudson 2005).

Figure 1. Historical ranges of four deer species from herds established in the late 1800s (chital, red and fallow deer) and early 1900s (rusa deer).



Potential distribution

The distribution of many plant and animal species is often well described by climatic variables such as mean annual rainfall and maximum temperature. Potential distribution can therefore be modelled by matching the climate of a taxon's overseas distribution with the climate across Australia. This match is a useful predictor of the risk of successful establishment of exotic mammals (Forsyth *et al*. 2004) and is used to assess the establishment risk of potential imports (Bomford 2003). Moriarty (2004) presented Bomford's unpublished maps for the eight species of deer established in Australia. In Queensland, fallow and red deer have potential distributions restricted to the southeast, while rusa deer are predicted to be restricted to coastal areas. Chital, sambar and hog deer all have wide potential distributions in the state determined by climate. There are obviously other factors, such as food, shelter and natural enemies, that determine a species' actual distribution. The occurrence of viable populations of sambar and hog deer outside these potential distributions in southern Australia indicates that these other factors can also mask a wider climatic tolerance in these species than that suggested by their native range.

Bomford's maps (Moriarty 2004) for the four Queensland species were redrafted using the PC version of the climate-matching software CLIMATE (Pheloung 1996) using the same overseas locations, but extending the resulting potential distributions by considering the species' Australian locations from Moriarty (2004) and the NRW surveys in 2006. Climate matches down to level 5 are considered a good representation of the potential distribution of exotic mammals in Australia based on a comparison between climate matches and actual distributions in Australia for a number of established species that have presumably spread to their full potential distribution (M. Bomford, Bureau of Rural Sciences, unpublished data). The resulting maps for deer are shown in Figure 3. Only the potential distribution for rusa deer required extension into the next lowest climate match band, suggesting it could spread well inland. Some western records for rusa (eg Jericho) suggest that the next climate match band (ie 3) may also be suitable. Some of the NRW records still need verification. This ideally needs to be evidence of a self-sustaining population, not simply presence of juveniles. Notably, there are unconfirmed sightings of fallow deer in the wet tropics (Hudson 2005) which appears climatically unsuitable

Legislation

Historical

Under the *Fauna Conservation Act 1952* and *Fauna Conservation Act 1974*, all deer were protected species and property of the Crown. Landholders could obtain permits to cull deer where they were a pest. Hunting for recreation and food continued, as it had since the introductions of deer in the late 1800s, despite being prohibited under these Acts. It was not until the late 1970s that hunting was legalised. Despite this, the permit system was largely ignored and the entrenched illegal hunt continued. Legal access to deer for hunting was limited.

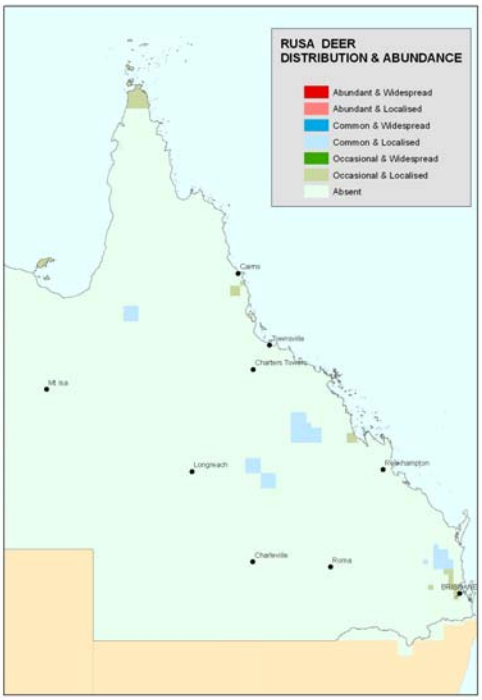
The advent of deer farming in the 1970s changed the economic status of deer. A deer trapping industry developed, bringing now valuable wild animals into farms. The *Deer Farming Act 1985* regulated deer farming through requirements for identification, movement and fencing. The Act also identified the historical ranges of the four deer species established in the wild in Queensland (Figure 1) as 'feral areas', placing restrictions on the farming of species outside their designated area. The intention was to minimise the risk of further spread of species outside these areas as a result of farm escapes.

In the 1990s, the entire system of deer management changed dramatically. First, the *Nature Conservation Act 1992* removed the species' protected status. This was followed by the repeal of the *Deer Farming Act 1985*, which removed restrictions on farming. For a short time, deer were accorded pest status under the *Rural Lands Protection Act 1985*, but they were subsequently removed from the list of declared animals by the *Rural Lands Protection Amendment Regulation (No. 1) 1997*. There was no longer any Queensland legislation for the management of wild deer and farmed deer were subject only to regulations applying to domestic stock generally.

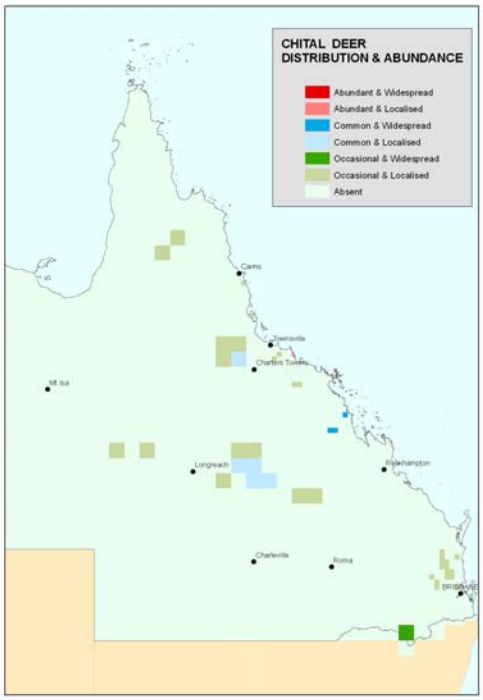
In the mid-1990s there was a downturn in the market for farmed deer products and there had been a protracted, widespread drought in Queensland. This made deer farming less attractive and appears to have resulted in farmed deer being released into the wild at least partly to

satisfy a previously unmet hunter demand. With no legislative barriers, there has been a proliferation of new deer herds established in the wild across the state over the past decade (Figure 2).

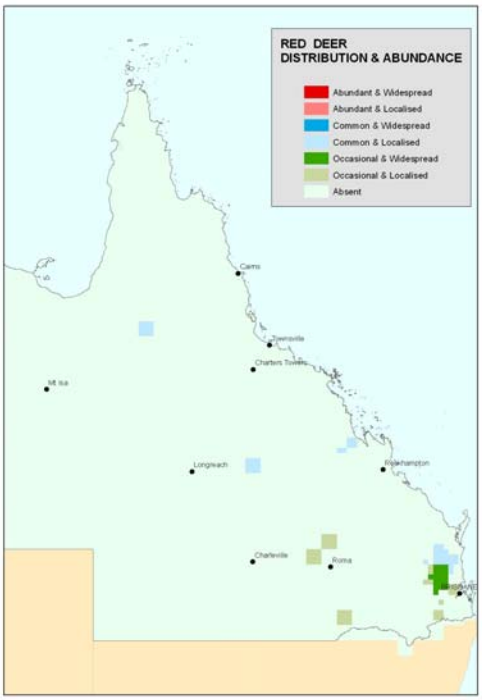
Figure 2. Distibution, density (occasional or common) and dispersion (localised or widespread) of wild populations of (a) rusa, (b) chital, (c) red and (d) fallow deer in Queensland in 2006. Large grid cells away from the east coast are ½o × ½o (~2,500 km2), whereas the smaller grid cells along the east coast are $\frac{1}{6}$o × $\frac{1}{6}$o (~280 km2).



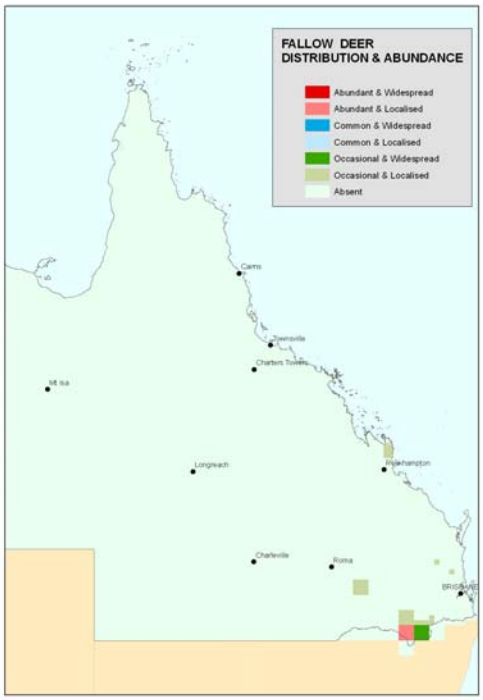
(*a*) Rusa



(*b*) Chital

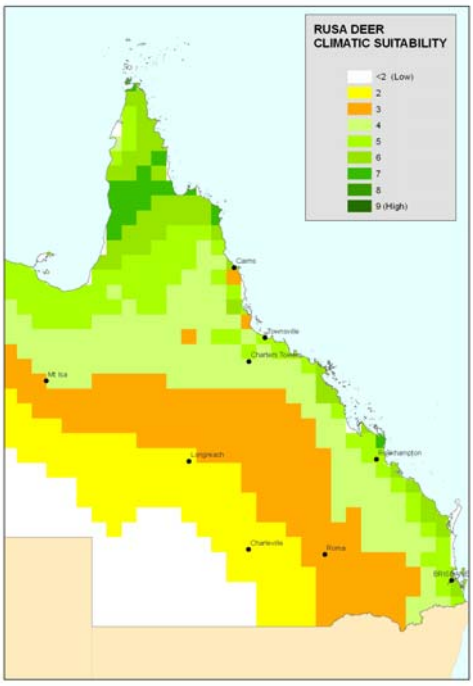


(*c*) Red

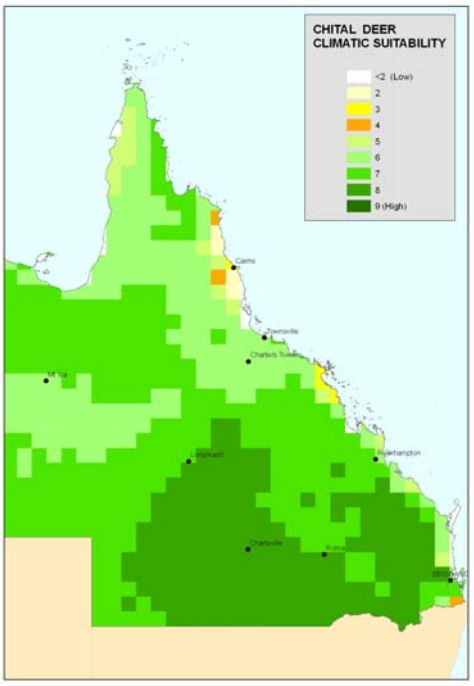


(*d*) Fallow

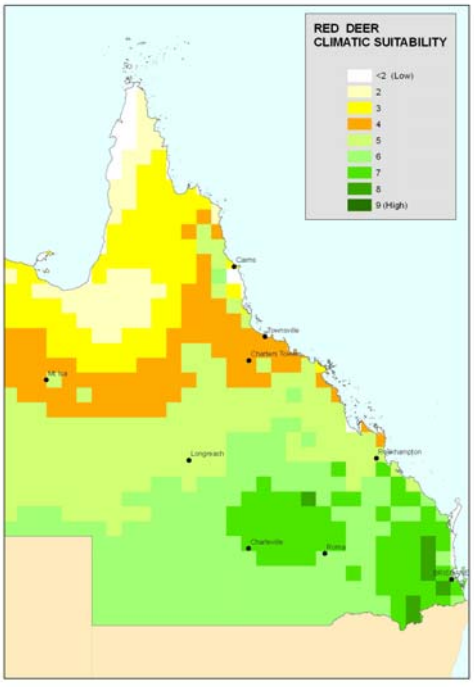
Figure 3. The potential distribution of (a) rusa, (b) chital, (c) red and (d) fallow deer in Queensland. The potential distribution is based on matching the climate of the native and introduced range of a species with climate in Australia, using the PC version of the software program CLIMATE (adapted from Bomford unpublished in Moriarty 2004). The potential distribution ranges from close matches with values of 9 down to poor matches of 0. Matches >4 are shown in green, representing high climatic suitability, while matches <5 are shown in yellow, representing low climatic suitability. Where the species distribution in Australia includes values in this latter category, the potential distribution (in green) has been expanded to include the lower climate match value.



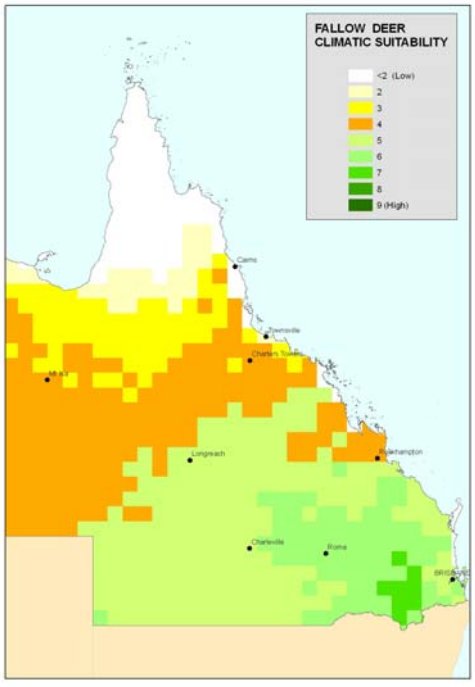
(*a*) Rusa



(*b*) Chital



(*c*) Red



(*d*) Fallow

Present

Under the *Land Protection (Pest and Stock Route Management) Act 2002*, all exotic mammals, reptiles and amphibians are declared as Class 1 pests. Exceptions are Class 2 or 3 pests and a list of non-declared species. This permitted list contrasts with a prohibited list, which is employed for weeds in Queensland. Declaration places an obligation on landholders (including state and local government on land they own) to control the impacts of the species on their land and it is an offence to keep (not Class 3) or release the species without a permit. Only certain activities, such as exhibition in zoos, are eligible for a permit. Eight deer species are listed as non-declared: the four species established in the wild in Queensland plus sambar and hog deer, that are established in the wild in other states, as well as wapiti (a subspecies of red deer) and white-tailed deer (*Odocoileus virginianus*). These are the species most likely to be farmed or found in zoos. Other non-declared species include mice, domestic stock, cane toads and Asian house geckos.

Class 1 pests are either not in the state or are in small enough populations that eradication will be attempted. NRW is primarily responsible for eradication efforts. Class 2 species include widespread species such as feral goats and pigs, foxes and rabbits. Class 3 pests must be controlled by landowners if the land is, or is adjacent to, an environmentally significant area. Control of Class 2 and 3 species is primarily the responsibility of local governments, landholders and community groups. NRW will coordinate and oversee that management and provide training and advice. Declaration under the *Land Protection (Pest and Stock Route Management) Act 2002* is generally reserved for species that have or potentially have adverse impacts over a substantial area of the state. Where the impact is localised, species may still be declared by local government under local laws.

The Department of Primary Industries and Fisheries (DPI&F) is also involved in the management of wild, exotic mammals by responding to, planning for and minimising the risk of exotic disease outbreaks. DPI&F also administers animal welfare legislation in the state and so provides guidelines for humane procedures for control, handling and housing animals.

Benefits of wild deer

There are economic benefits of having deer in Queensland beyond farming for venison and velvet. Wild deer are harvested for meat and recreation. Hunting is a growing recreational and commercial industry as well as a tool used in wildlife conservation and pest management. For some, wild deer simply have aesthetic value and would oppose their complete removal from the wild.

There are essentially three types of hunting in Queensland, distinguished by whether there is a payment and who is paid. Hunters may employ a guide, or they may pay fees to a property owner for access or they may gain free access (Dryden and Craig-Smith 2004). Commercial hunting enterprises across Queensland advertise hunting expeditions for all four of the wild deer species in the state. The Australian Bureau of Statistics does not collect data on the economic aspects of recreational or commercial hunting. However, Dryden and Craig-Smith (2004) estimate that $82 million is spent annually (in 2003 prices) on recreational hunting in Australia. It is likely that several million dollars are spent annually in southeast Queensland.

If deer have value in the wild, there will be some incentive to retain or even increase forested areas for deer on land that might otherwise be cleared or altered for grazing domestic stock. Furthermore, graziers receiving a substantial part of their income from deer harvesting, may reduce stocking rates of cattle to provide better deer habitat and maintain better land condition. Hunting organisations are also directly involved in conservation activities, working with both governments and private landholders. These activities include feral animal control and monitoring its effectiveness, through assessment of land condition and threatened species numbers.

A further benefit of harvesting of a pest population includes a reduction in population size. Theory suggests that the yield for the four wild deer species in Queensland will be maximised when the population size is roughly half to two-thirds of its unharvested size. Reduction in a population's size should promote its rate of increase as density-dependent survival or fecundity is improved. However, the objective of recreational hunting differs from commercial hunting in

that hunting opportunity is likely to be more important than absolute yield. As a result, there is a particularly strong incentive for hunters to conserve their hunting resource and a range of densities could potentially be considered optimal, depending on the hunting opportunity sought. To this end, 'quality deer management' (QDM, Hall and Gill 2005) is practiced in Tasmania, Victoria and NSW. This involves maintaining deer populations well below carrying capacity and at a sex ratio close to parity and restricting the trophy harvest to older stags. Excess females and low quality males are culled. Antler growth is strongly related to nutrition and so the practice of QDM produces higher quality stags which fetch large prices ($1,000s). This increased value provides a strong incentive to landholders and hunting guides to keep deer numbers lower than otherwise.

Costs of wild deer

Wild deer can have a range of impacts on primary production, the environment and human safety and property. Countering the intrinsic value of wild deer is the view that deer are an exotic animal and should be removed, if possible, from the wild. Such conflicting value judgements are difficult to both debate and reach any compromise.

Deer are likely to compete with domestic stock for pasture although quantitative data are lacking. In southeast Queensland, crop losses, including agricultural crops, orchards, forestry seedlings and cut flowers, are more noticeable. There is some debate about how important wild deer are as a vector for a number of endemic and exotic diseases. There is evidence that deer are not an ideal host for cattle tick, but they certainly carry ticks and that means there is a risk of wild deer carrying cattle tick into clean areas. Johne's disease, for which there is a national control program, is found in some red deer herds in southern Queensland.

Wild deer are becoming an increasing problem in urban and near urban areas, where they cause damage to property including gardens and fences and they pose a substantial traffic hazard. Control is difficult in built-up areas as shooting can be dangerous and there may be opposition from animal welfare and animal rights groups. Trapping or darting is often favoured, but can be inefficient and costly. Control of deer in built-up areas can be vigorously opposed by blockades and tampering with traps.

The current and potential adverse environmental impacts of deer in Australia let alone Queensland are not well documented and further research is required in this area. Overseas experience shows that wild deer can have marked environmental impacts which may be difficult to reverse. In New Zealand, wild deer and feral goats have substantially modified plant species composition in forest communities through selective browsing and this has had less obvious but still substantial effects on the litter-dwelling fauna (Wardle *et al.* 2001). In North America, native deer have increased following human alteration of habitat, further altering plant communities and threatening some species (McShea *et al.* 1997). It is difficult to extrapolate these observations to Australian ecosystems, beyond the fact that high densities of deer can alter the structure and composition of plant communities. What is needed is an understanding of the relationship between deer density and impact in various environments. This was highlighted by Forsyth *et al.* (2003) who offered guidelines for determining the extent to which deer must be controlled (eg target densities) in New Zealand before regeneration of preferred species might occur.

Management options

Given this background, there are four objectives for deer management in Queensland:

1. Reduce the number of introductions of deer into the wild (ie deliberate translocations, captive escapes) throughout the state, particularly of chital, rusa, sambar and hog deer.
2. Reduce the number of wild deer populations outside the historical ranges, particularly chital and rusa deer.
3. Reduce the natural spread of deer from the historical ranges (ie containment).
4. Minimise the negative impacts of deer inside the historical ranges.

The potential management actions to address these objectives are:

- Education of hunters and landholders to stop translocations.
- Involve hunters in reducing deer numbers outside the historical ranges. In particular, there needs to be control in high impact areas such as urban areas, orchards and crops, and areas of high conservation value such as the Wet Tropics World Heritage Area.
- Encourage QDM inside the historical ranges. This management would require management plans (regional or property or both) for deer outlining the strategy and how its effectiveness can be monitored.
- Prohibit the sale of deer to those outside the deer farming industry.
- Restrict the number of deer farms outside the established, historical ranges.

Underpinning these objectives is a number of largely untested assumptions:

- Outside the historical ranges, deer have the potential to spread over a large part of the state and have considerable, detrimental (economic, environmental and social) impact. Chital, sambar, hog and rusa deer have the potential for the greatest spread.
- QDM results in a lower density of deer compared with an unmanaged population.
- Deer populations within the historical ranges have reached a (dynamic) equilibrium with the available food supply (vegetation) (McGhie and Watson 1995). If this present equilibrium state of vegetation is unacceptable, then reductions of deer density may lead to regeneration of vegetation, although some impacts may not be reversible.
- Compared with domestic stock, native wildlife such as kangaroos and goats and rabbits in more arid environments, deer generally represent a small component of the total grazing pressure. Exceptions are some chital deer populations.
- Management of deer as game thus has a number of conservation benefits including lowered grazing pressure, retention of vegetation cover and incentives for landholders to reduce domestic stock numbers. In addition, there is the potential for monitoring of deer abundance, harvest and land condition by hunters and landholders.
- The disadvantage in promoting game management is that there may be an incentive for landholders to manage deer as game outside the historical ranges. This can be countered by legislation (ie declaration), education and gaining active support of hunting groups.
- Deer farming remains an established industry, but requires substantial, well-maintained fencing and intensive management. This can only minimise rather than eliminate the risk of escape.

A proposed option for deer management is to declare sambar, hog and white-tailed deer as Class 1 pest animals. This would involve removing them from the non-declared list. Rusa and chital deer could be declared as Class 2 pest animals. This recognises that state-wide eradication is not feasible for these species, but management of impacts in established areas is desirable. It may be possible to eradicate small, isolated populations outside these established areas. A similar strategy is applied to the management of many weeds in Australia (eg rubber vine, Agriculture and Resource Management Council of Australia and New Zealand, Australian & New Zealand Environment & Conservation Council and Forestry Ministers 2000).

Red (including wapiti) and fallow deer could be declared as Class 3 pest animals. This would only place an obligation on landholders to control these species near environmentally significant areas. However, it would still place a legislative barrier to sale and release. The lower level of declaration recognises their lower potential for spread (Figures 3c and d).

The declaration of Class 2 and 3 species would refer to wild deer, not domestic deer, to avoid permitting requirements for farmed deer. Most importantly, declaration would see the development of a management strategy for deer in Queensland, identifying stakeholder responsibilities, research needs, management action for specific areas and strategy monitoring and evaluation. Such strategies have been implemented for a number of pests in Queensland (http://nrm.dnr.qld.gov.au/pests). Clearly, further public consultation and a detailed assessment of the costs and benefits of wild deer will be an important part of implementing any declaration.

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Wild deer in Tasmania – exotic pest or valued resource?

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Tasmania boasts the potential to become one of the greatest fallow deer herds in the world and with the rapid and sustained uptake of Quality Deer Management its future appears very bright. This paper provides a brief look at the past present and future of Tasmania's fallow deer resource.

History

Although several species of deer were introduced into Tasmania in the 19th century, fallow deer (*Dama dama*) were the only species successful in becoming established. Early records indicate that 12 fallow deer (six males and six females) were brought from England to Tasmania in 1836 (Bentley 1998; Hall and Gill 2005). This small herd remained in captivity for upwards of 20 years until it numbered about 100 animals before being released. During this period a small number of extra deer were imported from England for hunting in game parks. By 1863, the Acclimatisation Society of Victoria estimated that the Tasmanian fallow herd had grown to approximately 800 animals (Bentley 1998).

In 2005 fallow deer can be found on over 30 percent of mainland Tasmania and the population is estimated to have grown to 20 000 animals (Hall 2004.). Wild fallow deer are classified as 'partly-protected fauna' under the *Wildlife Regulations 1999* and an annual season is proclaimed for male and antlerless deer. Each year, over 3000 licensed hunters harvest over 2500 deer (males and females) during the seasons. The number of hunters buying deer licences has risen each consecutive year for the past six years, which is a reflection of the increasing quality of the male deer and the quality of the deer hunting experience. Outside of the seasons landowners can apply to the Department for extra culling permits. The economic value of this level of deer hunting in Tasmania is estimated to be in the order of $5-6 million annually (Cause 1990; Game Management Services Unit, unpublished).

It does appear that in some areas fallow deer are expanding their current range at a rate greater than that of 0.8-0.9 km per year, which is considered the maximum for fallow deer (Challies 1985). There is speculation about the possible causes for this, including escape and release from deer farms, increased hunting pressure in some areas causing the animals to move, and illegal relocation of animals for hunting purposes. There is limited evidence for these movements (Moriarty 2004), and on the whole there is no definitive evidence to quantify these changes in distribution.

Game management of wild deer in Tasmania

What is game management? It is a term often used, but seldom understood. The classical definition by the 'father' of game management, Aldo Leopold, is ''the art of making the land produce sustained crops of wild game for recreational purposes'' (Leopold 1986). This definition embraces those innate bush skills that cannot be taught in any classroom. It is the ability to 'read' the land and understand how the many facets fit together to form a large cohesive picture. This knowledge is in abundance in Australia.

However, what is implied but not stated in Leopold's definition of game management is the need for scientific knowledge. In the context of wild deer management this is, in my opinion, what is lacking in Australia today. It is not enough for hunters to know what it is to be conservationists and only harvest surplus animals, and it is not enough for government agencies to recite the mantra that all exotic species are bad and must be doing damage. Rather, hunters, landowners

and government working together must develop and implement sound wildlife management programs to scientifically prove or disprove the value of a species irrespective of its native or exotic origins.

In 1993, the Tasmanian Deer Advisory Committee (TDAC) commenced just such a project to apply wildlife and game management principles to many of the complex and interacting issues involving wild fallow deer management in Tasmania. The TDAC is an advisory body to government and consists of representatives from the Tasmanian Farmers and Graziers Association, Forestry Tasmania, the Game Management Services Unit, and a number of hunting organisations.

In 1993 the TDAC employed a game biologist from the USA with a clear brief: research the fallow deer herd in Tasmania and recommend strategies to maintain it in a high quality state, in harmony with farming and the environment, and to manage the herd for sustainable, ethical hunting.

During the 25 years preceding the TDAC project numerous approaches to wild deer management in Tasmania had been attempted, although none had proven to be successful. This can in part be attributed to the lack of scientific merit of some programs, but more importantly, to the failure of those programs to balance the needs of landowners and hunters with the ability of the deer herds to meet those needs. If any progress is going to be made, this balance must be achieved.

When Brian Murphy began his project with the TDAC he found the relationship between landowners and hunters to be at an all-time low. Many deer herds had been neglected and mismanaged to a point where the sex ratio was highly unbalanced, with too many does and not enough antlered bucks. This unhealthy situation had arisen because of excessive hunting pressure on males and excessive protection of females.

However, over the next three years Brian turned this lose/lose situation around and many landowners and hunters re-evaluated their positions. Many landowners believed that if a solution was not found, their only option was to dramatically reduce deer numbers and, consequently, deer hunters.

Quality Deer Management

In response to similar conflicts between landowners, hunters and wild deer in the south eastern USA during the late 1980s, game biologists employed a strategy called Quality Deer Management (QDM). In less than a decade, this approach has proved so successful that it is currently applied in more than 30 states in the USA and involves thousands of hunters and landowners working in partnership – a win/win situation.

QDM is based on the biology of the deer and typically involves harvesting fewer young males combined with an increased harvest of females to maintain a population that is within habitat conditions (Hamilton 1989). The QDM approach involves the production of quality deer, quality habitat, quality hunting, and importantly, quality hunters. Hunters involved in QDM undergo a transition from being consumers of deer to active deer managers. Landowners benefit from QDM through a reduction in crop and pasture damage, more responsible hunters and additional revenue.

In just three years Brian and the TDAC project were able to transform the poor relationship that existed between deer hunters and landowners into a positive relationship with benefits for both sides. In late 1996, at the completion of the TDAC project, the Tasmanian government established the Game Management Services Unit (GMSU) to continue the QDM project and expand sustainable game management into other hunted species.

Data collection program

The obvious first step in any wild deer management program is to collect the necessary information on the herd from which to base future management decisions. Any statewide data collection program requires the cooperation of many landowners and hunters to be successful, and in the initial stages it is not uncommon to get the reaction that a data collection program is

simply a waste of time. Therefore it is helpful to break the task into smaller, manageable, pieces. The TDAC and GMSU gain wild deer data on a property-by-property basis that, collectively, allows a picture of the state scene to be developed.

Prior to the hunting seasons, data forms are made available to hunters with the purchase of their deer licence. On the forms they are asked to provide information on the animals that they harvest, including the date, location, colour, body weight, a series of antler measurements and a lower jawbone for age analysis. Data are also collected on female reproduction, such as lactation and the weight of any foetus.

The response to the data collection program has been remarkable. Whilst slow in the beginning, the GMSU now receives data on over 2000 harvested deer each year (Table 1). We don't pretend that we receive data on all the deer shot in the year, but we conservatively estimate that we receive data on 40 percent of the deer harvested in any year. When taken collectively, the GMSU now has records on almost 9000 harvested deer in Tasmania. No other Australian state that is trying to manage its deer resource can boast such an impressive database.

Table 1 Fallow deer known to be harvested in Tasmania 1994-2005

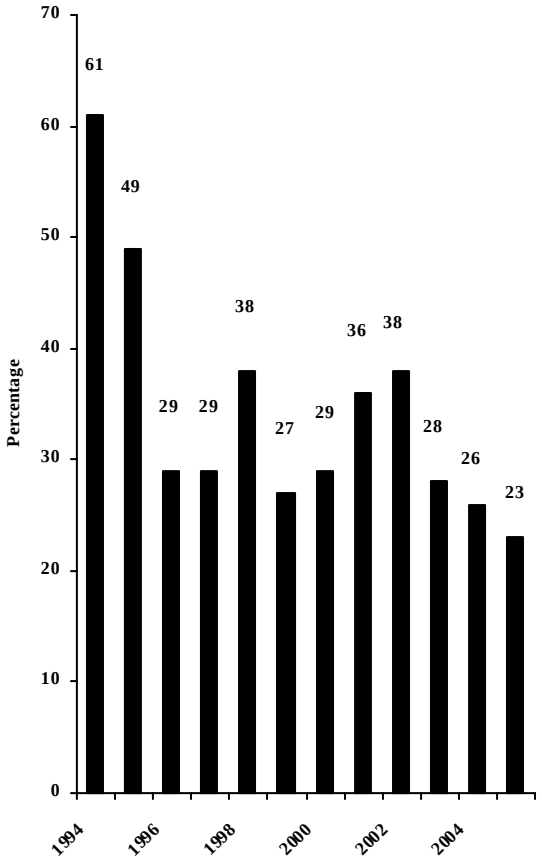
Year	Bucks reported	Does reported
1994	234	67
1995	210	136
1996	180	66
1997	214	52
1998	291	218
1999	296	150
2000	383	300
2001	341	267
2002	414	436
2003	428	660
2004	470	920
2005	737	1340

The data on the male deer harvested over the period 1994-2005 reveal a significant change in age structure, whereby in 1994, 61 percent of the harvest consisted of young animals (2.5 years) and this proportion had declined to 23 percent in 2005 (Figure 1). The change in age structure over the period is also reflected in the rapid, sustained, increase in the antler quality. By hunters restricting the harvest of young males they were able to demonstrate that the older male deer were capable of growing better quality antlers, which is what the hunters were seeking. The message from QDM of 'Let him go, let him grow' was being heard.

The landowners want less deer on their properties and the data collection program is able to demonstrate that this component of QDM is also being addressed. The number of does known to be harvested on an annual basis has risen by 2000 percent between 1994 and 2005 (Table 1).

We now have data on the harvest of wild deer on over 150 properties in Tasmania. In this way the objective of obtaining statewide data is being achieved – from the bottom-up, with the cooperation of, and for the mutual benefit of, hunters and landowners.

Figure 1 Percentage of 2.5-year-old male fallow deer known to be harvested in Tasmania, 1994-2005



Data collection and wild deer management

It is one thing to collect data, but how can the landowner use the data for the better management of wild deer? Table 2 shows the harvest data for one property.

Table 2 Fallow deer harvest statistics for one Tasmanian property

	1994-1996	1997-1999	2000-2002	2003-2005	Total
Bucks	64	99	100	202	465
Does	244	272	267	308	1091

Whilst the number of animals harvested is impressive, what does it mean for the landowner? If we convert these figures into Dry Sheep Equivalents (DSEs) then we can compare the deer harvested with the main pastoral activity on the property, which is grazing sheep.

Therefore: 465 bucks @ 1.2 DSE = 558 DSE
1091 does @ 1. DSE = 1091 DSE
Total = 1649 DSE

One DSE eats 0.8 kg of dry matter/day, so 1649DSE eat 1319.2 kg/day or 4815 tonnes/year.

There are two ways of looking at these data. Either, the landowner loses 4815 tonnes of food each year by having 1649 DSEs of deer on the property, or the landowner saves 4815 tonnes of dry matter by allowing hunters to remove 1649 DSEs of deer.

Put yet another way, 1649 DSE @ $25 gross margin/DSE = $41225 is the financial cost of the deer, or the financial saving by having hunters harvest this number of deer. By knowing the number of deer on the property, and the value of those deer, the landowner is in a position to decide how much culling needs to be done and what are the costs and benefits of that culling.

Delivering Quality Deer Management

During the past 20 years populations of browsing animals have increased in Tasmania to their highest recorded levels (Department of Parks, Wildlife and Heritage 1992). In many cases these animals cause significant damage to crops, pastures, forest plantations and native vegetation. Research has shown that wallabies and brushtail possums alone cause an estimated $20 million damage to agriculture and forest industries each year (Cleland *et al.* 1995).

The challenge faced by landowners and government agencies is to develop management strategies that achieve a balance between wildlife control and wildlife conservation. In Tasmania a program called Property-based Game Management (PBGM) is achieving that balance.

The Tasmanian Farmers and Graziers Association, the Tasmanian Deer Advisory Committee Inc. and the Department of Primary Industries, Water and Environment have been working together for several years to resolve the problems of browsing animals and have developed the PBGM program which is administered through PBGM plans. PBGM plans are property specific written agreements between landowners and hunters. The purpose of the plan is to manage wildlife, particularly game species, at acceptable levels compatible with agriculture, forestry and the environment while providing for sustainable hunting opportunities and fair compensation for the landowner.

The plans provide that the hunters, in return for hunting access, will undertake various tasks which include the control of browsing animals, property maintenance and property security to reduce trespass and illegal hunting. Hunters are also required to comply with a code of safety in the use of firearms, sign a legal waiver and indemnity and attend the property on a prescribed number of visits for hunting and property protection.

The plans do not diminish the rights of the landowner, who at all times retains the authority to cancel the plan without notice or reason.

To date, the staff from the GMSU have facilitated these plans on over 500 Tasmanian properties, covering in excess of 1.5 million hectares of private and public land and involving over 50 percent of Tasmania's licensed hunters.

When the QDM programs began to become popular in the early 1990s it quickly became apparent that the PBGM program was an ideal vehicle to deliver QDM onto properties.

In 1993, when Brian Murphy was employed in Tasmania to investigate solutions to problems faced by landowners, hunters and wild deer in Tasmania, he combined with an enthusiastic core group of hunters and an influential landowner to demonstrate the value of Property-based Game Management Plans. In 2005 this property's Plan is still in operation and serves as a blueprint for over 500 other properties in Tasmania.

Advantages of this Plan

The advantages of the plan to the landowner include:

- Retention of property control and knowledge of who is present on the property at all times.
- Ability to maintain a viable farming and grazing operation by harvesting adequate numbers of wildlife (including deer).
- Ability to ensure the safety of hunters whilst they are on the property.
- Maintenance of a working relationship with the property hunters and thereby implementing a successful Property-based Game Management Plan.
- Ability to reduce deer poaching and illegal trespass through the active involvement of the hunters and Wildlife Rangers.

In return the hunters are able to:

- maintain open communication with the landowner and have hunting access to the property
- conduct organised culling programs for native and exotic species as required by the landowner
- actively participate in a successful Property-based Game Management Plan by collecting data upon which practical wildlife management decisions are based
- improve the quality of the deer herd by restricting the harvest of young bucks whilst removing excess female deer,
- have the opportunity to voice their opinions on issues relating to wildlife management on the property
- ensure that sustainable wildlife populations are maintained for the future
- provide hunter education and training opportunities for new or young hunters.

What are the advantages of the plan for wild deer management?

By having a dedicated group of hunters on the property, the landowner is in a better position to monitor the deer populations on the property. The hunters record how long they spend hunting (hunter effort) and count the numbers of animals both seen and taken on the property. This information is summarised at the end of the year by the hunters and provided to the landowner.

Based on this accurate information, both the landowner and the hunters are able to make informed decisions about deer management — decisions such as whether the harvest of deer is sufficient, or too high or too low.

Quality deer management is one of the key elements of this property's plan. The hunters have collected information on the herd each year, which shows that the number of bucks seen per hour is rising while the sex ratio is trending towards equality. Hence hunter satisfaction is increasing (by seeing more harvestable bucks), and at the same time landowner satisfaction is rising because increasing numbers of female deer are being harvested.

The future of wild deer management in Tasmania

It is people who perceive some interactions with wildlife as a conflict, and it is our human value system that defines some animals as pests and nuisances. How good we are at solving wildlife issues depends on our skills in managing people, rather than managing animals.

It's getting harder all the time to solve problems by managing animals, and to please everyone while doing so. People in this country hold increasingly different views of wildlife. It's abundantly clear that even among people who have little direct knowledge about wildlife and wildlife management, almost everyone has a strong opinion on what to do — it appears that the less factual one's knowledge, the more likely one is to be outspoken about a solution. The situation becomes even more confused when the subject is native versus exotic species.

Historically, we have looked to politicians and government agencies to identify issues, allocate resources and solve the issues. Wildlife is a public resource in Australia and it is easy and superficial to say that animal damage mitigation is the responsibility of the wildlife agencies. The reality is that this approach is only the beginning.

These responsibilities begin with the legislative process at both the federal and state levels. The legislatures establish and assign responsibilities to agencies that directly affect wildlife control or management activities. Whilst these legislative mandates direct wildlife methods and costs, the same legislation has resulted in confused agency responsibilities. In some states the responsibilities for wildlife control are vested with agricultural agencies, whilst wildlife conservation belongs in a different agency. At a federal level, policy for endangered species is vested to one agency, while responsibility for control of depredation resides in another.

This example illustrates the complexity and maze of action that those involved with wildlife management and control must negotiate before attempting to coordinate with, and enlist the support of, agencies.

However, the time is long past where we should expand cooperation and coordination to include a partnership with full and mutual support. The agencies requesting support from the landholder

should, in their turn, provide adequate documentation and recommend and support the methods of wildlife management to be employed. Further, the agencies should assist in resolving the differences of opinion that may exist amongst the various interests concerning the wildlife operation.

The concept of integrated damage management is widely known and accepted for weeds or insects, as is the application of various tools and methods to mitigate damage. However the concept needs to be expanded for wildlife beyond the methodology phase to include cooperation, coordination and support from all the groups with an interest in sustainable wildlife management. Such an approach would represent an appropriate and responsible response to a matter of great public importance.

Consequently the ideas should be tested experimentally. Such experiments are usually so large that they should employ the approach of integrated management, where management itself is the experimental manipulation. For example, animal densities could be managed so that they vary from no removal to severe removal over short and long time periods. Without such an integrated management approach, the issue of overabundance cannot be resolved, and the problems and perceptions will remain the subject of debate.

Clearly from the above discussion, cooperation and coordination are absolutely essential to a successful wildlife management program. Management programs must be partnerships, and in this way will bring public perceptions closer to management realities.

Such an initiative has begun in Tasmania, and Australia, with the Property-based Game Management program for private land. In the short time since mid 1996, Property-based Game Management Plans have been successfully developed on over two million hectares of private land in three states, modeled on the success of the Tasmanian progam. The challenge is to expand the coverage of these plans over the majority of private land in Australia, and enthusiastically develop cooperative, sustainable wildlife management programs for the benefit of wildlife and people.

In addition, the rise and rise of Quality Deer Management programs in Australia offers hope that the previously ad hoc approach to wild deer management can be put on a more scientific footing.

The above discussion has deliberately focused on wildlife, rather than specifically about deer. The reason is very simple. Deer are now an integral part of the Australian wildlife, and no amount of moral or philosophical posturing will remove that fact. The management techniques relevant to deer are just as relevant to the broader wildlife.

If Australia, and more importantly Australians, are to have a mature approach to our wildlife management we must move away from the traditional approach of ‘love the natives and kill the ferals’ and embrace wildlife management for all its complexities, challenges and positive outcomes.

We have come a long way since signs like this were posted in Tasmania! Many properties have shown that Quality Deer Management works in Tasmania for the mutual benefit of hunters and landowners. The sustainable management of a wildlife resource, such as wild deer, can deliver political, social, economic, and biological benefits to all of the participants.

In conclusion, are wild deer an exotic pest or a valued resource in Tasmania? They are an exotic species, and they are a valued resource. They are also a pest depending on the circumstances and on whom you ask.

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Wild deer in South Australia: position paper for National Deer Workshop

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Government of South Australia, Department of Water Land and Biodiversity Conservation

Background

Wild deer (family: Cervidae) are known to exist in various parts of South Australia. Although, at this time, fallow deer (*Dama dama*) is the only wild species known to be abundant in parts of the state. The current populations of wild fallow deer first established in South Australia through wide liberations throughout the state in the late 1800s but have now retreated to pockets in parts of the south east, mid north and Mt Lofty Ranges. These surviving wild populations, which were formed from acclimatisation releases, are found in natural vegetation and forest edges where there is adjoining agricultural land. Both the distribution and abundance of these long standing wild fallow deer herds have receded since the early 1950s due to a range of factors including lack of suitable habitat due to agricultural development and the activities of recreational hunters.

Against this trend, a fallow deer herd in the Taratap area of the upper south east (established from releases into suitable habitat by hunters in the 1970s) has expanded its range northward in recent years into the southern end of the Coorong district around Salt Creek. This herd has become the most abundant fallow deer population in the state; most likely because of significant liberations of fallow deer from a commercial deer farm in the area rather than natural increases. However, broad further expansion of this herd's range northward and eastward into other districts is unlikely given a lack of suitable habitat in those districts and the herd is subject to high hunting pressure by landholders and recreational hunters.

Apart from the original herds established from acclimatisation releases there has also been an increase in reports of small populations of fallow deer establishing in new areas in the last ten years. It is most likely these new populations have arisen from ad hoc liberations by hunters or from farm escapes. A fall in the value in recent years of farmed fallow deer may have contributed to these liberations. New herds of fallow deer at Burra, Southern Fleurieu Peninsula, Elliston and Kangaroo Island have been reported in the last 5-10 years by local animal and plant control boards. Some of these new established herds of fallow deer have already been eradicated by farmers or by recreational hunting groups offering a service to private landholders (eg Murray Bridge, Burra, Keith, Currency Creek - source: local animal and plant control officers).

Small herds of red (*Cervus elaphus*), rusa (*Cervus timorensis*) and sambar (*Cervus unicolor*) deer have been reported in the upper south east in recent years. Small herds of red deer also exist in the area around the Bundaleer forest in the mid north and have been attributed to escapes from a deer farm. Sightings of rusa and sambar deer are certainly the result of accidental or deliberate liberations in recent years as these species are kept in very limited numbers in commercial herds (there is only one commercial herd of sambar) and there is no record of them ever properly establishing in the wild in South Australia. In the upper south east small populations of rusa, red and sambar deer are confined to an area from Salt Creek to Kingston.

Estimates made by the Australian Deer Association put the total number of fallow deer in the upper south east region at 2600, whilst the estimate of other species (red, rusa, sambar, chital) is around 650. No accurate estimate of deer numbers in other parts of the state is available.

Impact

There have been no detailed scientific studies on the effects of deer in South Australia and any such future study would be longterm and costly. However, as with other wild herbivores such as

wild goats, deer should be regarded as animals with the potential to cause damage to areas of agricultural production and native vegetation.

Anecdotal reports of damage to native vegetation and mallee fowl mounds in the upper south east of South Australia were reported to the Animal and Plant Control Commission during 2004 and 2005. Reports of damage to pasture and fodder crops (mainly lucerne) were also reported during 2004 when feed availability was poor due to unfavourable seasonal conditions.

The Department of Water, Land and Biodiversity Conservation has just completed a survey of 270 landholders in the Upper South East. The results identified that around 60 percent of landholders with wild deer on their land feel that potential disease threat and traffic hazard were the main impacts of wild deer.

Wild deer must be regarded as being a potential problem either in the event of an exotic disease outbreak or if tuberculosis became re-established. The ability of deer to contract and be a source of infection for bovine tuberculosis and Johnes Disease is well recognised in commercial deer herds. However, both diseases have never been isolated in true wild deer herds in South Australia. However, Johnes Disease has been isolated in red deer that have had recently escaped from a known infected commercial red deer herd. When densities of wild deer are low the ability to carry and transmit endemic diseases is significantly reduced, but if the density of wild deer was allowed to increase then the risk of endemic disease may also increase.

The degree of risk posed by wild deer in relation to a range of exotic diseases is difficult to establish. However, should a serious disease not presently in Australia become established here, the presence of any wild animals, such as deer, could present a problem.

State Policy

The State Policy on Wild Deer (adopted by the Animal and Plant Control Commission in 2000 and reviewed in 2004) provides a framework for the development of regional action plans to manage the impact of wild deer.

In response to this policy prescribed measures for control under the *Natural Resources Management Regulations 2005* require that:

- Landholders with wild deer on their land without their consent must control deer in accordance with Natural Resources Management (NRM) Board Regional Plans.
- Landholders who have deer on their land with their consent must confine their deer in a manner determined by the Regional NRM Board to minimise the risk of escapes.
- It is an offence to wilfully or negligently release deer into the wild under the NRM Act.

Currently if an owner of land fails to control wild deer adequately on that land an authorised officer may require a landowner to implement an action plan to address non compliance with the responsibility to control wild deer under the NRM regulations.

For landholders (both government and private) with wild deer on their properties, the major issue is to what level they should reduce wild deer numbers in order to minimise agricultural and environmental damage and other hazards, but the landholders also have a responsibility to one another because wild deer ignore property boundaries.

Landholders must control the number of wild deer on their property at an acceptable level, which is determined by the Regional NRM board after consultation with the landholder and other interested parties. Satisfactory levels of control may be achieved through the development of property deer action plans. These plans, which are developed for other pests, can be formulated between a board and one or more landholders working in cooperation to reduce deer density to a level where the following benefits are obtained:

- Short term benefit is increased production from domestic livestock due to reduced competition between them and wild deer for food and possibly water.
- Long term benefit is increased production and land value due to reduced land degradation and long term benefit for biodiversity due to reduced impact on native vegetation.
- Other benefits to the landholder include a reduction in the potential threat of losses and costs attributed to the outbreak of an endemic or exotic disease.

- The level of control must be sufficient to reduce to low levels the adverse effects of deer migrating from one property to neighbouring properties.

Current compliance with State Policy and Regulations

The increase in the abundance of wild deer in South Australia has been attributed to releases and escapes of farmed deer, deliberate translocations by hunters and a lack of coordinated control by landholders. This trend indicates a poor level of compliance with the current legislative requirements.

Whilst there has been no formal survey, anecdotal comments from stakeholders and national research suggest the following possible reasons for poor compliance with the requirements on farmers to keep farmed deer securely and for landholders to control wild deer:

- poor fencing standard, poor maintenance, unsuitable terrain, poor husbandry (overstocking) leading to escapes from deer farms
- poor markets and/or climatic conditions (industry downturn in early 1990s) leading to releases as result of poor fence maintenance, husbandry and deliberate action
- lack of hunting opportunities due to restrictions on access to public and private land and a reduction in habitat suitable for deer through change in land use resulting in liberation of deer to seed new areas for hunting
- legislation protecting deer in other states causing confusion and undermining of SA policy and legislation, combined with a poor understanding of legislative responsibilities by landholders
- a lack of knowledge and uncertainty by deer farmers, hunters and landholders about impacts of deer
- many landholders lack access to high-powered weapons, do not have the time to stalk deer or lack the training, qualifications or skills to undertake a deer control program
- perception that coordinated control programs will increase the level of illegal hunting by raising the profile of the area amongst hunters
- the transient nature of their presence and their large home ranges has made it difficult for boards to enforce landholders responsibility to control deer on their land
- the management of deer overabundance is a complex issue and regional boards do not have a dedicated staff to deal with deer problems across the region. As deer management requires significant ongoing commitment, other short term board priorities have resulted in authorised officers not being able to dedicate time to deer control as discrete project.

State wild deer strategy

In response to the above problems and poor levels of compliance with deer policy and legislation, a State Deer Compliance Working Group met in 2004 to review compliance arrangements and make recommendations on how compliance can be improved. In response to findings of this Working Group strategies were developed and are being currently implemented to:

- inspect all deer farms across South Australia to ensure compliance with statutory requirements to keep deer securely;
- notify all deer farmers of impending inspections and their statutory responsibilities for keeping farmed deer;
- develop inspection and compliance guidelines and provide training to authorised officers on deer fencing standards;
- develop and implement regional coordinated control programs and facilitate landholder action to meet their responsibility to control wild deer populations on their land.

Implementing strategy

There are limited control techniques available for deer. No poisons are registered for deer control in Australia and trapping, ground and aerial shooting are the only options available. Of these techniques, ground shooting (preferably at night with spotlight) is the most practical, cost

effective method, and is likely to meet animal welfare concerns provided codes of practice are followed.

However, it should be noted that many landholders lack access to high-powered weapons, do not have the time to stalk deer or lack the qualifications or skill to undertake a deer control program. In this case, the use of controlled or managed recreational hunting can provide the opportunity to find some middle ground where hunters, landholders and the community can benefit and assurances can be given to the community that deer are controlled using skilled marksmen that follow strict shooting codes of practice. This may apply to species such as fallow deer, which are already widespread, and where the level of damage can be managed to a low level. Conversely, different strategies may be required where there is a higher level of threat (eg in a high value conservation area) or where a species has not yet established. Some of the more prominent recreational hunting groups (eg Australian Deer Association (ADA) and Sporting Shooters Association of Australia SA Branch (SSASA)) are taking a significant interest in conservation issues and have assisted both public and private landholders in the eradication of new populations of deer and to manage the impact of widespread established deer populations that pose a significant threat on both private and public lands.

The former Lacepede Tatiara Robe Animal and Plant Control Board (now part of the South East Natural Resources Management Board (SENRMB)) coordinated a successful pilot deer control program involving private and public stakeholders around Gum Lagoon Conservation Park in 2002. Whilst the program was a successful model for other control programs in the area the board has not been able to attract enough interest from landholders for another coordinated program.

Since the Gum Lagoon Trial the SENRMB has not been able to develop ongoing coordinated control programs. However, five private landholders in the Gum Lagoon area have voluntary private agreements with the ADA SE Branch to undertake deer control on their land (60 000 hectares of land). The level of control depends on various agreements between the ADA and each individual landholder.

However, the recent survey of landholders in the pper south east reports that most landholders with wild deer on their land are willing to participate in coordinated control programs. Plans are in place to fund a position to help the SENRMB develop new cooperative coordinated control programs at a local and district level.

Management of Fallow Deer on Kangaroo Island

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Background

Kangaroo Island is nationally important for biodiversity conservation, primary production and nature based tourism. It has nearly 50 percent of native vegetation remaining (Department for Transport, Urban Planning and the Arts 1998) and an absence of foxes and rabbits. Being an island, biosecurity measures can play an important part in controlling species from entering the region. The Kangaroo Island Natural Resources Management Board (KI NRM Board) in conjunction with the Department for Environment and Heritage SA (DEH) is developing a biosecurity program to prevent and detect the introduction of pest species to the Island. Control programs of resident feral animals are also being developed. In 1999 fallow deer became feral on Kangaroo Island. It is hoped feral deer can be eradicated from Kangaroo Island, while their population is small and impacts are minimal.

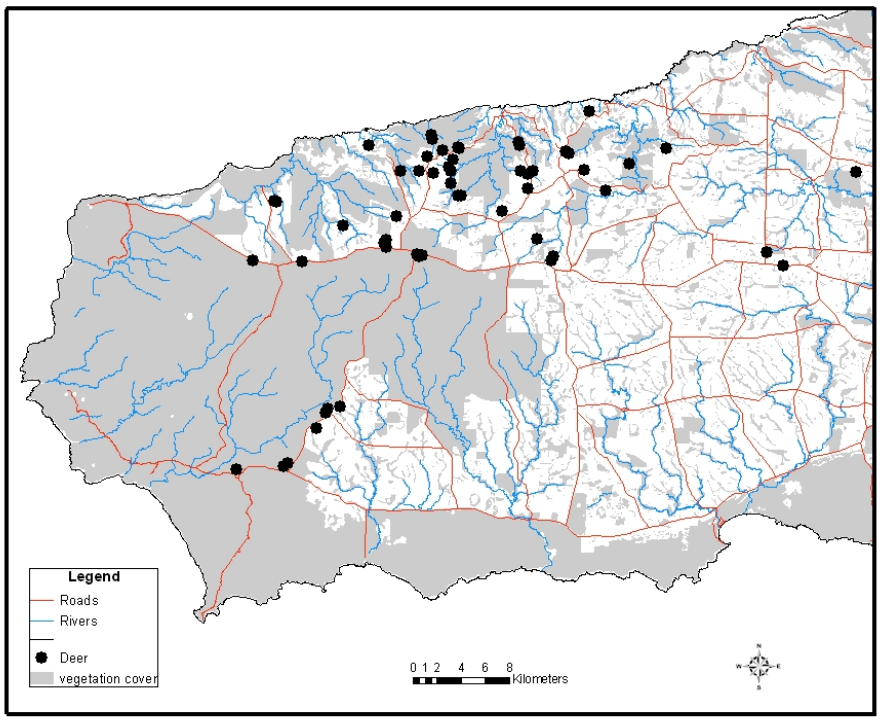
Fallow deer escaped from a deer farm on the western end of Kangaroo Island. The number that escaped is unknown due to the farm's fences being in poor condition, enabling deer to move in and out of the property for a number of years. However, it is estimated between 80 and 300 individuals escaped with a consensus that most were female.

The community and government agencies undertook a coordinated control strategy between 2000 and 2002 with a minimum of 90 feral deer destroyed by locals or the Sporting Shooters of South Australia. Lack of funding and government support resulted in a lapse in the program, although local hunters have continued to kill deer on an ad hoc basis.

Throughout the control campaign no centralised records have been kept of the population characteristics of shot deer and there are no comprehensive records of the number of deer shot since 2002. It is therefore difficult to determine the level of deer control undertaken from 2002 to 2005. The information obtained from the major landholders in the area now occupied by fallow deer estimates a minimum of 41 feral deer was destroyed in 2005. At a recent public meeting landholders estimated at least thirty feral deer have been culled each year since 2002. Sustained hunting pressure has been maintained on a number of properties, particularly on Great Southern Blue Gum plantations.

The current feral deer population on Kangaroo Island is estimated to be between 50 and 150 individuals, with a sex ratio strongly biased towards females. Following their release in 1999, feral fallow deer have spread at a rapid rate, covering an area of around 92 000 hectares (2005 records) (Figure 1). However, it is thought that the breeding population is still predominantly within 15 kilometers of the release area. Anecdotal evidence suggests the reproductive output is high at around 90 percent of adult females, with some individuals raising twins.

Figure 1. Distribution of fallow deer on Kangaroo Island up to and including 2005. In 2006 a more intensive search for deer signs confirmed the population is still predominantly in the same area with no recent records from the extremes of the range.



Registered deer farms

There are five registered deer farms on the Island stocking predominantly fallow or red deer. The property from which fallow deer first escaped stocked up to 1400 head. This property has been sold and is now under forestry management.

Why eradicate deer?

Potential impacts

The impacts caused by deer are yet to be fully realized on Kangaroo Island but could become substantial if the population increases and spreads unhindered. The impacts of greatest concern for Kangaroo Island are:

Environmental

- damage to areas of bushland through trampling, grazing and ring barking trees
- potential to graze threatened plant species
- spread of plant diseases such as *Phytophthora cinnamomi*
- reduced invertebrate biodiversity

Social

- increased levels of illegal hunting
- collisions with cars
- once in townships they become a nuisance knocking over garbage bins, damaging property through rubbing (eg car mirrors) and destroying domestic gardens

Primary production

- competition with stock
- spread of Johne's disease

- destroying trees, both native and commercial particularly during the rutting season
- damage to agricultural crops through trampling and grazing
- destruction of vineyards

Management options

Kangaroo Island can control fallow deer using one of three strategies:

1. retain the status quo of ad hoc management
2. the development of a sustainable control program where impacts are managed to a target level
3. eradication

The positive and negative issues relating to each approach are discussed below.

1. Retain the status quo

This action leaves the control of deer to the landholders and recreational hunters and is likely to slow the population growth but not eradicate them. Hence, densities and the area impacted are likely to increase. This action postpones control to a later date and is likely to be more expensive in the long term.

2. Sustainable control

This action needs ongoing management to ensure the feral deer population is managed to a level where damage is minimal. This will require an understanding of the impacts, the growth of the feral deer population, and the level of control needed. Resources for such a program would be substantially greater than eradication in the long term because such management is ongoing.

3. Eradication

Numbers of feral deer are still low and the area affected currently has substantial although patchy hunting pressure. With a coordinated and integrated strategy it may be possible to maintain the death rate above the birth rate. At this stage it is difficult to determine if all animals are at risk and a monitoring program is being developed to determine the distribution and abundance of the species. Being an Island, re-infestation from other areas can only occur from deliberate release and farm escapes. As the population size is still small, eradication could be trialed while the effort required is relatively low.

For the successful eradication of a pest animal population the following criteria are essential (Myers *et al.* 2000) and will be addressed by the Feral Animal Management Program:

- The socio-political environment supports eradication:
  Past actions indicate eradication is supported by the Island community. A recent public meeting concluded that eradication was worth trialing and would be supported. Representatives of the cattle industry regard eradication as the preferred option due to the threat of feral deer spreading Johnes disease to cattle studs.
- Immigration can be prevented:
  With a good biosecurity strategy and farm control this action is possible as Kangaroo Island is an island.
- Deer can be killed at a faster rate than they can replace themselves:
  This will require an understanding of the population size and structure, hunting pressure, and reproductive rate. Some hunters on the Island have kept good personal records of the age, reproductive status and sex of destroyed deer. This information may be able to provide the above.
- All reproductive individuals are at risk from the available techniques:
  Techniques will need to be trialed and an understanding of their distribution and habitat use refined.
- Deer can be monitored at very low densities:
  There are a number of monitoring techniques that will be implemented which allow for the detection of individuals at low densities. Improved communication with the community and a good reporting process of sightings is needed.
- The high costs of eradication can be justified:

At this stage we have not estimated the cost for eradication due to a limited understanding of the extent of the problem, however, control operations over the next 12 months will clarify future costs.

Regional management objectives

The Regional Management Objectives comply with the State Management Objectives (Department of Water, Land and Biodiversity Conservation 2005) and are specific to the social, political, economic and environmental context of Kangaroo Island. Future control operations will need the financial and operational support of the KI NRM Board and DEH, because the lower the number of remaining deer, the greater the time and effort required to eliminate each animal.

The objectives for deer management on Kangaroo Island are as follows:

Objective 1
All deer farmers compliant with the *NRM Act 2004* and regulations relating to the security of their animals by July 2006 and a protocol in place for the retrieval of any future escapes.

Objective 2
Assess the current procedures in place for importing deer onto the Island and implement processes that will ensure minimal biosecurity risks.

Objective 3
Develop an effective communication strategy allowing for the exchange of information from all participants.

Objective 4
Establish monitoring and evaluation programs by December 2006

Objective 5
Develop an understanding of the ecology of feral fallow deer on Kangaroo Island by collecting information on movements, habitat use, and group dynamics.

Objective 6
Develop and implement effective destruction techniques.

Objective 7
Develop predictive models of population changes under different management scenarios.

Objective 8
Assess the cost and feasibility of the eradication program.

Eradication techniques

There are limited techniques available to destroy feral deer. No poisons are registered for deer control in Australia. Trapping, ground and aerial shooting are the only options available. Of these techniques, ground shooting at night with a spotlight is regarded as the most practical and cost effective method. Stalking during the day may also be effective for skilled deer hunters.

The use of ‘Judas deer’ carrying radio collars has not been widely used in Australia but has been trialed with some success in New Zealand. This technique is being assessed for a trial on Kangaroo Island but may not be successful because deer have only been seen in small groups of three or less. Aerial shooting has been used in New South Wales to effectively mop up residual deer herds on private land after ground shooting. This could be very effective when combined with use of Judas animals, however, the thickness of the bush and low density of herds may render this management option unsuccessful on Kangaroo Island.

The initial strategy for control on Kangaroo Island will focus on hunting. Recreational hunting per se is considered to be an ineffective control method with regard to the objectives of eradication. Casual hunters can make deer wary and are unlikely to have the time and resources to hunt deer at very low densities.

Detailed management actions

A more strategic action plan is currently being developed by Clark McGhie (Australian Wild Country Adventures) Queensland. The actions proposed by McGhie are based on evidence suggesting the number of adult males in the population is small. McGhie proposes the following strategy:

Bucks first
As it appears there are a limited number of bucks on the Island, they should be targeted first. The proposal to destroy females in preference to males because they produce the young and are not restricted to one male is sound, however the sex ratio is already strongly skewed towards females and any buck fawn dropped has still got to survive another 15 months before getting a chance to breed.

Deer first
Promote the idea to landowners and hunters that it is preferable to inspect for feral deer and destroy all deer found before shooting other pest species such as pigs.

Rut shooting
Selected hunters should be trained in techniques to specifically target bucks during the rut as they begin to work rut stands and start to roar.

Pig dhooting
As the landowner will see far more benefit in the short term from pig shooting, it needs to be stressed that hunters included in this program will also destroy pigs at every possible opportunity once an initial inspection has been made for deer.

Data collection
Hunters included in the program will be issued with data collection sheets to record all deer sighted and destroyed, and dates, times, and sex. Jawbones from all deer taken are to be kept for aging.

Deer movements
Notes to be kept by hunters as to where deer are commonly seen entering or exiting properties, crossing roads, fawning or rubbing.

Landowner involvement
Landowners will be kept well informed of the campaign and asked to assist with access and information on deer movements.

Monitoring program

Deer are a difficult species to monitor due to their elusive and secretive habits. Spotlighting is difficult because deer move away from people, aircraft, spotlights and roads, making random sampling difficult. Recent studies have indicated that in areas where deer densities are relatively high two methods of monitoring are best and should be implemented concurrently (Forsyth and Scroggie 2003). They include:

1. Catch-per-unit-effort
    - easy to collect;
    - non random;
    - dependant on the skills of the hunters.
2. Pellet (scat) counts
    - On Kangaroo Island, deer densities are still too low to use pellet counts, but tracks could be an alternative technique.

Monitoring will be undertaken using the following techniques.

- monitoring by the community

This will be a relatively informal monitoring program that will rely on the community to inform the Project Managers of any sightings of deer.

- Catch-per-unit-effort (CPUE)

Targeted hunters will be asked to record the time spent hunting and the number taken within the area of known distribution.

- Passive detection

Track counts will be undertaken. Standardised methods will be put in place in the next 12 months. Trials of pellet counts have indicated that, over much of the deer range on Kangaroo Island, pellets are in low density and more difficult to find than tracks. Tracks have proved effective and because of the low numbers it is possible to estimate the number of deer in an area.

Threats to the success of the program

Although only a relatively small number of deer need to be destroyed, the task ahead is still substantial and will require coordination and support from the community and government agencies. Some of the threats to the program include:

- lack of funding to implement and maintain management actions
- reduction of public support if the program is halted or stalled
- further releases of deer from deer farms or imported animals

Acknowledgements

Thanks go to the landholders of Kangaroo Island and the staff of the Kangaroo Island Natural Resources Management Board who assisted with the collection of the available information. Clark McGhie was pivotal in getting the program moving, talking to hunters and landholders and assisting with the development of future directions.

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Feral deer situation in the ACT

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Background

Feral animal control programs in the ACT are conducted within the framework provided by the ACT Vertebrate Pest Management Strategy.

The strategy identifies that few impacts of deer have been quantified, and that few feasible control options are available in forest areas. Accordingly management of this species in the ACT has, until recently, been considered a low priority.

Feral Deer have been declared as pest animals in the ACT under the *Pest Plants and Animals Act 2005*, in recognition of the potential for deer to significantly increase their distribution (not based on their impacts, which, as outlined above have not been quantified).

Preparation of a management plan is required to enforce a pest declaration under the Act. However, it is acknowledged that the mobility of these animals across a range of land tenures will make it difficult to place a control direction on an individual. Cooperative action is the approach most likely to achieve success.

ACT deer situation

A significant proportion of the feral deer present in the area of the ACT are fallow deer suspected of escaping/being released from a collapsed deer-farming venture on a NSW property adjoining the ACT and the Murrumbidgee River (possibly in the early 1990s).

Despite initial control efforts being made, deer continued to disperse within the ACT, in particular along most of the length of the Murrumbidgee River, and also into mountain areas within Namadgi National Park, where few feasible control efforts were considered to be available.

In addition to the above sightings along the Murrumbidgee River other reported sightings of deer have become more common in recent years. These sightings include sambar and red deer in the southern end of the ACT, and fallow in the northeast.

There has not been a deer-farming venture approved in the ACT.

Current situation

A number of interviews were conducted, and questionnaires completed on feral animal distribution and abundance in the ACT (NSW Survey proforma used) following the 2003 bushfires. Most respondents indicated that sightings of deer had reduced very markedly immediately following the fires.

Environment ACT requested that rural landholders and park management staff report sightings of deer to help determine whether numbers were increasing following the fires, and to identify specific areas where deer were routinely located.

Over the past two years the number of reported sightings, and the numbers of deer sighted together, have increased. Whilst this information is not in a quantified form, it does provide strong anecdotal evidence of a recent increase in the deer population in the ACT.

As yet no actual impacts caused by feral deer have been identified. However, an increased potential for vehicles to collide with deer on rural roads is an issue that may emerge if the suspected increase in numbers continues.

There is no hunting or game legislation in the ACT to restrict deer hunting on private land, and none proposed. However over 90 percent of land in the ACT is currently managed by public land managers, or considered too close to urban development for this activity to occur.

Agreement to allow for restricted hunting within ACT Government managed land would require resolution of a range of factors including: pubic safety concerns (both real and perceived), insurance and risk management considerations, legislative barriers to members of the public discharging firearms on public land, equity of access, compliance monitoring, and maintenance of animal welfare standards.

Overcoming these barriers is possible, however, an analysis of the costs against potential benefits gained has not yet been undertaken.

Summary of potential deer control options in the ACT

- Poison – no product registered or acceptable to be used.
- Shooting – inefficient and high cost if performed by ACT Government staff. However some feeding stations have been established, and limited shooting in known hot spots occurs. No restriction to hunting on rural properties. Significant further work required before hunting access to public land could be considered.
- Trapping – difficult in most areas of the ACT. Apart from animal behavioural issues traps set in accessible areas are prone to disturbance by members of the public. The most likely option to succeed in the ACT is for government and rural landholders to work together, possibly constructing trap yards on rural leases along Murrumbidgee River.

The changing policy environment for red deer management in Scotland: from enterprise to societal needs, from individual to cooperative management

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Background

The people of Scotland have had a chequered relationship with red deer (*Cervus elaphus*), the largest native land mammal in the UK. Historically, red deer provided them with meat, skins and antlers for making tools and weapons; however, with the increase in domestic stock, particularly sheep and cattle, deer were seen as competitors for the scarce vegetation and were removed from large tracts of land brought into agricultural production (Clutton-Brock and Albon 1989). From the 18th century onwards, some large landowners removed the native people and their stock from the same land, to meet their desire to encourage the red deer population to recolonise the cleared land to provide the landowners with sport hunting (Hart-Davies 1978). This culminated with Queen Victoria's enthusiasm for everything Scottish, resulting in the wealthy English gentry purchasing large tracks of land (estates) which they managed solely for the sport it provided from deer stalking. Thus the modern sporting estate was born, which has existed to this day. With the new landowners came a culture that today is seen as quintessentially Scottish, eg castles, kilts, stalking.

The disenfranchisement of the majority of the Scottish population from harvesting the deer as a source of meat in embedded within Scots law, which states that nobody owns the red deer themselves but that the right to shoot red deer remains with the owners of the land upon which they roam. Since only 500 individuals own over 85 percent of Scotland this, in effect, has removed the deer from having any value for the majority of Scots, leading to an antipathy towards the animal because of its association with the social elite.

In the late 1950s the Red Deer Commission was established. It was a statutory organisation whose remit was to ensure that the welfare of the wild red deer herd was not compromised and that the deer population in Scotland did not damage the agricultural and forestry interests that exist side-by-side with the deer. In effect this meant that the Red Deer Commission was responsible for maintaining the status quo and ensuring the deer were managed to meet the cultural and economic objectives of the landowners, be they estate owners, farmers or foresters. This has led to increasing numbers of deer, with the population currently standing at around 350 000 individuals.

Historical red deer management

The primary target for deer stalking in the Scottish Highlands is the male red deer (stags). For the past century and a half has been has been predicated on the desire of the estate owners to ensure that adequate stocks of stags are available for them and their guests to stalk. This has encouraged the owners and their managers to increase the stock of red deer roaming on the estate through practices such as the provision of supplementary feeding during the winter to reduce over winter mortality and keep the stags hefted to a piece of ground rather than migrating to new feeding areas. There has also been the attitude that, in order to increase the number of mature stags available for stalking, the number of adult female red deer (hinds) needs to be kept high. In effect the more hinds there are, the more calves will be born, half of which will be stag calves. This has led to substantial increases in deer numbers, a bias in population towards breeding hinds (Clutton-Brock *et al.* 2002) and substantial impacts on the vegetation (SNH 1994).

In the past 15 years, the growing enthusiasm of the urban majority to return Scotland's landscape to its past condition, with more trees, has led to an increasing concern about the impact that these high numbers of deer have had on the landscape, particularly on tree

regeneration. This pressure, in part, led to a change in the remit of the newly named Deer Commission for Scotland (DCS, formerly the Red Deer Commission) to include the protection of biodiversity (''natural heritage'' in Scottish executive language) in Scottish law in 1996. This change, along with the perceived changes in policy related to the Scottish Parliament, has encouraged landowners to at least think about the possibility of changing their management of the red deer that roam on their land. However, there is the possibility that changes in management, to reduce numbers to meet biodiversity objectives, have led to a potential conflict between the environmental desires of the urban majority and the economic requirement of the landowners and those reliant on them for their livelihoods. As such there has been a change in the ways in which deer have been managed in Scotland, in a way that is much more inclusive of other peoples' requirements of the Scottish landscape and the goods and services it provides.

A new future for deer management in Scotland

Deer Management Groups

There is increasing awareness that wildlife does not respect land ownership boundaries unless a fence is placed in its way. For deer, for example, the home range is 1000ha, and there are large distances between the summer and winter ranges, particularly in the populations east of the Great Glen. This has led to a debate as to whether there could be effects from the management of deer on one estate on the herd of deer on a neighboring estate, especially where estate objectives are diametrically opposed (eg conservation vs trophy hunting). This led the Deer Commission for Scotland to help in the establishment of deer management groups in Scotland. Today there are over 50 Deer Management Groupz with the Association of Deer Management Groups (ADMG) that was established in 1992 to represent the DMGs. DMGs are not unique to Scotland although they have proved highly suitable to the Scottish pattern of land ownership, particularly where the holdings are generally large, as in the Highlands.

This concern has led landowners to put forward an approach to setting objectives for deer management that focus on the participation of all interested parties in the development of collaborative management plans for deer management. The process of collaborative management, involving the participation of all interested parties, is supported by the Association of Deer Management Groups (ADMG) (Deer Management Groups comprise groups of estates or other landholdings that share access to a discreet population or herd of deer which is managed as a common resource (www.deer-management.co.uk), the Deer Commission for Scotland and Scottish Natural Heritage (SNH) has the most effective means of achieving sustainable management of wild deer populations throughout Scotland. The aims of the collaboration are to achieve high standards of deer welfare; play a constructive role in the stewardship of natural habitats; and contribute to the local rural economy and employment.

DMGs are becoming involved in the development of Deer Management Plans, Best Practice, and are increasing the uptake in training through the Deer Stalking Certificate and other qualifications, and are bringing increasing professionalism and discipline to the management of wild deer.

Deer Management Plans

As part of the overall process of improving deer management within Deer Management Groups, and in order to take account of all of the desires and objectives of the range of stakeholders involved in setting targets and actions, the ADMG (in collaboration with the DCS) developed guidelines for Deer Management Plans which have now been implemented at a range of scales from National Parks, through DMGs and individual estates (www.dcs.gov.uk/BestPractice/gp_dplanning.htm). Along with helping to set objectives and the actions required to meet these objectives, the DMP also sets in place a framework for monitoring and reporting achievements against these objectives. The DMPs incorporate the management of deer for population performance and habitat/agricultural/silvicultural impacts; the latter may include fencing or diversionary feed as management tools and not just culling. The monitoring can be based on censuses, information from culling operations, and measuring impacts of sensitive vegetation communities or on agriculture or silviculture. If, as is desirable, the monitoring is done within the DMG, rather than by external bodies such as DCS, Scottish Natural Heritage or Forestry Enterprise, then the DMG can have ownership of the issue and the responses of the system to the management interventions. This will, however, require the

development of tools and methodologies that allow DMGs to implement their own monitoring schemes in a way that meets the scientific rigor necessary for reporting, but in a cost effective manner.

Research

Scotland has a long history of research on red deer, starting with the ground-breaking work of Fraser Darling and the establishment of long term research on deer behaviour, ecology and management on the east and west of the Great Glen (Darling 1937). In Fraser Darling's book, *A Herd of Red Deer*, it is clear what a harsh environment the Highlands of Scotland are for both the red deer and the researcher. Research on red deer on the Isle of Rum, which started in the early 1970s and focused on individual life history responses to changes in deer density, has shown that, because of competition for food in the winter, the high densities of deer leds to poor individual and population performance with lower reproductive success of females, poorer survival of the calves born, high stag mortality and poorer quality trophies of adult males (Clutton-Brock, Albon and Guinness 1982). The scientific community, therefore, advised the Deer Commission for Scotland in the early 1990s that the deer population could be substantially reduced (eg Clutton-Brock and Lonergan 1994; Buckland *et al.* 1996) to the benefit of both the environment (SNH 1994) and the economic returns from trophy hunting. In effect, the environmentalists and the landowners could both meet their different objectives by reduced deer numbers.

This view ran directly counter to traditional views of deer management and initially the advice of the scientists was not taken on board by either the government's statutory organisation responsible for deer management or the estate owners. However, due to the persuasive use of computer based scenario generation models by the scientists, combined with strong pressure from the environmental lobby, there has been a change in attitude of many landowners over the past eight years. In their 1998 Annual Report, for example, the Chairman of the Deer Commission for Scotland exhorted landowners to reduce their deer numbers to benefit their own economic goals.

More recently, computer modeling (eg Buckland *et al.* 1996) and studies of the ranging behaviour of deer using satellite tracking technology (Sibbald *et al.* 2001) have demonstrated the necessity for deer managers to cooperate in the management of deer populations that span a number of land holdings. This strengthens the need for effective Deer Management Groups (DMGs), which bring together the landowner, land managers and interest bodies, to be put in place and supported.

Census techniques

Historically, Scottish red deer have been censused by teams of individuals attempting total population counts from vantage points during the winter, when the deer are relatively easy to discriminate from the background. The RDC, and subsequently the DCS, has been the statuary organisation responsible for this and, because of the large labour force required and the large tracts of land to be covered, the approach has been to split Scotland into a set of about 33 counting blocks. Each counting block can be counted by a group of counters over a period of about two to three days, and counting blocks were censused on average every seven years. This limits the value of the information for the assessment of the responses of deer populations to management. As such, there needs to be either an increased investment in the DCS censusing team to increase the frequency of counts on particular blocks; however, there is also a need to get the DMGs to conduct their own counts of deer. For this to be effective there will need to be training given by the DCS to the DMG to ensure a standardised method is applied and the statistical rigor of the approach needs to be assessed by statisticians so that meaningful changes in population number/composition can be determined (Trenkel 1997; Marques *et al.* 2001).

Rapid Habitat Assessment

The change in remit of the DCS to include the protection of biodiversity was only one step in the process of trying to establish workable systems whereby red deer populations could be controlled sufficiently to allow the Action Plan targets for these habitats to be met. In Scotland,

the concurrent development of rapid habitat impact assessment techniques, using both ecological and statistical expertise, has now produced a sound, *affordable* ecological tool for land managers to assess the degree of impact of large herbivores on all the habitats present (Brewer *et al.* 2004). The next challenge for the applied ecologists is not just to focus on densities, but to develop an understanding of how differences in spatial pattern of habitat mixtures interact with red deer densities and population dynamics to drive vegetation change in different areas, in both the short and longer term (Palmer *et al.* 2003, 2004). This will help provide managers with advice about how to manage deer populations for local impacts rather than managing the deer at the scale of the management unit.

Modeling deer management scenarios

HillDeer is a computer-based decision support tool designed to help staff of the Deer Commission of Scotland provide advice to Deer Management Groups and individual (Buckland *et al.* 1998) estates on the numbers of red deer that can support the sustainable use of the open hill deer forest areas of Scotland. From information on the current numbers of red deer and their larder weights, and the areas of the most common vegetation types and their current status, HillDeer predicts the impacts of culling regimes on the future numbers and performance of populations of red deer, and their effect on the status and proportions of the different vegetation communities.

The background to the development of HillDeer was the identification by The Association of Deer Management Groups with the then RDC that there was a need to develop a tool to assist in the process of developing Management Plans for each Deer Group. Such plans require explicitly derived information on what the sustainable numbers of deer are for a Group area and a culling policy that allows that objective to be achieved. Sustainable use was considered to involve maintaining the same amounts of the most important vegetation types in an appropriate state and providing desired deer performance.

HillDeer uses a small number of inputs as information. These include: the geographical identification of the area; the area of each of the six main vegetation types, which information can be obtained from the Land Cover of Scotland dataset; the status of the vegetation, obtained from a brief field survey; the most recent counts of stags and hinds, which are now done by most Groups and estates annually; and the larder weights of hinds and stags, which are also recorded annually. Information is also required on the numbers of sheep and estimates of rabbit numbers as they influence the impact of grazing on the vegetation. The degree of disturbance of red deer populations by man is also taken into account as that may influence the vegetation types grazed. Finally the amount of supplementary feeding of stags in winter is required as this can influence the vegetation grazed and the weight of stags.

This information is then used by the software program to predict the amount of vegetation that is produced by each vegetation type, which vegetation types are grazed by red deer, and what the amount of vegetation removed is, as this influences its productivity and its long-term nature. The productivity of hinds and stags is then predicted. On the basis of this information and information on the counts of red deer and larder weights in previous years, the size of the red deer herd is predicted. The more information that is available on counts, the more accurate will be simulations of future populations. By using different culling rates the effects on population size and performance can be predicted over periods of time up to 20-30 years ahead.

Although a large amount of information about the changes in the deer population and the vegetation can be viewed, the key information of value to managers of deer populations concerns the changes in the numbers of hinds and in the vegetation.

HillDeer is being used by staff of the Deer Commission for Scotland to facilitate decision making about the appropriate size of their red deer population in relation to the objectives that they and other bodies set, and what culling strategy that they need to adopt to achieve their target populations. In conjunction with a Rapid Habitat Assessment methodology being developed for Scottish Natural Heritage and the Deer Commission for Scotland by the Macaulay Land Use Research Institute, HillDeer assists in encouraging the grazing of Scotland's hill areas in a manner that will allow conservation objectives to be met.

The population dynamics model was designed to run at the level of the deer Management Group, as immigration and emigration are not included in the model (Trenkel 2001). This limits the population dynamics component of HillDeer when being run at the estate level, as it is in this

case. The habitat model, on the other hand, can be run at any scale of management unit, as it predicts the consequences of a given level of grazing pressure by deer roaming on a piece of ground. The only limitation for using the habitat component of HillDeer for this particular exercise is if there is large seasonal migration of deer onto or off a piece of ground which is not related to the vegetation composition of the piece of ground.

A number of deer management options are presented, based on results generated by HillDeer, using the following information relating to individual DMGs:

- geographic identification of the site;
- areas of different vegetation types;
- current status of vegetation;
- counts of stags and hinds;
- culling information;
- approximate larder weights of deer.

From this information the following questions can be answered:

- What is the sustainable deer carrying capacity of the area under different management options?
- What is the long term effect of current deer numbers on the hill vegetation?
- What are the implications of a change in culling policy?
- What will happen to deer performance and behaviour if an area is afforested?
- What will the effect of different management options on the cull of different age/sex classes of animals?

Figure 1: Effective deer management relies on the fusion of information into a Deer Management Plan that is owned by all of those who the management affects.

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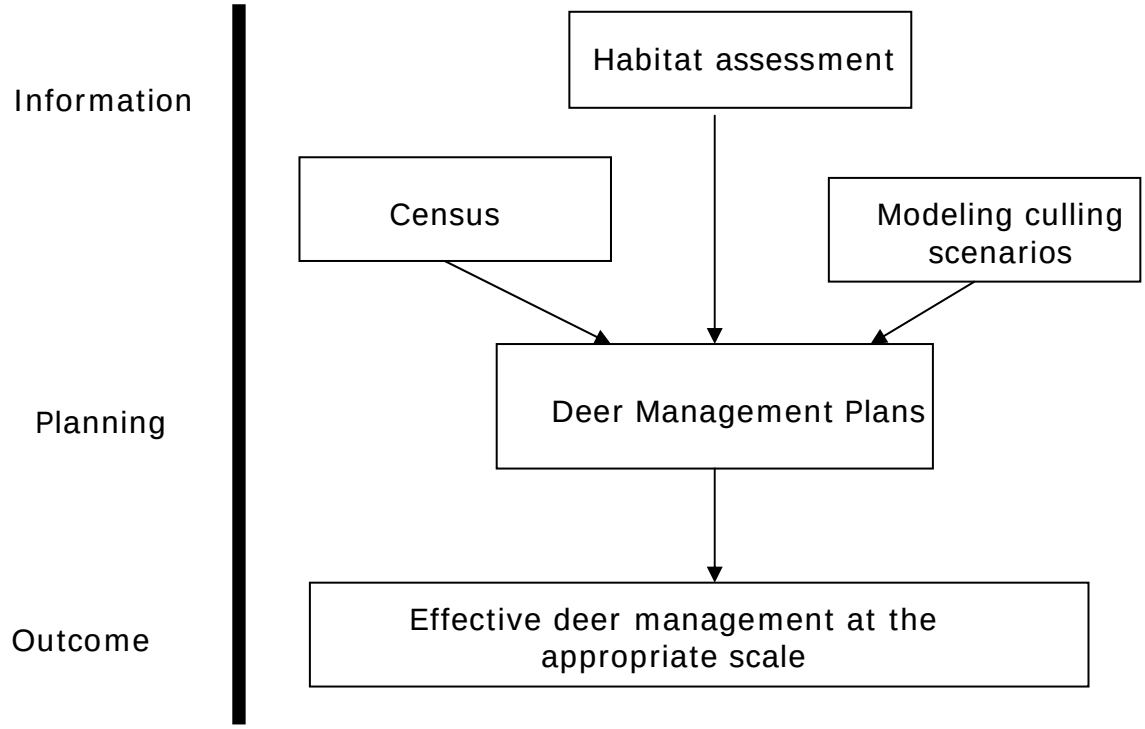

Conclusions

Red deer management in Scotland shows how science can be used to help resolve conflicting approaches to deer management in a society that is changing its management goals. Deer Management Groups are the way forward for collaborative deer management, which takes into account the fact that deer range over a number of holdings and that a broad range of participants are now involved, or at least interested, in the ways which deer are managed. Whilst no formal analyses have been conducted, the Scottish experience seems to suggest that the most effective DMGs have a strong chairperson and secretary and/or an executive

committee. The active participation of the majority of members of the DMG in drawing up deer management plans is also a prerequisite for effective participatory involvement in deer management. This indicates that, in the future, more research will be needed on the process of development and implementation of deer management to inform further development of effective collaborative deer management.

As highlighted above, a range of inputs is required for the development of effective deer management plans (Figure 1). This includes information on the current resource, such as deer numbers and distribution, the ability to model scenarios that allow the deer managers to assess the consequences of deer culling operations for deer numbers, herd composition and impacts on the natural environment, and provides tools for managers to monitor the outcomes of their actions. In my view the future of deer management will require much closer cooperation between the managers and scientists than has hitherto been the case.

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What can Australia learn from deer management overseas?

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Introduction

Of the 18 species of deer introduced into Australia only six species survive in the wild (Department of Natural Resources and Mines, Brisbane 2005). Most of these are still expanding their range via natural dispersal or by escapes from farms and releases (Moriarty 2004). It is unclear whether this is a growing problem for native species and ecosystems or for agricultural production, but in any event there are major legislative differences between states on the legal status of deer, and policy conflict within some states on how to manage current deer populations and their ongoing spread.

Some Australian deer managers are looking overseas for models for managing their deer (eg Hall and Gill 2005). In this paper I give some opinions on the question as to whether reliance on policy and management systems used in other countries, either where deer are native or where they are exotic species, will result in suboptimal management in Australia. In other words, what will Australian managers have to learn for themselves?

National and state policy

If deer were not present in Australia would current policy permit their introduction and release into the wild? All species of cervid in Australia are currently listed as category 3b (animals that may be kept for various purposes but under an appropriate permit) and as 'extreme' or 'serious' threat categories (ie their dispersal should be limited) in the Vertebrate Pest Committee's Guidelines for the Entry, Movement and Keeping of Exotic Animals. One deer species, rusa deer (*Cervus timorensis*), which is already in Australia, has been assessed under the new risk assessment process (Bomford 2003) that confirms the original VPC categorisation (W Kirkpatrick, pers comm). A species not in Australia, sika deer (*Cervus nippon*), is currently being proposed for removal from the permitted live import list maintained under the *Environment Protection and Biodiversity Conservation Act 1999* (T Stefani, pers comm). Thus, in retrospect, the Commonwealth would presumably not have permitted any importation of deer and might eradicate wild deer from Australia if it could.

However, that is clearly neither technically possible (Bomford and O'Brien 1995) nor legally (and socially) possible, given some state legislation. The current state and territory legislation on deer gives them various statuses, from partial protection in Tasmania, to game animals in Victoria and New South Wales, to declared pests in the other states.

The manageable questions then become:

- Where do Australians want to have wild deer and where do they not?
- What density is wanted at places where deer are wanted or present?
- Who should harvest or cull the populations to achieve the desired densities?

The first of these questions is similar to that posed for exotic animals in countries such as New Zealand (Parkes and Murphy 2003). Basically, biodiversity managers do not want established exotic species to spread further in the wild. In contrast, the question is only asked at a trivial level in countries where deer are native – Americans generally want native deer everywhere they used to be, so long as they don't cause a nuisance.

The second question is superficially common to countries where deer are native, as well as to those where they are not, but differs at the policy level. Where deer are not native (and sometimes where they are but have adverse impacts) the aim is to hold deer below some density. Where deer are a resource to be utilised (usually where they are native) the aim is to sustain a harvest, which may be the maximum sustained yield from a population at about 50 percent plus of carrying capacity. It may also be a smaller harvest of trophy animals usually

from some lower density where animals are in optimal condition and produce the best antlers (Caughley and Sinclair 1994). The exotic rusa deer in New Caledonia are the main source of protein for Kanak people, who presumably require high densities to ensure easy harvests, although such densities are a cause for concern amongst conservation groups (de Garine-Wichatitsky *et al.* 2005). Where deer are a protected species the aim is to have populations with no harvests, ie at carrying capacity.

The third question, who should harvest or cull the deer, is a political and social question common to all deer management.

Where should deer be allowed?

Deer in Australia would eventually spread naturally to all areas of suitable habitat contiguous with their present range and to most others not so located with the aid of humans. How to stop natural and human assisted spread is not addressed here, other than to discuss the management of farmed deer and farm escapes as one mechanism of spread.

Some Australian states have legal instruments in place that limit deer farming (eg deer are a prohibited entrant in the Northern Territory), or they could do so using amendments to similar laws to manage farming of other ungulates, such as goats, that are proscribed in some areas in South Australia and Western Australia (Department of the Environment and Heritage, Victoria 2004). Similarly, deer farming is forbidden in a few areas in New Zealand where wild deer do not exist (Fraser *et al.* 2003).

Nevertheless, deer are often farmed in areas where no wild populations exist and here present a real risk when they escape. In New Zealand, a study was made of the causes of escapes from deer farms and on the effort required to remove such recent populations (Fraser *et al.* 2003). The process of identifying causes, and therefore the balance between investing in proactive (eg enforcing fencing standards) or reactive (eg surveillance and prompt control) management, has some lessons for Australia. The summary of the New Zealand results is noted in Table 1.

Table 1. Results of a survey of farmed deer escapes in New Zealand from Northland and Taranaki regions (data combined) during 1993–1999 (after Fraser *et al.* 2003).

Parameter	**N**
Number of farms	58
Number of deer	12 520
Number of escape events	27
% of farms reporting at least 1, 2 or 3 escape events	25.9, 15.5, and 5.2%
Mean number of deer escaping per event	13 (range 1–270)
% of times all deer were recaptured and repenned	85%
Cause of escapes of 33 events where this was known: 1. Human error: gates left open 2. Human error: escaped during handling 3. Acts of God: eg storm damage to fences 4. Inadequate fences: jumped intact fence	 30.3% 6.1% 30.3% 33.3%

With these limited data (and assuming the ability to recapture or deal with escapees is the same for all causes) it seems managers should allocate 67 percent of their resources to reactive management (to deal with causes 1–3 that are inevitable despite good husbandry) and the rest to proactive management (eg by improving fencing standards).

Managing for target densities versus managing for target harvests

Of course having the same target density for all deer populations is not some national imperative – managers can target any density from zero to K depending on the goals identified for the site or region. Goals can range from the 'political', eg some areas reserved for conservation might proscribe all exotic species so deer would be held as near zero as possible, or other sites might be allocated for hunters and deer held at higher densities to sustain recreational harvests. In practice, deer in some sites in national parks in Australia (eg hog deer (*Axis porcinus*) in Wilsons Promontory National Park) are not hunted or culled (presumably

because all hunting is banned in national parks) and are held at carrying capacity, which to an outsider seems an odd practice.

Where some rational, evidence based process is used to determine the target densities for deer based on their impacts on native flora and fauna or on damage to crops and competition with livestock, a question is whether Australia can learn from other countries? My opinion is that Australians will have to do their own research to answer this question.

Deer impacts in New Zealand forests are unlikely to be exactly replicated in Australian forests because the relationship between deer densities and forest understorey biomass and composition is dependent on the buffering effect of palatable food falling from the forest canopy (Nugent *et al.* 2001). Basically, all accessible understorey plants that are more palatable than canopy leaf-fall are eaten across a wide range of deer densities, and it is not until very low densities are reached that any significant regeneration of highly preferred species occurs. This also means that deer can remain at higher densities than would be permitted by the food source with which they have a direct interaction (accessible understorey plants) – at least in the medium term. It is unclear whether deer in Australia eat fallen canopy leaves – mostly eucalypts – at all, and so it is more likely that the deer density/food resource relationship is direct and more linear; whether it is interactive is unknown.

Deer impacts in deciduous or coniferous North American and European forests that have evolved with several sympatric ungulates and predators are also not likely to be relevant to Australian situations.

Who should harvest or cull?

It is clear that the Tasmanian approach to deer hunting, based as it is on private access to the resource and fee paying hunters, is an echo of the Texan hunting paradigm, where almost no land is in public ownership. One question Australians must answer is whether this paradigm is suitable in all states and on public tenures in all states. The answer to that depends in part on whether such hunters can reduce and hold deer densities at the desired levels.

In New Zealand, all wild deer remain the property of the Crown until legally taken, and legality depends on a hunter having permission of the landowner. The largest landowner is the Crown itself through the Department of Conservation (DOC), which manages over 30 percent of the country. Fortunately for New Zealand hunters, DOC sees deer as a pest and encourages hunting. However, this 'legally taken' rule has also given de facto property rights to private landowners, and many restrict hunting if they can. Many New Zealand hunters see access to hunting as a right and object to (and sometimes ignore) attempts to stop access either by harvesting rules or by restrictive rights. Despite this large recreational harvest of deer (circa 70 000 deer were shot by recreational hunters in 1988; Nugent 1992), recreational hunters could not reduce the New Zealand deer populations sufficiently to achieve conservation goals except in easily accessible areas with low forest cover, and they are still incapable of achieving the very low deer densites required in many forest ecosystems to allow palatable plants to regenerate (Nugent *et al.* 2001).

In the past, the state also culled huge numbers of deer (Nugent and Fraser 2005), but it was not until the advent of effective aerial hunting for game meat in the late 1960s that deer densities were reduced sufficient to achieve many of the government's conservation goals, especially for red deer in their preferred alpine grassland habitats (Parkes in press). As an aside, this commercial harvest is extremely price sensitive and for that (and other reasons) has recently collapsed so that deer are again venturing back into their preferred habitats and doubtless increasing in numbers (Parkes in press).

In summary, recreational hunters in New Zealand, with few restrictions on where they can kill deer and none on how many they can kill, have not been able to reduce deer densities enough to satisfy conservation land managers. Australian states have a more restrictive approach to access to hunting that has grown out of their particular legislative histories, no commercial hunting industry, and little official culling. Some or all parts of this ability to kill deer will have to be developed (from legislation to policy to practice) if Australian land managers and land management regulators are to have the tools to set and achieve target densities for their deer populations.

Conclusions

Australians cannot merely copy overseas deer management systems and should not in general even follow the policy systems used in countries where deer are native species. Policy approaches in countries where deer are not native, such as New Zealand, are more appropriate, although most Australian states have historical legislative baggage (more appropriate to European landowning systems) that they would have to resolve or circumvent to achieve optimal biological outcomes.

The Tasmanian approach may well be appropriate for deer on private land, where the owner can balance any production cost (and ignore any loss of biodiversity values) from the presence of deer against the income from selling hunting rights. I note that in Tasmania they are managing fallow deer (*Dama dama*), which have very low rates of dispersal (Caughley 1963) and so are less likely to cause external costs to neighbours who do not want deer. However, in my opinion this approach is inappropriate for public land, especially the conservation estate, because restricted hunting access is highly unlikely to achieve the lower deer densities that may be desired by conservation managers. The range of achievable target densities are my guess in the absence of any information on deer impacts, but since free access recreational hunting in New Zealand seldom achieved conservation managers' goals, it seems unlikely that restricted access hunting would do so; a point to be tested in Australia. However, given that all hunting access is denied on some conservation estates in some states, hunters might well ask for access on the principle that even if they provide no conservation benefit from their hunting, at least they would do no harm.

One process that Australian managers might copy is to survey the causes of escaping farmed deer as one step in improving the ability to stop deer spreading in the wild.

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Rusa deer (*Cervus timorensis*) in New Caledonia: overview of current research and management perspectives

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Introduction

Rusa deer (*Cervus timorensis*), were introduced to the main island of Grande Terre (New Caledonia, South Pacific) during the 1870s. The deer (estimated to be 12 individuals) were imported from the island of Java, Indonesia (Chardonnet 1988). The population reached an estimated 220 000 animals before the Second World War, and is currently thought to number over 110 000 (Chardonnet 1988). Today, rusa deer are widespread in the 'Grande Terre', where they represent an important food resource for both Melanesian and European people, but also a potential threat for the conservation of its biodiversity (de Garine-Wichatitsky *et al.* 2005a). This paper provides a brief overview of the research activities carried out on rusa deer in New Caledonia, with emphasis on their ecological and sociological impacts and on the management perspectives.

Overview of research activities

Deer farming

Until the late 1990s most research work carried out on rusa deer in New Caledonia aimed at providing information to improve deer farming (see synthesis in Le Bel *et al.* 1999b). Since the 1980s, the deer farming industry has slowly but steadily increased its activity. In 2004, slightly more than 30 deer farms (mainly in Southern Province) have produced 256 tonnes of deer meat representing 106 M CFP (DAVAR 2005). The commercial production is currently limited to venison (exported to the EU), although exports of live animals to Asian countries occured in the past (Le Bel 1993), and velvet production has also been considered (Le Bel 1998).

Nutritional importance of deer meat

Venison represents a major source of animal protein for New Caledonians, especially for rural populations (de Garine 2002). Large scale nutritional surveys have not been carried out to estimate precisely the consumption of deer meat, but local surveys revealed that it ranks amongst the most frequently consumed food of animal origin: 60 percent of the adult males kanaks (Melanesian origin) and 47 percent of the adult males caldoches (European origin) interviewed by de Garine (2002) in the Pouembout area (Province Nord) had consumed deer during their last meal; as had 30 percent of the children from two kanak tribes (Hienghène and Pouembout, Province Nord) interviewed in March 2005 by de Garine-Wichatitsky *et al.* (unpublished data). Urban populations apparently consume deer meat less frequently, but it is noteworthy that venison seems to be equally important for both kanak and caldoche rural communities (de Garine 2002). Although there are no reliable statistics, it is clear that the great majority of deer meat consumed in New Caledonia is from hunted deer, either legally or illegally (''poaching'' refers to hunting on private estates without the owners' consent and/or nightshooting with spotlight), and farmed deer only represent a minor proportion of the total amount of deer meat sold (< 15 percent according to Baudonnel 1999).

Sociocultural importance of deer

Meat provision is the main motivation of deer hunters, but the social, recreational and educative importance of game hunting (ie introduced rusa deer, wild pig (*Sus scrofa*), and endemic 'notou' (*Ducula goliath*) and flying foxes (*Pteropus spp*)) should not be underestimated. Hunting is a very prestige enhancing activity in both the Melanesian and the European communities (de Garine and de Garine-Wichatitsky 2006). It is also a major social and recreational activity for

adult men. A survey by de Garine (2002) in the rural areas of Pouembout (Province Nord) and Poya (Province Sud) revealed that over 50 percent of adult men (hunters) hunt deer every weekend on average (10 percent of deer hunters living in the urban area of Nouméa; DRN Province Sud, Nouméa 2000). Hunting also plays an important role in the education of New Caledonian children and represents a major component of the discovery of their natural environment. During preliminary surveys in primary schools of Hienghène and Pouembout (Province Nord), 76 percent of the children (5-8 years old) interviewed had a positive perception of hunting, and 42 percent of them had already been involved in deer hunting activities with adults (de Garine-Wichatitsky *et al.* unpublished data).

Deer ecology and impacts

Since 1998, several studies of the ecology of wild rusa deer have been carried out (de Garine-Wichatitsky 2003b; de Garine-Wichatitsky *et al.* 2004b; Le Bel *et al.* 1999a). Radiotracking studies in savanna/sclerophyll forests of the west coast of Grande Terre (de Garine-Wichatitsky 2003a; Le Bel *et al.* 1999a) showed a remarkable site fidelity of does, limited seasonal movements (except males during the rut) despite significant decrease of forage resources during the dry season, and gave an estimated annual home range of approximately 500 ha (Spaggiari and de Garine-Wichatitsky 2006). The diets of rusa deer in New-Caledonia comprise a large number of plant species and plant types, including grass, forbs, shrubs, trees and vines (de Garine-Wichatitsky *et al.* 2003). Rumen content analysis of deer from two sites of native forests (sclerophyll forest and rainforest) showed that deer consumed approximately 60 species (de Garine-Wichatitsky *et al.* 2005c), although it is estimated that the total number of species (especially endemic) consumed by deer in the rainforest is much higher.

The indirect impacts of rusa deer on native ecosystems (eg nutrient cycles, perturbation regime, etc) have not been investigated, but studies on the direct effects of rusa deer (plant consumption, fraying) revealed major impacts, especially on threatened native sclerophyll forests (Bouchet *et al.* 1995). Browse surveys in 12 sites of sclerophyll forests suggested that more than 100 plant species (for a total of 179 species identified) were consumed by introduced ruminants (mainly rusa deer) (de Garine-Wichatitsky *et al.* 2004b). Rusa deer represented a direct threat of local or global extinction for at least 13 plant species listed by the IUCN redlist (de Garine-Wichatitsky *et al.* 2004b; de Garine-Wichatitsky unpublished data). In addition, the interactions between rusa deer and introduced invasive weeds are complex, and the results of deer control/eradication could result in unexpected consequences for biodiversity conservation (de Garine-Wichatitsky and Spaggiari 2003). In sclerophyll forests, high deer densities are associated with a high frequency of invasive weeds (de Garine-Wichatitsky *et al.* 2004b), possibly as a consequence of reduced competition with native deer sensitive plants, and germination tests from deer faeces suggest that rusa deer can actively disseminate several introduced species of graminoids (de Garine-Wichatitsky *et al.* unpublished data). However, browse surveys and exclosures also suggest that rusa deer can contribute to the control of major invasive weeds, such as *Passiflora suberosa* (de Garine-Wichatitsky and Spaggiari 2003; de Garine-Wichatitsky *et al.* 2004b). With the exception of sclerophyll forests, there is no detailed information on the impacts of rusa deer on other native ecosystems of New Caledonia (rainforest, maquis), but it is suspected that they represent a potential threat for biodiversity conservation, at least in rainforests (de Garine-Wichatitsky 2003b; de Garine-Wichatitsky *et al.* 2005c).

Monitoring tools

A crucial step for the success of ungulate management plans is the design and implementation of monitoring tools that allow an objective assessment of the efficiency of the control operations. Nocturnal line transect using spotlight counts of deer from a 4×4 vehicle was used by Le Bel *et al.* (1999a) on a private property of the west coast, but population estimates were highly variable and the method was not considered reliable for most forested or rugged terrain in which wild rusa deer live. Deer census was deemed not suitable as a management tool for rusa deer in New Caledonia, and the feasibility of indexes of population trends and bio-indicators (see review by Groupe-Chevreuil (1999) for Roe deer *Capreolus capreolus* in France) has been investigated (de Garine-Wichatitsky and Saint-Andrieux 2003).

Several parameters related to deer density and impacts have been measured annually for the past three years on two experimental sites of sclerophyll forests (de Garine-Wichatitsky *et al.* 2004a) to monitor rusa deer population trends (kilometric index of abundance derived from

Vincent *et al.* 1991; faecal pellet counts, ''standing crop'' procedure derived from Mayle *et al.* 1999) and impacts (browse surveys similar to Guibert 1997). Improvements of the recording procedure using smaller plots (3.1 m^2 vs 40.0 m^2) and a modified sampling design (plots along transects vs systematic grid) are currently being investigated across five sites of sclerophyll forest where deer densities have been estimated using line transect or total counts in exclosures (Roques-Rogery and de Garine-Wichatitsky, unpublished data). Simulations of the accuracy (CV) of faecal pellet counts according to the number of plots/transects sampled will be assessed using a procedure similar to Forsyth *et al.* (submitted; see also the presentation by D Forsyth during this workshop). Browsing scars on selected woody species were also recorded on the same plots to calculate a browsing index (see Morellet *et al.* 2001). This procedure allows the calculation of a confidence interval for this index of deer impacts, and simulations will also be performed to assess the variations of this index according to the number of plots/transects sampled.

The implementation of management plans of rusa deer populations negotiated with stakeholders on two experimental sites of sclerophyll forests outlined several practical questions (de Garine-Wichatitsky *et al.* 2005b). Annual variations of the kilometric index of abundance and faecal pellet counts are used to monitor deer population trends, and the recording procedures are simple enough to allow the active participation of stakeholders in data collection, after minimal training (wildlife technicians of Programme de Conservation des Forêts Sèches, Province Sud and Province Nord as well as hunters participated in the recording of kilometric index in 2005). However, the main goal (for conservation stakeholders) of deer management plans is the reduction of the impacts on biodiversity. Browse surveys give an indication of the overall browsing pressure on woody plants, but it appeared that in some situations they did not accurately address the specific questions related to the plant species of conservation importance. Managers were concerned about the regeneration of these (often rare) species, and specific monitoring experiments using small exclosures (eg *Ochrosia inventorum*; de Garine-Wichatitsky *et al.* 2005b), were set up to provide quantitative data (eg recruitment; percentage survival of seedlings) as a basis for the negotiation of management goals between stakeholders.

Management perspectives

Conflicts between stakeholders' interests

The management of wild deer populations in New Caledonia is the subject of strong debate. There seems to be a general agreement that deer populations on Grande Terre have increased over the past decades (DRN Province Sud, Nouméa 2000; de Garine 2002; de Garine-Wichatitsky and Dauré unpublished data), although this statement is not based on robust scientific data, and there are apparently large discrepancies between localities. Rusa deer are perceived as an increasing problem for agricultural and forestry productions (competition with cattle for pastures, crop raiding, browsing of forestry plantations), and for biodiversity conservation (impacts on endemic plants and invertebrates, restoration of degraded native ecosystems). Wild populations of rusa deer are also considered as a resource by hunters (nutritional and recreational importance) and by deer farmers (capture and ''embouche'' in deer farms). There are thus very different views about the management goals of wild deer populations between stakeholders (services de l'environnement conservation programs and NGOs, hunters associations, kanak tribes, cattle and deer farmers, forestry and crop producers, research organisations), and between sites. In addition, access to hunting territories often results in conflicts between individuals or communities, but the origin of these conflicts is often linked to land tenure issues (eg Demmer in prep), which are particularly acute in the postcolonial context of New Caledonia.

The way forward: global policy and local actions

There is currently no general policy regarding the management of wild deer populations in New Caledonia, and deer control operations have been restricted to a few sites of conservation interest and to several farms, often as a result of private initiatives. An evaluation of wild deer populations at the scale of Grande Terre would be technically difficult and of little value for a management perspective. But information on the distribution of deer populations and their impacts would be of great value to identify priority areas for deer control in order to reduce their negative impacts on agricultural and forestry productions and on native ecosystems. At a local

scale, management plans of wild deer populations negotiated with local stakeholders should include the following steps: 1) define a management unit (deer population within administrative boundaries compatible with deer home ranges); 2) define long term and short term objectives (reduction of impacts) with stakeholders; 3) negotiate population control strategies (capture, shooting) and quotas with all stakeholders; 4) use relevant monitoring tools (deer population trends and impacts) and revise periodically hunting/capture quotas according to the progress made towards the objectives (reduction of impacts).

Conclusion

Despite significant progress over recent years, there are still some knowledge gaps in the understanding of the socio-economic and ecological importance of rusa deer in New Caledonia. These need to be addressed by research in order to set up efficient science based management plans (eg the relationship between impact levels and deer densities; characterise and quantify impacts of deer on native ecosystems other than sclerophyll forests). However, deer control operations should be developed and conducted with the existing knowledge. Also, the design of management plans using an adaptive management procedure should fill the gaps. Indeed, one of the first priorities to improve the management of wild deer populations in New Caledonia is probably not research, but there is a need to facilitate the communication between stakeholders and to set up priorities with wildlife managers and researchers. Following the line drawn by this Canberra workshop, we suggest that a similar meeting to address the question, ‘‘What are the issues for the management of deer in New Caledonia?’,’ should be organised in 2006 with all New Caledonian deer stakeholders.

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Participatory methods for enhancing deer management

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Introduction

There are many conflicting views concerning the value of wild deer as a resource. Deer can be perceived as a pest due to the damage they inflict on agricultural or forest crops, which can incur significant public or private financial costs (Verheyden *et al.* 2006). Over abundant deer populations may also cause damage to biodiversity, since their grazing or browsing can inhibit regeneration of native trees, and can also change the structure of the vegetation, having indirect consequences for other plants and animals occupying the same habitats (Gill andand Beardall 2001; Allombert *et al.* 2005). Yet, at the same time, some species of wild deer may be a component of native biodiversity and also a valuable financial resource, through venison and trophy hunting, both of which can provide jobs and profits for the economy (Milner *et al.* 2006). This wide range of benefits and costs, which are experienced to varying extents by different stakeholder groups, provide a considerable challenge for the effective management of deer in ways that embrace the diversity of stakeholder interests (Gordon *et al.* 2004; Hall and Gill 2005).

The challenge of management is further exacerbated by some uncertainties surrounding both deer and their impacts. The elusive nature of many deer species and the inaccuracies surrounding the techniques available for density estimation from dung counts mean that obtaining accurate assessments of population density is difficult. This makes the reliable detection of population change even more uncertain (Smart *et al.* 2004). Management to reduce impacts through the reduction of population densities is dependent on the assumption that there is a positive (and relatively linear) relationship between impact and density. However, the impact/density relationship for most deer species in most situations is not quantified, and the nature of the relationship is affected by environmental and habitat factors, as well as by interaction with other grazing herbivores, including other deer species, and domestic livestock. There are also frequent conflicts in the objectives of different stakeholder groups concerning deer management. Hunters will seek to maintain populations at sufficient levels to provide reliable shooting opportunities, whereas conservationists concerned with the impacts of deer on ground flora or tree regeneration will want to reduce densities to much lower levels. The adverse effects of deer in urban areas, specifically impacts on parks, gardens and road traffic accidents, have also led to increasing concern over rising population levels. In landscapes which are characterised by a mosaic of different habitat types or land uses, management problems are frequently exacerbated due to differences between the objectives of neighbouring landowners relating to deer management.

Since many stakeholder groups have specific objectives regarding the management of deer, these same groups may also have a wealth of informal knowledge and understanding concerning deer and their impacts in local areas. Because of the inaccuracies associated with formal scientific assessments of deer impacts and densities, and the time and labour required to gather the appropriate data, the combination of formal scientific knowledge with informal stakeholder knowledge is likely to be of benefit in increasing the overall knowledge base. Such a collaborative process may also bring other advantages in terms of management, since it could help to build mutual trust and understanding between scientists and deer managers, and also between different stakeholder groups. This collaboration is likely to bring benefits in terms of increased cooperation between stakeholders, leading to more effective and efficient deer management.

In this paper, we describe two methods by which stakeholder expertise can be incorporated with formal scientific knowledge to enhance understanding of deer and deer management. Firstly, we discuss how participatory GIS can be used to improve predictive maps of deer distribution and density. Secondly, we describe how traditional bio-economic models could be extended to include stakeholder knowledge within an interactive setting.

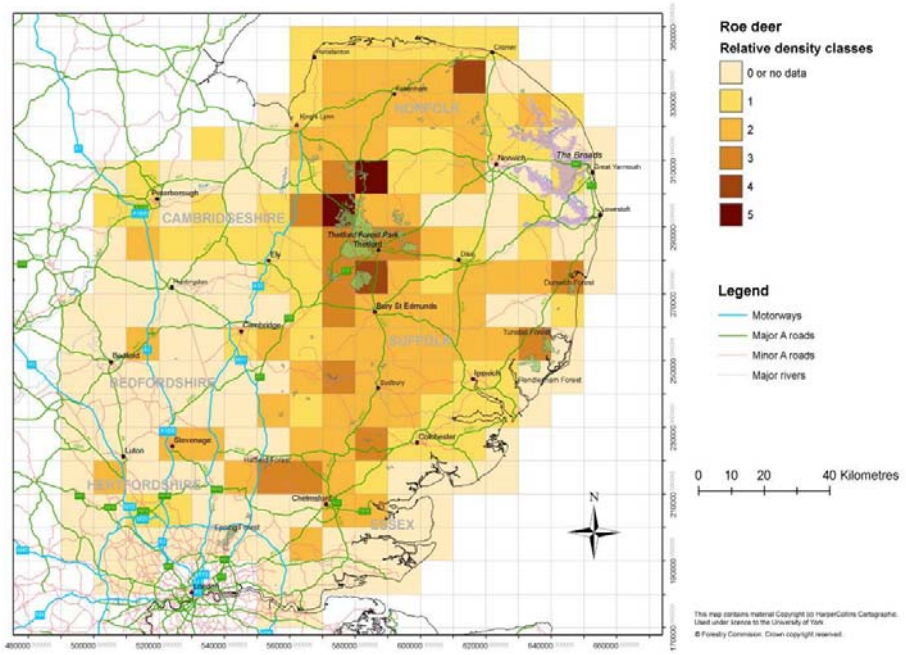
Participatory GIS

Participatory GIS (P-GIS) is a means of engaging stakeholders with formal scientific knowledge within a spatial map based setting (Abbot *et al.* 1998; Quan *et al.* 2001). It is therefore especially useful for considering patterns or processes that vary spatially. It has been used for examining patterns of pollution and their impacts on the human population (Cinderby and Forrester 2005), but it has not previously been applied in a wildlife context. We are currently using it as a means of incorporating informal expertise to improve estimates of deer density in the east of England (incorporating the counties of Norfolk, Suffolk, Essex, Hertfordshire, Cambridgeshire and Bedfordshire).

We have established a novel way of predicting deer densities based on indirect estimation from a regression model fitted to deer road traffic casualty data. In this method, we constructed a regression model to predict deer road traffic casualties at the ten km square resolution (10 x 10 km) in the east of England using various explanatory variables related to habitat and road traffic conditions. We then used only those explanatory variables that would be associated specifically with deer to predict relative deer densities across the region and calibrated these relative densities by species using known densities from specific locations within the region (White *et al.* 2004).

These maps can then be used as baseline predictions for the P-GIS exercise (Austin *et al.* 2006; Figure 1). Based around discussion of these maps, experts are asked questions, such as their overall rating of the quality of the density predictions, and whether they perceive any specific general landscapes or regions where the model may be over or under predicting densities. They are then asked to identify on the maps those areas with which they are particularly familiar or have specific knowledge. Within these areas, they are then asked to make any alterations they think necessary to the model predictions. The same process can also be used to examine their perceptions relating to areas where management conflicts occur or where deer management is relatively successful. The map of density predictions can then be refined based on the analysis of many expert responses, and an improved density map produced. Because this final map reflects both formal scientific knowledge and expert stakeholder perceptions, it is likely to be not only more accurate, but also far more acceptable to stakeholders as an aid to strategic deer management than a map which was produced by scientists in isolation.

Figure 1. Example map used for participatory GIS exercise, showing the relative densities of roe deer across the East of England.



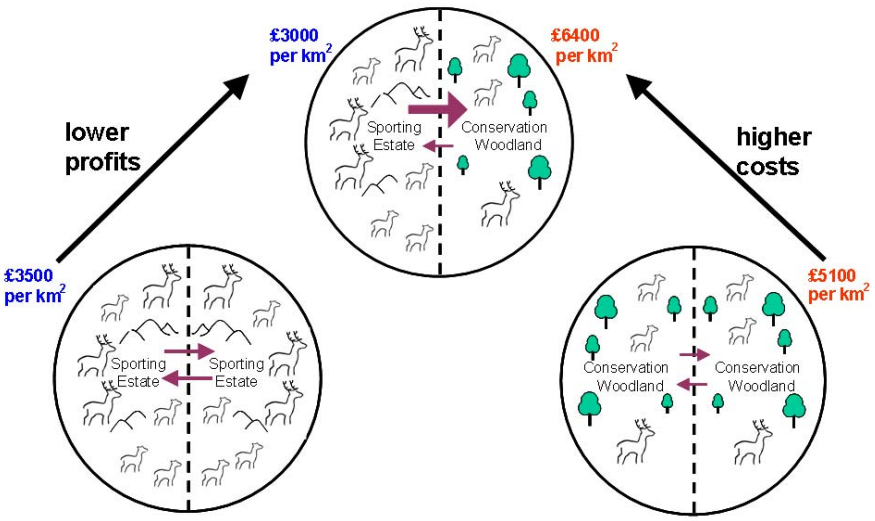
Bio-economic modeling

The perception by various stakeholders of deer as either a resource or a pest broadly determines their management objectives for deer. However, as discussed previously, this can result in conflicting objectives between neighbouring landowners. Management undertaken to fulfil these objectives can have significant adverse consequences for the various landowners; for example, reduced financial returns from hunting, reductions in public biodiversity benefits caused by reduced populations of native species, or the prevention of tree regeneration.

The interactions between population dynamics of wildlife and the financial consequences for management outcomes traditioopnally have been examined using bio-economic models (Clark 1990). Bio-economic models of deer management link the population effects of management interventions over time with their economic consequences. They can be used to examine the financial consequences of specific management actions and also to 'optimise' management over time with respect to specific objectives, whether these are in terms of maximising profits from hunting or maintaining the deer population below a certain threshold level that will allow regeneration of trees (Conrad and Clark 1987).

We have been using this approach to consider the indirect consequences of specific management objectives on neighbouring landowners (Smart *et al.* 2006). In Scotland, there is a tradition of managing red deer for hunting ('stalking') on many estates. Population levels are maintained at relatively high levels so that fee paying clients will be able to find deer to shoot, and specifically to ensure a large number of older stags, which have higher trophy value. These stalking estates sometimes border onto areas of the landscape that are being maintained for conservation purposes, often with the objective of enhancing the regeneration of native pine trees. Our analysis has shown that, compared with uniform landscapes of either stalking estates or conservation woodlands, the pursuit of contrasting objectives by neighbouring stakeholders within a mixed landscape of stalking estates and conservation woodlands, carries economic costs for both parties. Profits on the stalking estate are reduced and management costs for the conservation woodland are increased (Figure 2).

Figure 2. Management model illustrating the contrasting situations in deer management on two adjacent properties, showing total present valued profits (£ per km² in blue) and costs (£ per km² in red) accruing to each party over 25 years of management. Compared with uniform landscapes of either stalking estates (bottom left) or conservation woodlands (bottom right), the pursuit of contrasting objectives byneighbouring stakeholders within a mixed landscape of stalking estates and conservation woodlands (top centre) carries economic costs for both parties. Profits on the stalking estate are reduced and management costs for the conservation woodland are increased.



Bio-economic modeling used in this way can, therefore, identify the salient issues arising from management according to specific predefined objectives, which can be used to inform policy development and further research. However, it has certain shortcomings. It assumes that motivations for managements are consistent within stakeholder groups, that the objectives of all stakeholder groups can be expressed adequately in financial terms, and it ignores other motivations such as social, cultural or attitudinal constraints.

Currently, we are developing methods to overcome some of these shortcomings by extending the bio-economic modeling approach into an interactive setting with stakeholders. Using focus groups, the bio-economic model can be 'played out' with stakeholders. The stakeholders themselves can determine their management strategies, and the interactive setting allows them to observe the predicted consequences of these actions over time, both in terms of achieving their own long term management objectives, but also in terms of how their actions affect the ability of other stakeholders to meet their own objectives. This allows the overall impact of different management strategies to be elucidated across a number of properties at a landscape scale. The stakeholders can then develop alternative collaborative management strategies that may have minimal adverse consequences for them individually but could enhance the effectiveness of deer management overall, and may even reduce some of their individual management costs in the long-term. The use of bio-economic modeling in this type of interactive setting therefore has considerable potential to enhance understanding between different stakeholders, build collaborative approaches to management and enable stakeholders to approach management at a landscape scale in a more strategic and efficient manner.

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Wild deer in SE Queensland – graziers' pest or charismatic megafauna?

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The wild red deer herd in southeast Queensland

There are 16 000 to 20 000 wild red deer in the Brisbane and Mary River valleys of southeast Queensland. The population has existed in its present location for 130 years. It has been a recreational resource and social amenity (the Esk Shire logo includes the red deer) and was the source of the original stock used through the 1970s and 1980s in the establishment of a deer farming industry. Wild deer are used by recreational hunters, and provide an additional income stream for graziers. Several commercial safari hunters (guides) operate in the Brisbane and Mary River valleys, and members of recreational hunting clubs (eg the Australian Deer Association, RIDGE Inc.) hunt in the region.

On the other hand, some graziers and farmers, especially in the Crows Nest area, are concerned about a possible increase in the deer range, the predations of deer in orchards, and the possible role of deer in the transfer of cattle ticks. Local authorities have expressed concern at the encroachment of wild deer into peri-urban areas of Toowoomba and Brisbane. Deer have been reported in the gardens and roads of some western Brisbane suburbs.

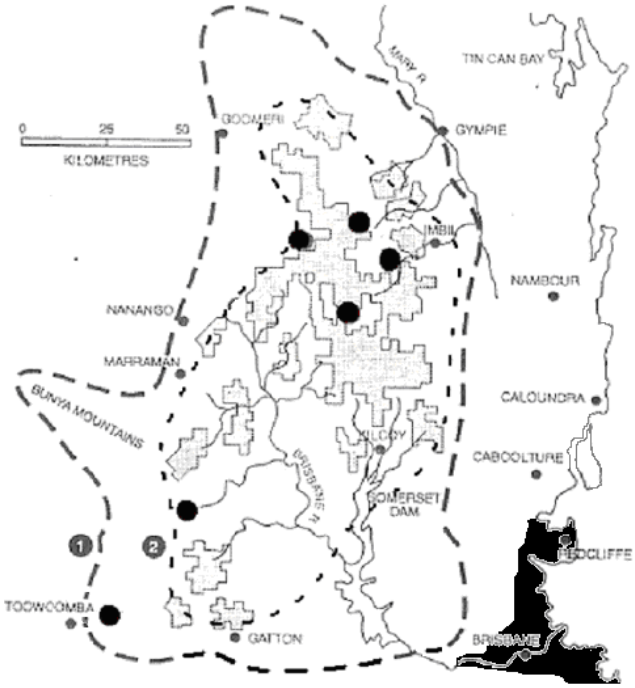
These conflicting aspects of the red deer herd make its presence controversial and the subject of conflicting views, sometimes vociferously stated. This paper reviews the available data on the herd's location, size and structure, its capacity for growth, and its possible effects on the local beef cattle and safari hunting industries.

Wild deer may adversely affect beef cattle production by acting as a disease reservoir – especially as a vector in the spread of cattle ticks, and by competing with cattle for food. They potentially may cause nuisance in more intensively farmed and densely populated areas. Thus, we need to know:

1. Where are the wild red deer and how many are there?
2. Is the population likely to continue growing?
3. Are they likely to carry cattle ticks and infest 'clean' areas; are they possible reservoirs of other diseases?
4. Do they compete with cattle for feed; are they likely to control or spread weeds?

In 1999 and 2000 a series of studies of the tick burdens, herd composition, health and reproduction rate, and diet composition of wild red deer was carried out at five sites in the Brisbane River valley (Finch 1999 2000; Dryden and Finch 2002), and a study of nutritional status was made at a sixth site near Toowoomba in 2003 (Finch 2003). An aerial count of deer was made in the first five locations in 2001.

Figure 1: Location of wild red deer in southeast Queensland (① presumed outer limits of the existing range, ② area with the greatest concentration of wild deer). The six study sites are indicated (●).



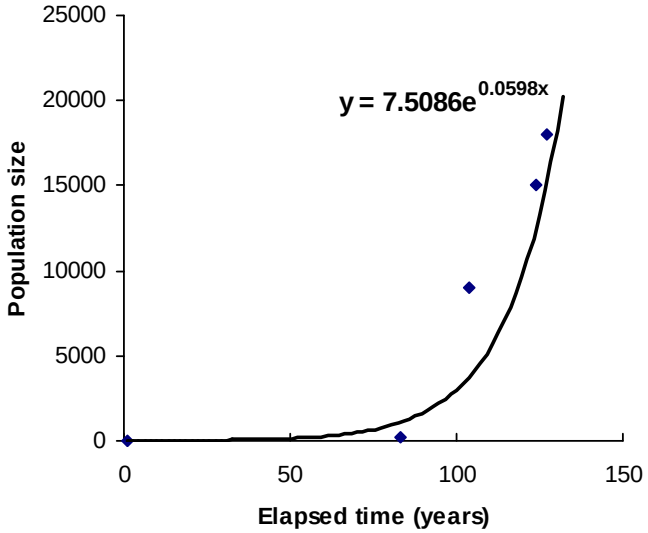
The size and location of the wild deer population in southeast Queensland

Twelve red deer were released in 1873/4 at Cressbrook, near Toogoolawah, in the Brisbane River valley. Two hundred and ten deer were sighted in 1956/7 (Roff 1960). The population was estimated to be 8000 to 10 000 in the 1970s (QNPWS estimate cited by Williamson *et al.* 1984), and was thought to have increased to about 15 000 in 1998 (ADA estimate cited by Finch 2003). The current herd size is not known exactly, but there are probably 16 000 to 20 000 animals in the central area indicated by (1) on the map in Figure 1, based on the aerial survey carried out by RIDGE Inc. in 2001.

The herd is located largely in the upper Brisbane and Mary Valleys (Figure 1; redrawn from McGhie and Watson 1995). The central area of about 750 000 ha is bordered by the Warrego Highway in the south, and stretches east to Somerset Dam and the Conondale Ranges, north along the Mary River to the Coast Range, and west to Yarraman and Cressbrook Creek. The density of deer in this central region is about one animal to 35 to 45 hectares. This is essentially the area described by Roff (1960) as being the wild red deer range at that time.

Concurrent with an increase in population size has been a spread of animals out of the Brisbane River valley into surrounding areas, mainly to the north, west and south. The boundaries of the present range of about 1500 000 ha (McGhie and Watson 1995) include an area north of Goomeri, the Bunya Mountains and the Crows Nest and Cressbrook dam areas between Esk and Toowoomba in the west, the western suburbs of Brisbane in the east, and there are probably some deer south of the Warrego Highway near Gatton and Laidley.

Figure 2: Estimated increase in the red deer herd size 1874 to 2001



The herd size has increased at about 6 percent per year (Figure 2) over the last 130 years. It is not at all certain that this increase will continue at the same rate. In the last ten years or so it has probably been assisted by escapes and releases from deer farms, and there is increasing awareness by local authorities of the potential problems that these animals may create and a willingness to cull surplus animals. Nevertheless, it is clear that the spread of some deer into more densely populated and intensively farmed areas is having adverse impacts on human activities and that the herd size needs to be controlled.

Herd composition, reproduction rate and health

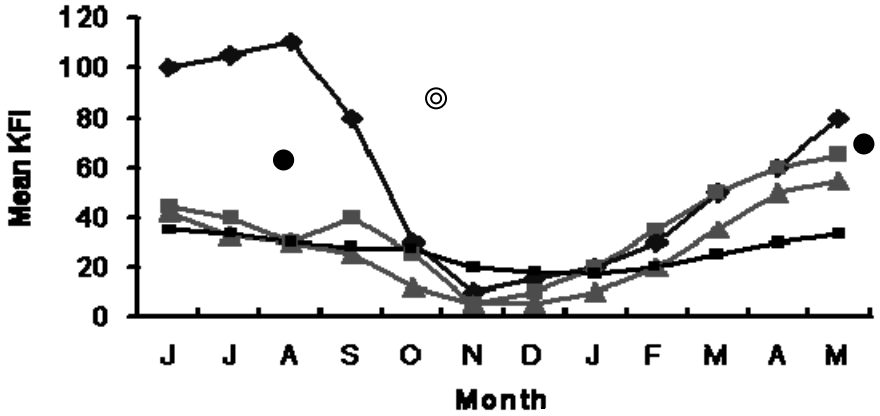
The herd age and sex composition, as determined from observations made at five sites, is summarised in Table 1. It was difficult to distinguish calves from female yearlings in March, and adult hinds from yearling females in July/August. The numbers of female yearlings and calves were estimated by assuming parity between male and female births, and applying in July/August the calf:hind ratio observed in March. If these assumptions are correct, then we note that there is an 87 percent conception rate (determined directly on hinds which were shot; three per site on each occasion), and a calving rate of approximately 60 percent. There seems to have been a substantial loss of calves, weaners and yearlings. The older animals, especially the spikers, may have left the hind herd, and we may not have been able to find some of the younger animals. If this is so, then we will have underestimated the number of yearling hinds in the herd in July/August, and overestimated the number of adult hinds. An alternative is that there are losses of young animals through disease, misadventure or predation (crows and dingos have been suggested as responsible). We expect some losses of young animals: Audige *et al.* (2001) recorded calf losses of ten percent and weaner deaths of six percent (mainly from yersiniosis) in New Zealand farmed red deer herds. These presumed losses might explain the relatively slow increase in the wild deer herd size compared to New Zealand, where similar animals were introduced at about the same time (McGhie and Watson 1995).

Table 1: Herd age and sex structure in the Brisbane River valley in 2000 (from Finch 2000)

Class of animal	March	July/August
Spikers (male yearlings)	40	19
Calves + yearling hinds	120	--
Weaners + adult and yearling hinds	--	94
Estimated female yearlings	40	19
Estimated number of calves/weaners	80	45
Hinds	137	75 [1]
Lactating hinds	73%	33%
Pregnant hinds	--	87%
Calf:hind ratio	58:100	60:100

[1] estimated Kidney fat indexes (KFI) are a good indication of an animal's energy status (Riney 1955) and we used them to investigate the nutritional status of the southeast Queensland red deer. The animals sampled in both surveys (2000 and 2003) were in generally good nutritional condition with average KFI of about 65 percent in both autumn and winter. Apart from the Cressbrook deer, which were in very good condition, these results showed that animal condition improved consistently from the southwest to the northeast of the region (Dryden and Finch 2002). Further work is needed to find out what environmental characteristics are responsible for this. In Figure 3 these KFI are compared with values reported in surveys conducted in North American wapiti and white tailed deer and red deer in New Zealand. The Queensland deer are demonstrably in much better nutritional condition than those in the other surveys. Nutritional status will change from year to year, but it is interesting that there appears to be little effect of season within years (admittedly from a small sample), and that both surveys (which were two years apart) gave similar indications of good nutritional status.

Figure 3: Kidney fat indexes for North American wapiti and white tailed deer, and New Zealand and southeast Queensland red deer (from Smith 1974, cited by Finch 2003). Symbols not joined by lines are mean values for the hinds sampled at five sites in the Brisbane River valley in 2000 (●), and deer sampled at Cressbrook Dam in 2003 (◎)



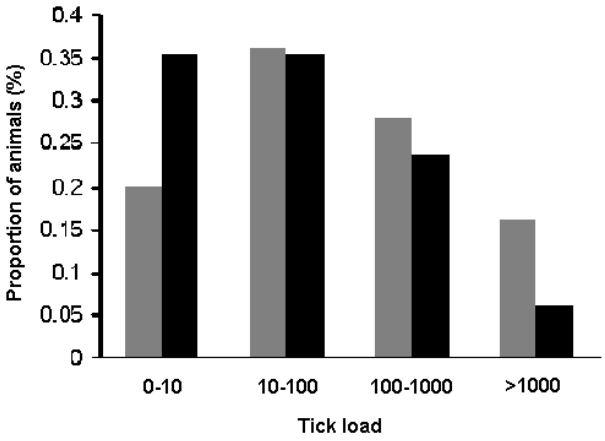
Tick burdens, infectious diseases and internal parasites

The western edge of the wild deer range in the Crows Nest region lies just west of the Queensland cattle tick protected area, ie the transition zone between ticky and clean country (Figure 4). Graziers have argued that red deer can be infested with cattle ticks and that because deer, especially stags, probably move over long distances they could carry ticks from 'ticky' into 'clean' country.

Roff (1960) noted that cattle ticks were found on some deer in his survey. We also found that red deer carry ticks, and if severe enough, their burdens may pose a risk to the animal's health. (Finch (1999) showed that there was a negative relationship ($r = -0.321$; $P = 0.041$) between tick burden and animal condition score, although we cannot say which is the causative factor. It appeared that red deer carry fewer ticks (<4.5 mm) than cattle in the same locality (Figure 5). This suggests that deer are not as good hosts for cattle ticks as cattle, an observation which is consistent with observations made on cattle grazing with rusa deer in New Caledonia (Barre *et al.* 2002).

Figure 4: Cattle tick areas in Queensland (from Department of Primary Industries and Fisheries 2005).

Figure 5: Proportions of deer ( ) and beef cattle ( ) carrying different loads of cattle ticks on properties surveyed in the Brisbane River valley.



There appears to be no information on the health status of wild red deer in Queensland. McKenzie *et al.* (1985) published a survey of diseases in Queensland farmed deer. They found the parasites *Orthocoelium* (*Ceylonocotyle*) *streptocoelium*, *Fasciola hepatica*, *Echinococcus granulosus*, *Capillaria* spp, *Cooperia* spp, *Dictyocaulus viviparus*, *Haemonchus placei*, *Oesophagostomum venulosum*, *Spiculopteragia asymmetrica*, *S boehmi* (*spiculoptera*), and the ticks *Haemaphysalis bancrofti*, *Ixodes holocyclus* and *Boophilus microplus*. However, they concluded that these infestations did not pose serious health risks to the deer.

The helminths commonly found in sheep and cattle, ie lungworms, *Haemonchus*, roundworms, *Ostertagia* and *Trichostrogylus,* seem to cause few ill effects in farmed deer. *Oesophagostomum* (nodule worm) and *Haemonchus* (barber's pole worm) have been found in

intensively farmed deer in southeast Queensland, but they apparently do not cause a problem in practice.

There was no evidence, in 1982, of tuberculosis, brucellosis, or infectious bovine rhinotracheitis (Queensland Department of Primary Industries 1983). Serological surveys of farmed red deer showed leptospiral antibodies in 13 percent of deer, mucosal disease antibodies in three percent and ephemeral fever virus antibodies in a significant percentage. Additional data from McKenzie *et al.* (1985) indicated that Queensland deer had been exposed to a range of viral diseases. These data are summarised in Table 2.

Table 2. Prevalence of viral diseases in Queensland farmed deer herds (from McKenzie *et al.* 1985).

Disease/organism	Proportion (%) found serologically positive
Leptospira hardjo	14.5
Brucella abortus	0
Bovine ephemeral fever	43
Five epizootic haemorrhagic disease of deer viruses	19 to 50
Bovine virus diarrhoea	4
IBR IPV	0
Akabane virus	90
Bluetongue group antigen	48

These results offer some information, but do not completely clarify the potential for wild deer to act as disease reservoirs or in the spread of cattle ticks. Although it seems clear that deer carry fewer ticks than cattle, we have no good data on the movement of hind herds or of individual stags in the non rut seasons, so we cannot predict to what extent they are likely to carry viable ticks into clean country. Further, the role of other potential tick carriers, including vehicles, horses, cattle and native animals such as the bandicoot, has not been investigated. Concerning the other diseases, we cannot easily extrapolate from farmed deer to wild deer. The animals are the same species, but they live in quite different environments, with different animal densities, exposure to other domestic animals, especially cattle, and pasture management. More work is needed to quantify the potential effects (good or bad) of wild deer on animal health.

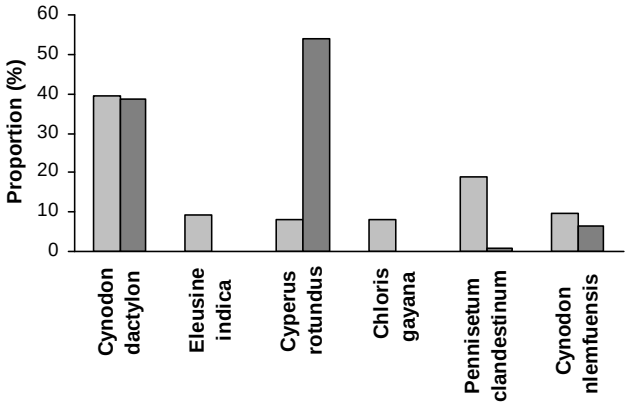
What do deer eat?

Finch (2000) found that wild red deer shot in the Brisbane Valley had 35 to 53 pecent grass remnants in their rumens in March, and 12 to 35 percent in July. This is similar to observations made with rusa deer in the NSW Royal National Park, and suggests that the deer vary their diet according to the quality of the available vegetation.

These deer may eat a wide variety of plants. Species which Finch (2000) observed deer to sample included pasture grasses and legumes (white clover, siratro, glycine, paspalum, and green couch), the fodder tree leucaena, and a variety of non poisonous (verbena, *Sida* spp, dandelion) and poisonous (lantana, wild cotton, groundsel, inkweed, rattlepod) weeds. We cannot quantify the contribution of any of these species to the total diet (although at least some of these may have contributed to the 'non grass' component of the diet as identified from rumen samples), nor the possible effect of eating them on the spread or control of these weeds. The diet of red deer grazing a native/ introduced species pasture was examined using faecal alkanes. We found that these hinds preferred green couch (*Cynodon dactylon*) and nutgrass (*Cyperus rotundus*) and avoided rhodes grass (*Chloris guyana*), kikuyu (*Pennisetum clandestinum*) and crowsfoot grass (*Eleusine indica*) (Figure 6).

There is almost certainly an overlap in the diets of deer and cattle grazing in this region, but the effect has yet to be quantified and there may be substantial differences in the diets selected by these species, especially in winter. The higher growth of grasses in summer, coincident with the summer rainfall maximum, will further tend to reduce any adverse impact of the red deer population on beef property carrying capacities.

Figure 6: Species composition of a mixed native/introduced grass pasture ( ) and of the diet selected by red deer hinds ( ) (from Whelan 2004).



Are the wild deer an economic resource?

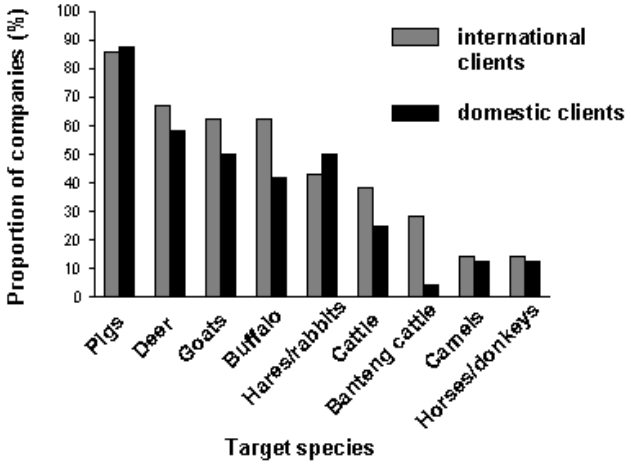
It has been argued strongly by organisations such as RIDGE Inc. and the Australian Deer Association that the wild red deer herd is an important recreational and commercial resource. Also, there are some 15 commercial safari hunters in southern Queensland and many of these are located near the Brisbane and Mary River valleys.

The safari hunting industry nationally earns about $5 million annually (Dryden *et al.* 2003), and we estimate that recreational hunters spend about $54 million annually on direct hunting costs. These are probably underestimates, as many hunters spend large amounts on their recreation (Table 3). We cannot break these figures down to estimate the amount spent hunting in southeast Queensland, and we recognise that species other than deer are hunted. However, deer are a highly preferred species (Figure 7) and the southeast Queensland herd is the largest wild red deer herd in Australia.

Table 3. Expenditure on hunting (annual expenditure by clients of safari hunters/members of recreational hunting clubs, percentage of clients/hunters) (from Dryden *et al.* 2003).

Annual expenditure	Domestic safari clients	Recreational club members
Less than $1000	16.7	21.4
$1000 to $5000	41.7	57.1
$5000 to $10,000	8.3	14.3
More than $10,000	33.3	7.1

Figure 7. Species preferred by international and domestic clients of safari companies (from Dryden *et al.* 2003).



Trophy quality is an important issue for the client of commercial safari hunters, and is important, although less so, for recreational hunters. Commercial safari hunters support quite intensive interventions to achieve better quality trophies: 61 percent would support the use of controlled hunting (perhaps similar to that used in property based game management where limits on the numbers of male and female animals are imposed), and 48 percent would support the use of game animal breeding (Table 4). Recreational hunters are also interested in interventions to maintain the quality of the resource: 50 percent of clubs would support controls on population size and management to improve trophy quality, 36 percent would support game animal breeding, and 29 percent would support mechanisms to control the herd sex ratio. Landholders' organisations favour the shooting of only nominated animals.

Table 4. Preferred methods of managing or controlling populations of wild exotic animals in Australia (from Dryden *et al.* 2003).

Management method	Proportion of companies/clubs (%)	
	Safari companies	Recreational hunting clubs
Eradicate all these populations	8.0	14.3
Control the size of these population	69.6	50.0
Influence the sex ratio	30.4	29.0
Manage to improve trophy quality	60.9	50.0
Use purpose-bred exotic animals	47.8	36.0
Exert no control on these populations	8.7	0

Conclusions and recommendations

1. The wild deer population is continuing to expand in size and range. This is beginning to impact on more densely populated and intensively farmed areas.
2. The increase in population size is promoted by the good nutritional environment, but possibly restricted by losses of young deer. These losses may be caused by predation.
3. Red deer probably pose little threat to beef cattle production. Deer probably impose little pressure on the food available to cattle. Deer may have little effect on the spread of cattle ticks, although we need more information about the dispersion of stags.
4. Deer appear to eat weeds. It is not known if this is likely to contribute to the spread or control of these plants.
5. This is the main wild red deer herd in Australia and is an important hunting resource. Recreational hunting is a potential income stream for southeast Queensland graziers and the

herd supports a commercial safari hunting industry and would be attractive to international hunters.

There are clearly some questions that have not been answered fully. We need more research to investigate the extent of dietary overlap between cattle and deer, and the effect of deer on weeds. Controlled studies of the interactions between deer, cattle and the cattle tick are also needed, to determine the effects of red deer on tick viability and spread or containment. We also need an up-to-date assessment of health status.

The resource implications of the red deer must not be overlooked. This herd is unique in Australia, and Queensland red deer hunting forms an integral part of the 'South Pacific 15', which is a group of trophy animals sought after by international hunters. Recreational hunters pay trophy and access fees to local graziers. Local hunting organisations are prepared to assist in managing this herd, both to improve its trophy quality and to control incursions into intensively farmed and peri-urban areas. The synergies that might be generated by cooperation between state government agencies and these hunters are worthwhile exploring.

Acknowledgements

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An evaluation of the status and management of wild deer in Australia in 2005

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Abstract

With their introduction into Australia beginning in the early nineteenth century deer have joined a long list of introduced species, many of which have become significant pests. Unlike rabbits, feral pigs, foxes and others, deer have not been considered as having significant adverse environmental or socio-economic impacts in Australia until quite recently. There are long standing wild populations in several states that have been managed for many years as a valuable resource for hunting rather than as a pest. In very recent times a perception has developed that wild deer numbers are increasing in Australia, with a wider distribution. The basis for these concerns will be examined, with a review of wild deer management in Australia.

Introduction

There is an increasing focus on the need for effective management of wild deer in Australia, with concerns being expressed in some quarters about their status as an emerging pest animal. In looking at the origins of these populations, the role of the acclimatisation schemes of the nineteenth century in introducing deer to Australia is well known, and reviewed very ably by Bentley (1998). This activity was a response to the fact that there were no native cervids to be found on the continent, just as there were no endemic primates, felids, bears, elephants or rhinoceros. Indeed the fauna of the Australian region is totally and dramatically different from that of Asia, with the biota of the two regions separated by the Wallace Line, which at one point between Bali and Lombok runs through a strait only 25 kilometres across. It was realisation of this difference that was one of the drivers for Alfred Wallace in developing his theories on biogeography and evolution in the 1880s (van Oosterzee 1997). In any event, the absence of endemic deer species resulted in early and persistent attempts after European settlement in 1788 to introduce these animals into Australia. The first introduction is attributed to surgeon John Harris, who imported chital deer (*Axis axis*) from India in 1803. By 1809 the herd had grown to some 400 animals on his property near Bathurst. It is an interesting historical footnote that these deer were apparently able to escape through broken fences, thus creating what was probably Australia's first wild deer herd (Bentley 1998).

In his definitive work on the origins of the wild deer herds now found in Australia, Bentley (1998) indicates that at least 25 species or subspecies of deer were brought to this country, largely during the nineteenth century. Today only six species survive in the wild, these being sambar deer (*Cervus unicolor*), red deer (*C elaphus*), rusa deer (*C timorensis*), European fallow deer (*Dama dama*), chital deer (*A axis*) and hog deer (*A porcinus*) (Strahan 1995). The origins and distribution of wild deer in Australia have been reviewed more recently by Moriarty (2004), with a more intensive survey of land managers conducted in New South Wales and the Australian Capital Territory by West and Saunders (2003). The former estimated that there are about 200 000 wild deer in 218 herds in Australia, with seven percent of these herds originating from acclimatisation society releases, 35 percent from deer farm escapes/releases and 58 percent from transplantations (deliberate releases). Moriarty (2004) further estimated that the acclimatisation societies were responsible for introducing the forbears of about 85 percent of the current wild deer in Australia, with six percent originating from deer farms and nine percent from deliberate releases. West and Saunders (2003) found that the six deer species collectively inhabit five percent of NSW and the ACT, compared to two percent in an earlier survey in 1996. Even earlier reports by Wilson *et al.* (1992) and Murray and Snowdon (1976) suggested that wild deer inhabited smaller areas of NSW than those observed in 1996. Despite this apparent increase in the size of the wild deer population, West and Saunders (2003) noted that in contrast to the many other introduced species in NSW, a majority of respondents to their survey

did not perceive wild deer to be overly abundant. A majority (41 percent) did indicate that there had been a moderate to high increase in the distribution and abundance of wild deer, and attributed increased illegal and deliberate releases or escapes as the main reason for this increase. Hard evidence to support this belief was not provided, but given that they were found to inhabit only five percent of the state, deer are still much less widespread than animals like feral pigs and foxes.

It is a belief in some quarters of an apparent increase in both the number and distribution of wild deer in Australia that has resulted in the current discussion about the potentially adverse environmental and socio-economic impacts of wild deer, as opposed to their value as game animals. There is certainly a significant diversity of opinion on the true status of wild deer, and an intense debate about how they should be managed, involving conservation and animal health authorities, land owners, hunters, animal rights groups, the animal welfare lobby and the community at large. There is now a need to resolve these difficulties, and to determine how best to manage Australia's wild deer in the time ahead. There has in fact been a considerable amount of deer research in Australia over the last 20 years and more, especially at the Universities of Sydney, Queensland and Western Sydney. However, this was largely directed towards the deer farming industry, and little was done on the management of wild deer.

Progress will only be made in this regard with better knowledge of the ecology and actual impacts of Australia's wild deer herds, whether these impacts are in protected areas, on agricultural and horticultural enterprises, as a traffic hazard and as a possible complicating factor during exotic disease outbreaks. This is not to suggest that no action should be taken until all the issues are resolved, but the adoption of rational and cost effective management strategies for wild deer in Australia is constrained to a large extent by the lack of scientific data on the actual rather than the perceived impacts of all of the deer species across their present range.

Options for management

There are relatively few options currently available for the management of wild deer in Australia, complicated not only by technological constraints but also by the elusive nature of the animals, their scattered distribution and the rugged terrain that many populations inhabit.

The options for controlling a wild deer population are as follows:

a. shooting from the ground or from helicopters
b. trapping and relocating
c. poisoning
d. fertility control

Ground shooting is generally more appropriate than aerial shooting, given the nature of the terrain and vegetation where most deer are found. Skilled hunters are required to deal with these elusive animals, and in protected areas this will often be the preferred option for removing a new wild deer population. Trapping has been successful in some situations, but there will always be animals that are trap shy and shooting is usually required as well. A successful fallow deer trap was described by English (1979), with a similar approach being used to capture rusa deer in Royal National Park (Anon 2002).

The poisoning of deer is not sanctioned in Australia due to animal welfare and non target species concerns about the use of toxins like 1080. The fertility control option is promoted heavily by animal rights groups and others who seek a non lethal solution for the control of wild deer. There is no such technology available that could be applied to Australia's wild deer, despite considerable research in this area. Current systems require that the animals be injected or implanted with the contraceptive agent, and this is simply not feasible with these wild populations at this time.

The current management of wild deer in Australia is restricted to giving them partial protection as a game animal in Tasmania and Victoria, with the adoption of restricted annual open hunting seasons, while in all other states and territories they are considered to be an introduced non indigenous species that may be controlled as pest animals. Until quite recently very little concern has been expressed about their pest status, and there has been little systematic management of any description outside Tasmania and Victoria. A recent review by the Bureau of Rural Sciences (BRS) on the management of pest animals in Australia did not have deer

listed as having even minor pest status, but did acknowledge their value as a game animal (Hart 2002).

A new development in NSW has been the bringing down of the *Game and Feral Animal Control Act 2002*, administered by the Game Council of NSW. Under this new Act deer have been given game status, as have a number of species of introduced birds. The Game Council is required to direct a significant proportion of its revenue towards research on biodiversity conservation, and habitat restoration. As a consequence of this legislation deer can now only be hunted by holders of a Game Council permit, whether on public or private land. The effects of this new status for deer in NSW are yet to be determined, particularly in the face of the NSW Scientific Committee's listing of herbivory by all six deer species as a Key Threatening Process in NSW. This may result in the putting in place of a Threat Abatement Plan (TAP), and it is far from clear how this process will be affected by the status under different legislation of the same animals as game species. This is typical of the dilemma confronting those responsible for developing rational management strategies for wild deer in Australia.

Ecology of wild deer

Any management plan for wild deer in Australia must start with an understanding of their ecology, with environmental conditions here often being very different from those in the regions from which they originated. It is no coincidence that only six of the 25 or so deer species that were brought to this country have survived in the wild, with a belief that only sambar and possibly rusa have shown an ability to readily extend their range away from the crops and pastures of man (Bentley 1998). In seeking the most effective methods for the management of Australia's wild deer herds, these elusive and cryptic animals pose significant challenges for landowners and those concerned with the management of protected areas. They often live in rugged inaccessible terrain, which makes aerial and ground shooting quite difficult. This is precisely why they are viewed as a challenge by deer hunters. West and Saunders (2002) believe that the ineffectiveness of the available control techniques may be partly the reason why the control effort has not increased over recent years, to match a perceived increase in deer abundance and associated impacts. This is further complicated by the varying community attitudes and values attributed to deer, from their being considered to be a premier game animal, to their being seen as an introduced pest species, or as an alternative farm species.

Adverse impacts

There have been wild deer in Australia since the early nineteenth century, but they are at low densities in most areas (Strahan 1995). It is therefore not surprising that there have been relatively few specific studies on the nature and extent of their social, economic and environmental impacts. The available pool of funding has clearly been directed to research on more important pest species. Furthermore, Snowdon and Murray (1976) concluded that wild deer would pose a relatively small risk in the event of an exotic disease outbreak, compared to pest species like feral pigs and goats. This is still the view expressed in AUSVETPLAN, Australia's contingency plan for dealing with an exotic disease, with the distribution of wild deer seen as limited to small, localised populations that are considered unlikely to play an important role in an outbreak of a disease like Foot and Mouth Disease (FMD) (AUSVETPLAN Wild Animal Manual 2000). The potential for wild deer to be involved in any major way in the transmission of other diseases has not been raised as a major concern by Australian animal health authorities. There might be concerns if Chronic Wasting Disease (CWD) was to enter this country, but this has not happened to date.

Nonetheless, there is a perception that wild deer constitute a new and emerging pest problem (Moriarty 2004), but the hard evidence to support such concerns must be examined. A significant proportion of the research that has been carried out with wild deer in Australia has been with Javan rusa deer in NSW, most recently by Moriarty (2005). The past and present management of this population is an example of the challenges that arise in seeking to understand the impacts that these animals might or might not have, with a view to the development of sound management strategies that the community will accept.

Rusa deer in Royal National Park NSW

The Javan rusa deer (*C. t. russa*) in Royal National Park (RNP) south of Sydney have long been the centre of controversy. Present in the Park since 1907, these deer have been viewed variously as interesting, charismatic animals, as introduced pests, or as a source of breeding stock for deer farms – several hundred were trapped for this purpose starting in the 1970s (Bentley 1998). The population in RNP has apparently fluctuated in size due to factors such as bushfires (most recently in 1994 and 2002), and these deer are now also to be found in the coastal escarpment country well south of RNP. They range across all public and private land tenures.

A study in RNP by Hamilton (1981) found that rusa deer could alter the structure, species abundance and composition of grassland communities, but he concluded that the influence of rusa deer on the regeneration of bush appeared to be small. He also examined the dietary overlap between rusa deer and swamp wallabies (*Wallabia bicolor*), and found that they ate substantially different foods. Overlap was only 13 percent in summer, increasing to 54 percent in winter when there was less plant growth. Hamilton (1981) concluded that there was little evidence of any major impact of the deer on native plants and animals, with some apparent benefits in their utilisation of invasive plant species like blackberry (*Rubus fruticosis*).

In the two decades after Hamilton's study the rusa deer in RNP continued to attract community interest, with some opposition to a series of unsuccessful attempts to reduce the number of deer in the Park. A variety of methods were used, including the use of baited enclosure traps. As well as their potential environmental impacts (trampling and overgrazing, ring barking, antler rubbing, dispersal of weeds, creation of trails, exposing soils to erosion and compaction) the deer were also causing concern as a potential traffic hazard and as a significant nuisance in urban gardens adjacent to RNP. A further concern was the regular poaching of deer in RNP by illegal hunters, with possible effects on public safety. As a consequence, the NSW National Parks and Wildlife Service (NPWS) developed a Deer Management Strategy in 1997, which was done with the involvement of the community and a number of stakeholders in seeking the best way to manage the RNP deer population. To assist with this process an ecological study was conducted between 1999 and 2002 by Moriarty (2005), focusing on the population dynamics and impacts of rusa deer in the Park. He found that grazing and trampling by rusa deer could alter the composition and structure of a number of Endangered Plant Communities, including the Sutherland Shire Littoral Rainforest. Eight threatened species of plants were being eaten by the deer. The deer population in RNP was estimated to be about 3000 animals.

The RNP Rusa Deer Working Party was established by NPWS in 2000, with the task of developing a Deer Management Plan. This was achieved using a very comprehensive process of community consultation and public education (Shephard 2002), which resulted in a plan to reduce deer numbers in the Park by ground shooting (NSW National Parks and Wildlife Service 2002). The plan has now run for three years, with the target of reducing the number of deer in RNP to a population of no more than 1000. With only a little over 500 deer removed by ground shooting, the effectiveness of this plan to date is questionable, just as it must be said that the figure of 1000 deer was chosen with no scientific data to support such a target. This illustrates the current difficulty, referred to by Hart (Department of Agriculture, Fisheries and Forestry Australia 2002), in seeking to understand the nature and extent of the actual environmental impacts of herbivores, and in relating population densities to the level of these impacts. This certainly applies to all wild deer populations in Australia, and is arguably the most significant obstacle to the development of effective management plans.

Deer as game animals

From their earliest introduction to Australia deer have been prized as a trophy animal, and as a source of game meat. Sambar deer are generally acknowledged as the major game species in Australia, with an estimate of at least 17 500 recreational deer hunters in Australia (Cause 1990). O'Brien (1990) made a case for the pragmatic reassessment of exotic species management in Australia, including recognition of values for recreational hunting and game meat production. This has been taken up in Tasmania and Victoria, where game management units have been established within the conservation departments of those states. The intensive management of deer for hunting in both states produces very significant income for landholders, for communities, and for the conservation of biodiversity. In these programs deer are seen as a

resource rather than as a liability and they are managed accordingly. This applies in Victoria not only to sambar deer but also to hog deer, which are found in a population that constitutes arguably the most significant genetic resource for this species outside the Indian subcontinent (Mayze and Moore 1990). This population has been managed and monitored quite intensively for many years, which has included disease surveillance and population control by the use of ballotted hunts.

The potential value of deer as game animals has been recognised for many years, just as has the positive role of ethical hunters in the conservation of biodiversity. An oft quoted example is the regulated use of hunters to remove feral goats and foxes as an integral part of 'Operation Bounceback' in the Flinders Ranges of South Australia. A new role for hunters has arisen in the national disease surveillance system, with an awareness that hunters may be amongst the first to encounter an exotic disease in remote areas. Future hunter education courses will include information on the recognition of unusual clinical signs in animals in the field and what to do when they are encountered.

Animal welfare

The humaneness or otherwise of all pest animal control techniques is under constant public scrutiny. It must be acknowledged that there is community concern about some of the methods used to control pest animals in Australia, and this includes hunting. In the case of hunting, public perception is further complicated by the increasing level of restriction being placed on the ownership and use of firearms in Australia, coupled with the negative stereotypes often associated with hunters. This can only be countered by effective public education on the conservation and economic benefits of well regulated hunting, and by hunters consistently adopting high ethical standards in all their activities. To assist in this process the Game Council of NSW has developed a Code of Practice for hunters, with a number of mandatory provisions. These relate particularly to animal welfare, ethical behaviour and respect for landowners and the environment. Furthermore, a new federal initiative has been put in place in late 2005, with the Australian Animal Welfare Strategy (AAWS) likely to play a part in the development of management options for wild deer.

Conclusion

The wild deer of Australia are now attracting more attention than they have done in 200 years. The surveys of West and Saunders (2003) and Moriarty (2004) raise concerns that wild deer might become a much bigger problem in the future if nothing is done about them. The simple fact is that almost nothing is known of the actual impacts of wild deer in Australia. West and Saunders (2003) found that wild deer still only inhabit about five percent of NSW, while Moriarty (2004) calculated that 85 percent of the present wild deer population was derived from animals released by acclimatisation societies in the nineteenth century. These long-standing populations of wild deer have been viewed much more as a resource than as a problem for many years now. This is not to say that local deer problems cannot occur and, in the case of protected areas and peri-urban regions, all reasonable steps should be taken to prevent the development of new populations of wild deer. This could well include the use of accredited hunters in selected areas. Any consideration of the situation with wild deer in Australia raises little doubt that the debate about the values that should be attributed to these animals in this country will continue for many years to come.

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Science based management of wild deer in Australia: A case study – rusa deer in the Royal National Park

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Abstract

Six introduced wild deer species are now well established throughout much of eastern and southern Australia. Evidence suggests that many wild deer populations are increasing their distribution and abundance. This situation mirrors the eruption of ungulate species in New Zealand in the mid 1900s. A key factor in the success of managing these species in New Zealand was the initiation of targeted and strategic management programs based on scientific data. A similar management process is urgently required for Australian wild deer populations. A management program for rusa deer in the Royal National Park, based on scientific data, may be the start of such a process in Australia.

Introduction

Six introduced deer species have formed wild populations in Australia. These are fallow deer (*Dama dama*), red deer (*Cervus elephus*), sambar deer (*C unicolor*), chital deer (*Axis axis*), rusa deer (*C timorensis*) and hog deer (*A porcinus).* All six deer species have been introduced into Australia through acclimatisation societies and more recently through liberation from deer farms and deliberate releases by trophy hunters (Bentley 1998; Moriarty 2004a; Jesser 2005). Recent evidence suggests that the number of deer populations in Australia is increasing and that larger established deer populations have significantly increased their range since introduction (Moriarty 2004a; Jesser 2005). A similar eruptive pattern has been described for a range of ungulate species, for example, elephants in Africa (Fowler 1981; Caughley and Krebs 1983; Fayer-Hosken *et al.* 1997; Hawthrorn and Parren 2000), deer in North America (Leopold *et al.* 1947; Morrison 1985; Skogland 1991; McCullough 1997) and a range of ungulate species introduced into New Zealand (Caughley 1970; 1971; 1983; 1989; Rose and Platt 1997; Fraser *et al.* 2000; Forsyth and Duncan 2001; Forsyth and Caley 2006).

The management of wild deer in Australia has become a complex and challenging science (see Moriarty 2004a; Hall and Gill 2005). Most wild deer populations in Australia are currently managed without any fundamental knowledge of their ecology or interactions with Australian ecosystems (see Moriarty 2004a). In New Zealand the process of scientific data informing the targeted management of deer and other ungulate species has been well established over the last 50 years (Forsyth *et al.* 2003). A key factor in the success of deer management in New Zealand is the recognition of the environmental and social impacts of deer, as well as their value as a hunting resource (Nugent and Fraser 1993). This paper aims to highlight the lack of scientific information on wild deer in Australia and promote the benefits of the strategic management of these species using scientific information.

What do we know about the ecology of wild deer species in Australia?

There are few published scientific studies on wild deer in Australia. There is, however, a large amount of literature with general information on deer. This literature includes reference publications, which have a brief description of each species biology and distribution (Roff 1960; Rolls 1969; Frith 1973; Walker 1975; McKnight 1976; Murray and Snowden 1976; Keep 1979; Brunner *et al.* 1981; Grubb 1990; Wilson *et al.* 1992; Groves and Bishop 1989; Low 1999; Van Dyck and Strahan 2008), several books describing deer species world wide with sections on deer in Australia (Morris 1949; Lever 1985; Whitehead 1972; 1993; Long 2003), deer hunting literature which includes information on deer behaviour, management and some biological information (Presidente et. al 1978; Presidente and Driasma 1978; Anon 1978; Harrison and

Slee 1995, Dunn 1989; Cause 1990; Green 1993; Slee 1995a,b; Bentley 1998; Harrison 1998; Hall and McGahie 2000; Harrison *et al.* 2006) and an expanding information bank on farmed deer in Australia which describe aspects of deer nutrition, reproduction and health (Anderson 1978; English 1979, 1980, 1981a,b, 1985, 1990, 1992; Mulley 1984; Mulley and English 1991; MacDonald 1995; Department of Primary Industries Qld 1985; Tuckwell 2001).

More recently information on deer management (Murphy 1995; Department of Primary Industries, Water and Environment Tasmania 1999; Moriarty 2004a; Finch and Baxter 2007; Hall and Gill 2005, 2007) and specific state and local deer management strategies (McClure 1996; Department of Environment and Conservation NSW 2005; Jesser 2005; Department of Water Land and Biodiversity Conservation SA 2006) have been produced, along with Key Threatening Process determinations (Department of Environment and Conservation NSW 2004; Department of Sustainability and Environment Victoria 2008), distribution surveys (West and Saunders 2003; Moriarty 2004a; West and Saunders 2007) and deer monitoring protocols (Forsyth 2006). In addition several conferences have been held to better define the management and status of deer species in Australia (Latrobe University 1978; NSW Department of Primary Industries 2005; Forsyth 2007).

All of these publications provide useful background information on deer species in Australia. However, detailed information on deer ecology that can be used in the strategic and targeted management of these species and their impacts is largely unavailable. Table 1 shows that there is 'poor' to 'very poor' ecological information available for most wild deer species in Australia, with the exception of rusa deer and hog deer. Importantly the current knowledge of movement ecology and impacts for most deer species was rated as 'poor' or 'very poor'. The lack of fundamental information available on deer ecology in Australia compared to the same information on two other important pest ungulate species (feral goats and feral pigs) is also highlighted in Table 1. If deer population trends in Australia continue to increase at their current rate, deer species are likely to rival both feral pigs and feral goats in distribution, abundance and impacts in the near future (Moriarty in press).

Future directions for wild deer research in Australia should at first focus on establishing the relationship between deer density and damage, initially in sensitive habitats with abundant deer and later in lower priority ecosystems. Obtaining information on the distribution, abundance, rate of increase and movement ecology for deer populations inhabiting important conservation areas (eg sambar deer in the Australian Alps) should also be considered as a high priority. In addition, testing a range of deer management techniques in Australian ecosystems and estimating their cost effectiveness (see Nugent and Chocquenot 2004) will also be important. Lower priority information on other aspects of wild deer ecology, for example, diet, body condition, body measurements, antler cycles and aspects of the behaviour of each species, will also be important in providing an overall context for each species in Australia.

Table 1: The estimated scientific knowledge of the ecology of wild deer species in Australia. Each section was scaled from 1 to 5 with 1 indicating 'very poor knowledge' and 5 'very good knowledge'. Population dynamics refers to mortality, reproduction, rate of increase, body measurements and condition. Life cycle refers to age estimates, antler cycles and the timing of breeding and birthing seasons.

Deer Species	Home Range	Habitat Use	Life Cycle	Population Dynamics	Distribution and Abundance	Behaviour	Impact
Fallow	**2**	**2**	**3**	**2**	**2**	**2**	**2**
Red	**1**	**1**	**2**	**2**	**2**	**2**	**1**
Sambar	**1**	**2**	**2**	**1**	**2**	**3**	**2**
Rusa	**3**	**3**	**3**	**3**	**2**	**2**	**2**
Chital	**1**	**1**	**2**	**1**	**2**	**1**	**1**
Hog	**1**	**2**	**3**	**3**	**2**	**3**	**1**
Feral Goat	**5**	**4**	**5**	**4**	**5**	**4**	**5**
Feral Pig	**5**	**5**	**5**	**5**	**5**	**4**	**5**

Management realities for wild deer in Australia

Deer management in Australia has the potential to be a complex and politically sensitive science (Caughley 1983; Moriarty 2004b; Hall and Gill 2005). However, initiation of targeted strategic management programs based on scientific data and recognising environmental and social impacts of deer, as well as their value as a hunting resource, may provide a way forward. Australia is faced with two management situations for wild deer species. These are the detection and management of new deer populations and the management of existing, established wild deer herds.

Moriarty (2004a) clearly identifies that the release of new deer populations through escapees from deer farms and illegal liberation of deer by a small minority of hunters was a problem requiring the urgent attention of land managers. In 2000 93 percent of deer populations in Australia were estimated to be from one of these two sources (Moriarty 2004a). Despite these figures and evidence showing that these smaller human induced herds are spreading and increasing in abundance, very little detection effort and localised control of new deer populations has occurred in Australia (Moriarty in press). Urgent development of reactive management strategies by state governments for these new populations is required. These strategies should be modeled on the successful Northland model for the management of new deer populations in New Zealand (Fraser *et al.* 2003).

Established wild deer populations should be managed with a specific emphasis on their environmental and social impacts. The fundamental scientific basis for management of deer impacts in New Zealand and in other areas overseas is the relationship between deer density and damage (Department of Conservation New Zealand 1997). Knowledge of these thresholds allows land managers to target deer management to areas that are most susceptible (Forsyth *et al.* 2003).

The establishment of deer management zones in Australia may also be useful (see Nugent and Fraser 1993). Each zone could be set up to achieve clear objectives based on deer impacts and the estimated reduction in density required to achieve these objectives. The use of appropriate management techniques in each zone could also be explored, with sensitive areas requiring higher reductions in deer numbers likely to require state funded aerial and ground culling operations (see Nugent and Chocquenot 2004). However, less sensitive areas requiring lower reductions in deer density could be established as recreational hunting blocks, which require a far more modest investment by government agencies (Fraser and Sweetapple 1992; Nugent

and Fraser 1993; Fraser and Speedy 1997). This structure may also allow concepts like Quality Deer Management to be incorporated into the management process (Hall and Gill 2005).

A case study: Rusa deer in the Royal National Park

Rusa deer were introduced into the Royal National Park in 1906 by the then park trustees (Department of Environment and Conservation NSW 2005). Since introduction this population has increased its range to now encompass an area from the southern Sydney suburb of Sutherland to Ulladulla on the NSW south coast. The number of deer estimated to occupy Royal NP is around 3000 (Moriarty 2004b) with conservative estimates of the greater south coast population at around 10 000 animals (Moriarty 2004a). The management of this population has been sporadic, and limited to unsuccessful attempts to trap and remove animals and more recently has included a ground shooting program. Initially ground shooting was met with hostility from elements of the greater Sydney community. In 1999 the then National Parks and Wildlife Service set up a research program to provide scientific information on rusa deer ecology and impacts in the Royal NP to inform the management of this species in this high profile area.

Results of the scientific study showed that rusa deer home-range size ranged from less than 1 km^2 to 8 km^2, with most animals showing seasonal habitat selection mainly based on localised resources or breeding territories. Dispersal in subadult males was shown to be density depended. Analysis of population parameters showed that this population was relatively stable with the rate of increase estimated at ten percent. Analysis of reproductive material showed a typical seasonal cycle of breeding peaks in winter and calving peaks in autumn, with body condition shown to be regulated by the breeding season in males and lactation in females. Blood samples taken from around 100 deer showed low antibody titres to several wildlife and stock diseases. Analysis of deer rumen contents showed they consumed 155 native plant species, including two endangered species, nine vulnerable species and thirteen regionally uncommon species. Deer diet overlap with the swamp wallaby (*Wallabia bicolor*) was shown to range from 24 percent in autumn to 60 percent in winter. An exclosure experiment showed that large differences existed between plots located in high deer density locations compared to low deer density locations for the habitats of littoral rainforest (54 percent less understorey species at high deer density sites), sandstone gully forest (33 percent less understorey species at high deer density sites) and sandstone heath (27 percent less understorey species at high deer density sites).

Around 1200 animals have been removed from Royal NP since the start of the 2002 ground based culling program (B Sullivan pers comm). This level of reduction is unlikely to affect overall deer numbers in the Royal NP, due to compensatory recruitment by the population following culling (see Caughley 1977). However, what may be achieved is localised success in areas where deer impacts were identified as being significant (Moriarty 2004b); for example, in and around sensitive littoral rainforest patches. Further monitoring of deer density and impacts and the establishment of deer damage thresholds will be critical to the continued success of this program.

Conclusion

It is clear that the lack of fundamental knowledge of the ecology and impacts of wild deer in Australia is one of a number of factors obstructing the effective and targeted management of these species. Information on movement ecology, population dynamics and the relationship between deer density and impacts are required for most species. Managing deer populations based on their impacts, similar to the process undertaken in New Zealand as well as in the Royal National Park, will be crucial to the success of future wild deer management programs.

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The Game Council NSW and its emerging role in game (including wild deer) and feral animal management in NSW

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Introduction

In other states and countries, responsible hunters are contributing to positive environmental, social and economic outcomes through organised conservation hunting activities; however, until the establishment of Game Council, NSW society had not taken full advantage of the capabilities of private hunters operating on public and private land, in an organised, regulated way. The Game Council NSW was established in 2002 and is presently establishing itself in the important role of facilitating private hunters in assisting in the management/control of game and feral animals on both private and public lands in NSW.

The *Game and Feral Animal Control Act 2002*

The *Game and Feral Animal Control Act 2002* was enacted on 10 July 2002 and the subsequent creation of the Game Council of NSW occurred in 2003. A major task of Game Council NSW has been to establish the state's first NSW game hunting licensing system to achieve the objectives of the Act, which are to provide for the effective management of introduced species of game animals, and to promote responsible and orderly hunting of those game animals on public and private land and of certain pest animals on public land.

Game Council structure

The Game Council's board comprises 16 Councillors appointed by the Minister for Primary Industries. Half of the Council members have been appointed from research agencies and government departments and the remainder represent a broad cross section of the hunting fraternity. The Game Council is a Statutory Authority charged with administering its own act of parliament. As such, it is an organisation reporting directly to the Minister for Primary Industries. Game Council NSW presently has ten full time and five part time staff,including: five Game Managers; four based in the regional areas of NSW, one in the Sydney Metropolitan area, and five management and support staff based at the Central Office in Orange; and four part-time staff managing the written permission booking system and associated call centre in Orange and one assisting with the introduction of R-Licence requirements in the Sydney Metropolitan area.

Game Council functions

Game Council NSW has the following seven functions that reflect the objectives of the *Game and Feral Animal Control Act 2002*:

- to liaise with the Pest Animal Council, Rural Lands Protection Boards and other relevant bodies in connection with their respective functions
- to promote or fund research into game and feral animal control issues
- to administer the licensing system under this Act for game hunters (including the granting of licences and the enforcement of the Act) and to engage agents for that purpose
- to represent the interests of licensed game hunters in matters arising under this Act
- to make recommendations to relevant Ministers for the purposes of Section 20 (Declaration of public lands available for hunting game)
- to provide advice to the Minister on game and feral animal control (whether at the request of the Minister or on its own initiative)
- to engage in such other activities relating to the objects of this Act as are prescribed by the regulations

Objectives of the Game Council in the near future

Following the roll out of the NSW Game Hunting Licensing System in September 2004, the objectives and functions stated within the Act have shaped the medium term objectives of the Game Council NSW. These objectives include developing the systems required for public land hunting, such as:

Declaring public lands for game hunting involving:

- promoting responsible hunting on both private and public lands in NSW
- represent licensed hunters to public land managers and government
- better facilitate licensed hunter involvement in game and feral animal management programs throughout the state

Since the establishment of Game Council NSW, licensed hunters are becoming

more involved in a growing number of game and feral animal mitigation and management programs throughout the state. These programs vary from duck mitigation programs on remote rice growing properties in the Murray-Riverina to deer control programs adjoining urban areas (For example, Mid North Coast Deer Control Program and the Illawarra Deer Management Working Group). Farmers and land managers are increasingly recognising the benefits of utilising Game Council licensed hunters to undertake game and feral animal control programs at no cost to their operations.

This is lifting the standard of hunting by promoting hunter education opportunities, a mandatory code of practice, public awareness campaigns and setting benchmarks for hunting organisations and their membership.

The Game Council has developed a hunter education program, the

accreditation for which will be a prerequisite for any hunter wishing to hunt legally on declared public lands. The *Hunter Education Handbook* covers issues such as safety, legislation, animal welfare, and ethical behaviour. Through public awareness campaigns, Game Council NSW will assist in addressing issues such as of illegal hunting, rural crime, and responsible, ethical hunting.

Wild deer management in NSW

Wild deer in NSW are game animals for the purposes of the *Game and Feral Animal Control Act 2002*. A licence is required to hunt game animals in NSW. However, there are exemptions from licensing. A game hunting licence is not required by:

- a person who is hunting on any land owned or occupied by the person or by a member of the person's household or by a corporation of which the person is an officer or employee,
- a person who is hunting animals listed in section 5 (2) in accordance with a duty imposed on the person (or on any corporation of which the person is an officer or employee) under the *Rural Lands Protection Act 1998* (see: http://www.legislation.nsw.gov.au/summarize/inforce/s/1/?xref=RecordType%3DACTTOC%20AND%20Year%3D1998%20AND%20Actno%3D143&nohits=y) or the *Wild Dog Destruction Act 1921 (see: http://www.legislation.nsw.gov.au/summarize/inforce/s/1/?xref=RecordType%3DACTTOC%20AND%20Year%3D1921%20AND%20Actno%3D17&nohits=y)* to suppress and destroy the animals (other than a person assisting any such person in the performance of that duty),
- a person who is hunting as a professional game hunter in the course of any paid employment or engagement (other than a person of a class prescribed by the regulations),
- a person employed by any public or local authority (including an employee of a rural lands protection board) who is acting in the execution of his or her duties as such an employee.

There are seasons for certain deer species. These seasons have been set for animal welfare reasons. If a species of game animal does not have an open season listed, it can be hunted all year. Seasons do not apply to landowners, professional hunters or commercial hunters (Table 1).

The *Game and Feral Animal Control Regulations* also stipulate that use of spotlights or electronic devices for hunting deer is not allowed by hunters who are hunting according to their

Game Hunting Licence. This clause does not apply to landowners, professional hunters or commercial hunter.

Under the Act and Regulations, landowners and land managers always have the right to manage or control deer in NSW to any level they choose.

Table 1: Seasons for deer hunting

Deer species	Hunting season	Bag limits	Hunting method
Red *(Cervus elaphus)*	1 March to 31 October	No bag limit	▪ Bow ▪ Hunting with dogs* ▪ Firearm
Wapiti *(Cervus elphus canadensis)*	1 March to 31 October	No bag limit	▪ Bow ▪ Hunting with dogs* ▪ Firearm
Fallow *(Dama dama)*	1 March to 31 October	No bag limit	▪ Bow ▪ Hunting with dogs* ▪ Firearm
Hog *(Axis porcinus)*	1 April to 30 April	1 Female 1 Male	▪ Bow ▪ Hunting with dogs* ▪ Firearm
Sambar *(Cervus unicolor)*	All year	No bag limit	▪ Bow ▪ Hunting with dogs* ▪ Firearm
Chital *(Axis axis)*	All year	No bag limit	▪ Bow ▪ Hunting with dogs* ▪ Firearm
Rusa *(Cervus timorensis)*	All year	No bag limit	▪ Bow ▪ Hunting with dogs* ▪ Firearm

Case Study: Game Council role in facilitating private hunter involvement in community-based feral animal control programs in the Mid North Coast

The operations staff provides an essential coordination and communication role between Game Council licensed hunters, land owners/managers, community groups and other agencies. This role has facilitated licensed hunter involvement in a number of community based game and feral animal control programs; for example, on the Mid North Coast, the Hunter Valley and the Illawarra region. As of March 1 2006, in excess of 170 deer have been shot in the last year by Game Council licensed private hunters under Game Council organised programs in these areas, at no cost to the landowners or ratepayers involved.

PROGRAM: Mid North Coast Deer Working Group

The Mid North Coast Deer Working Group was formed in Port Macquarie in 2002. It includes representation from RLPB, NPWS, Forests NSW, NSW Police, Hastings Council, the Deer Farming Industry, RSPCA, Hastings Valley Hunting Club, and other interested groups. The establishment of the Working Group is a result of growing community concern about increasing deer population in the Port Macquarie and Coomba Park areas. Deer pose a number of problems in these rural/residential areas, particularly in relation to motor vehicle accidents. They are also causing damage to crops and market/residential gardens in these areas.

Game Council NSW joined the Mid North Coast Deer Working Group in July 2004 and set about assisting the Working Group by facilitating the involvement of NSW Game Hunting Licence holders in the deer control programs under the auspices of the Working Group. With deer posing problems at the urban/rural interface, there were a number of safety related concerns regarding the use of firearms in close proximity to residential areas. To address this, a Risk Assessment Procedure was developed to provide advice and ensure safe procedures for the control of deer in these areas.

The risk assessment process

In response to requests for assistance in deer control from landowners or land managers, the Game Manager undertakes a Risk Assessment of the property before developing deer control procedures. The risk assessment and procedures are submitted to the land owner/manager, local police, RSPCA and local council for consideration before being finalised. Once approved, licensed hunters are linked with the land owner/manager to initiate control as per the risk assessment and procedures. This provides hunters with guidelines on how to best undertake control of deer on the property in the safest manner possible. The procedures, however, do not replace or override any existing legislation regarding firearms or animal welfare.

Figure 1: An example of a shooting station and hunting area identified on private property. The yellow triangles represent corner markers of the hunting area, radiating out from the shooting station. This provides a shooting lane that is safe.

Conclusion

It is anticipated that government agencies, farmers, public land managers and pest control officers will embrace the concept of utilising responsible, licensed and accountable hunters in game and feral animal management. Another effective means to aid in the integrated control of feral animals, including wild deer, can only benefit this state, environmentally, socially and economically.

As Game Council NSW evolves, it will continue to work with land managers and pest and feral animal management agencies where hunting has been identified as a key management tool or as an add on to existing integrated control efforts.

Australian Deer Association

Australian Deer Association Inc.

National Profile

The Australian Deer Association (ADA) was established in 1969. It is a national organisation and has a total of twenty branches throughout Victoria, South Australia, Queensland, Tasmania, New South Wales and the ACT.

The ADA is the largest deer hunting and deer conservation organisation in Australia with approximately 3500 members nationally.

ADA's primary objective is the conservation and management of Australia's historical wild deer herds to provide sustainable hunting opportunities. ADA also considers that the long term welfare of the deer comes before the short term interests of hunters. ADA has a strong history of initiating deer conservation and research projects and has proposed changes to hunting regulations where they have been considered necessary for the benefit of the deer.

The Association and its members are also dedicated to the retention of habitat for deer and other wildlife and the preservation and extension of public access to Australian bushland.

The ADA takes a strong stand against cruelty and incompetent or irresponsible hunters. The Association requires that ethical hunting is a condition of its membership, therefore all members must abide by the Association's Code of Conduct.

The ADA conducts comprehensive hunter education programs that have a strong emphasis on ethical behaviour. The hunter education courses, which are run in Victoria and Queensland, are the best of their kind in Australia and are internationally recognised and duplicated by groups overseas.

The ADA has actively encouraged and financially supported the production of numerous publications on deer management and conservation, hunting, hunter safety, education and training, both in Australia and overseas.

All members receive the association's glossy, bi-monthly journal, *Australian Deer* - a prestigious magazine that is distributed all over the world to people interested in deer. The magazine is widely regarded as one of the finest hunting/conservation magazines available.

Some notable achievementspromotion of ethical hunting through the development of a National Code of Conductinitiated legislative change to enable legal deer hunting in Queensland

- restoration of hog deer and their habitat in Gippsland
- gained access for deer hunting in National Parks in Victoria
- rehabilitation of fallow deer herds in South Australia
- survey of economic value of recreational deer hunting in Australia
- provision of a world class Hunter Education Course at Rawson, Victoria
- establishment of the Bunyip sambar deer research project
- instrumental in the development of Property Based Game Management in Tasmania
- contributed to the formation of the NSW Game Council and access to public land hunting

ADA'S position on the management of wild deer

One of ADA's primary objectives is the sustainable management of deer, as a cultural asset, on public and private land to enhance this valuable public resource for the benefit of the whole community. To assist in achieving this, ADA, along with wildlife and feral animal agencies, needs to improve our understanding of wild deer behavior and ecology and the best methods of management of deer populations.

The Association:

- will strive to have all state governments and agencies recognise traditional and legal wild deer populations as part of our important cultural heritage estate;
- acknowledges that, in the same way as any native species, deer must be managed to minimise any impact on conservation values, agricultural practices and other private land enterprises;
- does not support illegal deer populations and considers that any deer populations that have been illegally established should receive sustained attention by state wildlife authorities to correct the situation;
- will assist in eradication, management and control programs and strive to have state authorities recognise the value of deer hunters, and deer hunting, as a practical tool in managing deer populations (eg a system that encourages the taking of female deer is more effective in population control than a trophy dominated system.).

ADA supports the principle of facilitated partnerships by seeking collaborative working relationships with:

- state wildlife departments
- state statutory authorities managing national/state parks and reserves
- landcare groups
- state farming organisations

In partnership with others, ADA can contribute towards the resolution of deer related issues with the establishment of Property Based Game Management (PBGM) programs to address:

- deer related issues for land managers
- improved management of deer and deer habitat on private land where landholders are rewarded for their commitment to such a program

Cooperatively, we can seek to raise public awareness of the benefits of responsible management of wild deer populations.It is recommended…

- that state legislation and regulation must be appropriate in allowing for effective management of all wild deer
- that state governments, after consultation with all key stakeholders, develop a management strategy to effectively manage wild deer populations
- that the employment of professional game biologists and managers to carry out deer management plans is essential to ensure management objectives are achieved.

Current state activities

Queensland

- further research into the social and economic value of wild deer
- induce appropriate classification status for wild deer through legislative change
- contribute to development of management plans for sustainable use of deer
- Queensland hunter education course recognised as an accredited course by the NSW Game Council

Victoria

- actuate the adoption of a deer management strategy by the Government
- development of PBGM for effective deer management and control
- advance the Memorandum of Cooperation with Parks Victoria as a framework for deer management within Parks including joint monitoring programs
- recognition by Government of the need for appointment of game managers

South Australia

- working towards conserving the historical herds of fallow deer and implementing strategies for eradication of all other deer species
- assisting with the implementation of NRM State deer strategy in conjunction with all stakeholders through representation on advisory bodies and provision of expertise

- facilitating effective management of deer on private and public land to minimise impact on agricultural practices and the environment

New South Wales

- providing support to NSW Game Council to facilitate access to public land for feral animal control
- through membership of an approved organisation, enable hunters to comply with the reporting requirements of the NSW Police Firearms Registry

Australian Capital Territory managing deer populations for private landowners under a controlled 'Conservation Through Hunting Program'

- communicating with government through Environment ACT with regard to survey, monitoring and access proposals for leased land and ultimately public land to minimise the impacts of deer

Tasmania

- promoting the expansion of Quality Deer Management and PBGM in support of the Tasmanian Deer Advisory Committee and the Game Management Unit (DPIWE)
- research into the benefits of an extension to the deer hunting season
- development of partnerships with Forestry Tasmania and Hydro Tasmania that provide for management of deer on government land.
- accreditation for all hunters to enable ongoing access to private property

The Australian Deer Association is in a strong position to contribute to the successful management of wild deer throughout Australia, which includes the integration of control and sustainable use of a valuable resource.

Wild Deer In Queensland

RIDGE Inc (Research Into Deer Genetics and Environment Incorporated)

A brief history of the RIDGE group

The group known as RIDGE (Research into Deer Genetics and Environment) was initiated in 1992 as a non profit organisation open to all interested parties, with the aim of instigating a self funding, self regulating and sustainable management system for wild deer in Queensland.

The group has actively promoted management techniques, such as strategic fencing, cropping and pasture rotation, combined with hunting for venison and trophies along with seasonal herd culling, to provide a balance within wild deer herds that is acceptable to land users. (McGhie and Watson 1995)

These management principles have been based on information and research from other countries, as well as information gathered from Australian Government Departments, Sporting Clubs, private individuals and research conducted directly by the group itself. All management principles are currently being evaluated and refined under actual field conditions.

RIDGE actively supports cooperation between landowners and hunters by providing legal access through a balloted hunting system. This system provides the opportunity for gathering data and educating new hunters towards an ethical approach to hunting, while at the same time allowing the participating landowners to obtain a financial reward from wild deer on their land. This system has received widespread support from local authorities and other land users.

The RIDGE group's ongoing research strategy is funded largely from money raised within the group, while personnel from Queensland universities and private individuals carry out this research.

RIDGE membership is growing steadily and has representation from the majority of deer interest groups within Australia.

Overview of wild and domesticated deer in Queensland

Introduction to the wild

(*An Introduction to the Deer of Australia*, Bentley 1998)

Red deer (*Cervus elaphus*)
The first red deer were brought into Queensland in 1873. Initially there were two stags and four hinds presented to the Queensland Acclimatisation Society which was operating with Government consent at that time. These animals were gifts from Queen Victoria to the people of Queensland for their food and recreation.
This first release was at Cressbrook near Esk. In total nine animals, being six females and three males were introduced, which originated from German, English and Scottish bloodlines.

Fallow deer (*Dama dama*)
The first shipment of six fallow deer arrived in Queensland from Tasmania during 1865. They were held in Brisbane by the Queensland Acclimatisation Society prior to their release at Westbrook, the Darling Downs and Warwick, during the period 1870 to 1872. A further introduction was made at Pikedale in 1890.

Chital deer (*Axis axis*)
The Queensland Acclimatisation Society released chital deer on the Darling Downs during 1870 but there is no evidence that this herd survived. A further introduction of two stags and two hinds from Ceylon was made at Maryvale Station, on the Burdekin River by pioneer and explorer, Mr William Hann in 1886.

Rusa deer (*Cervus timoriensis*)
In 1912 between eight and ten deer were introduced to Friday Island, with full permission of the Federal Government, by Mr N H Hockings. These animals or their descendants later swam from there, or were transported, to colonise Prince of Wales and other islands.

Hinchinbrook Island
The Queensland Government released two red deer males and two females on Hinchinbrook Island during or near 1900, as future food for castaway sailors. A further liberation of one stag and one hind was made during 1915 or 1916. These animals were protected under an Act of parliament.
It is unclear if any animals still remain from this original liberation.

Deer farming

Wild deer have been caught and confined by landowners since soon after their initial liberation. This was done as a novelty, rather than for any economic gain; however, deer capture and farming for profit started in earnest during late 1977.
Farmers wishing to capture deer were required to apply for a permit from QNPWS were subject to strict restrictions and were required to pay a royalty to the Government for each deer taken. A permit was required to make captured deer 'farmed deer', and a further fee was also required.

From 1 October 1985, deer farmers were required to be licensed with the DPI for an annual fee of $15. There were three main categories of licence:

- feral area,
- non feral area
- combined

Farmed deer were required to be earmarked and ear tagged, strict fence height requirements were set, and movement restrictions were imposed (DPI circular 1985). As the majority of deer farmers were also existing cattle producers within the established 'feral' deer areas, there was constant pressure on government departments to relax restrictions that were seen as stifling the deer industry. These included:

- fence height requirements
- movement restrictions
- trapping restrictions
- hunting restrictions
- non feral area restrictions.

The *Deer Farming Act 1985* stayed in force until 1995. Once repealed, it allowed for substantial movement of deer into areas formerly restricted by legislation. This has helped to create present problems that exist with numerous new feral populations.

Present position

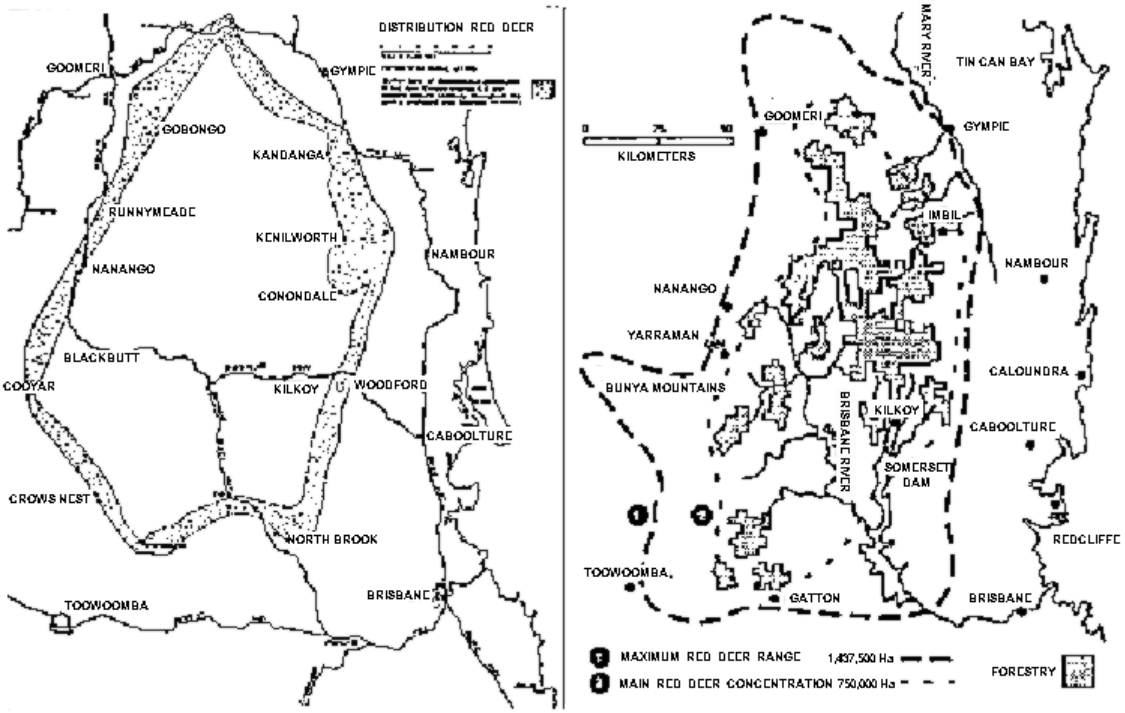
Wild deer in historical areas
Since the end of the deer trapping era in the early 1990s, there has been a slow recovery in wild deer numbers in line with 1995 RIDGE estimates. In many areas, local opinion suggests that deer numbers have reached a plateau due to increased hunting pressure brought about by the delisting of deer from 'protected fauna' to 'feral' in 1994 (McGhie and Watson 1995).

The 'feral' range of the red, fallow and axis deer herds in Queensland were defined under the *Deer Farming Act 1985.* (Govt Gazette 1985 p. 383).

Red deer (*Cervus elaphus*)
During 1978, AKSearle QNPWS, detailed the distribution of red deer in the *Queensland Agricultural Journal* (Figure 1).
MS Parker and AK Searle did this again in 1980 and 1981. They described the herds then as being 'stable' (*Queensland Agricultural Journal* 1981).
The Red Deer range was again defined for the Conservation Through Sustainable Use of Wildlife Conference at the University of Queensland in 1995, as being essentially similar to the 1985 description (McGhie and Watson) (Figure 2).
The existing core red deer range as detailed under the *Deer Farming Act 1985* is estimated at (+/-) 750 000 ha with an overall population of between 8000-10 000 animals in 1991. (QNPWS 1991)
Present population estimates stand at between 10 000 – 15 000 animals in the same area (McGhie and Watson 1995). This estimate does not include any deer originating from recent

releases outside of the designated ‘feral’ areas, nor does it include new releases of other species of deer in this area.

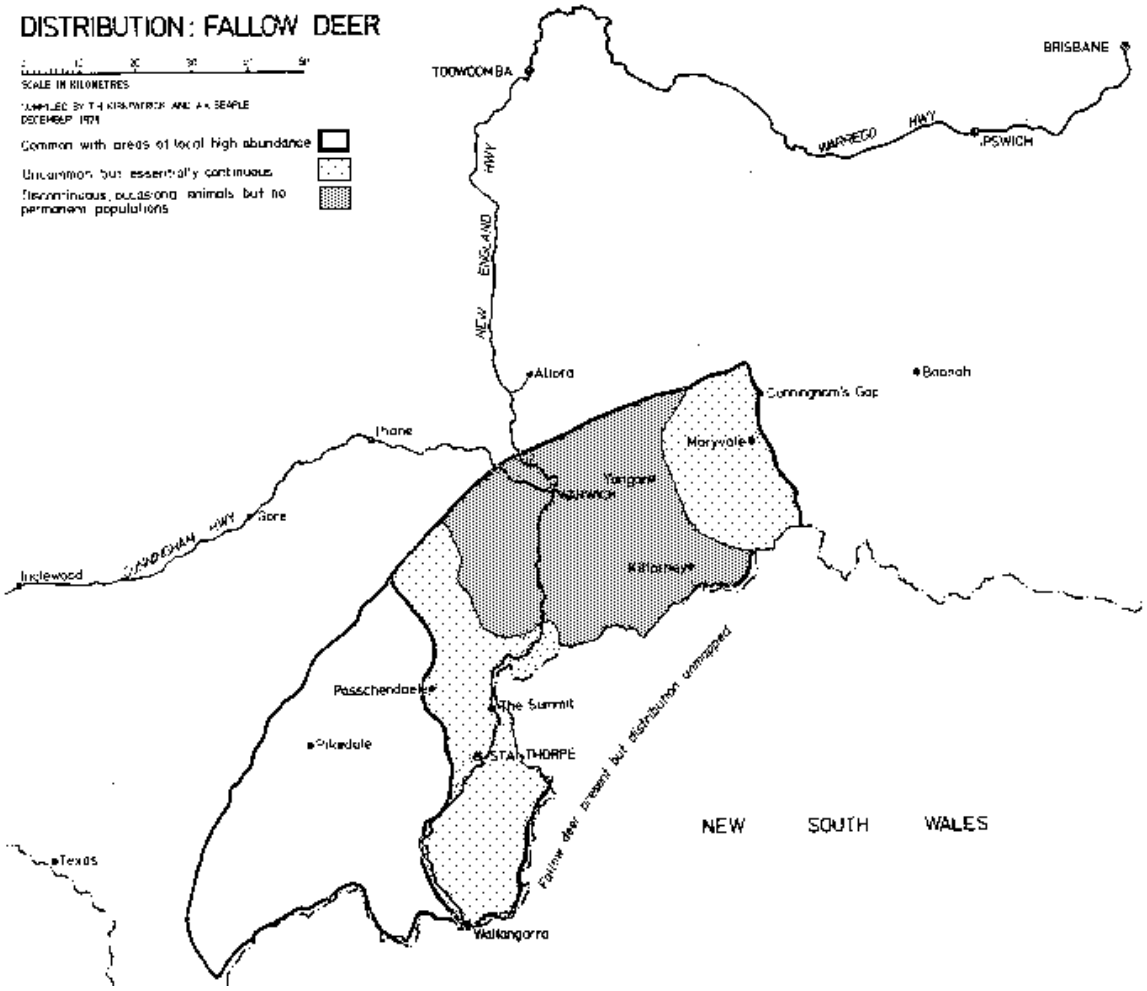
Figures 1 and 2



Fallow deer (*Dama dama*)

The present range of fallow deer in Queensland remains very similar to what was described by Parker and Searle in 1978 (Figure 3). Fallow deer populations have increased noticeably in some areas and have reduced considerably in others. It is felt that overall, fallow deer numbers in Queensland have stayed constant since the end of deer trapping in 1992, at approximately 1800 to 2500 head.

Figure 3



Axis (*Chital*) deer (*Axis axis*)
Chital deer numbers in the historic range around the properties Maryvale, Niall, Bluff Downs etc increased due to favourable seasons and only limited trapping pressure during the 1990s.
Continuous drought conditions for many years has seen some individual herds suffer significant losses but has also caused the spread of axis deer into new areas. Localised professional shooting for venison has reduced populations significantly in other areas.

Rusa deer (*Cervus timoriensis*)
Moluccan Rusa deer still remain on Prince of Wales and Friday Islands at the tip of Cape York Peninsular. Small herds have established on some other adjacent islands but numbers have remained relatively constant due to heavy local hunting, some harvesting for deer farming and the availability of feed.
RIDGE feels that due to these factors, the actual herd size and present distribution of both these herds would require further research in the near future for accurate estimation.

New releases of seer

Prior to 1991 there were very few releases of farmed deer into new or existing deer areas due to the very high prices paid for deer as breeding stock for the deer industry. Drought, fluctuating prices and reduced restrictions within the deer industry made deer affordable for some hunters to purchase and release for future hunting.

In some areas, deer farmers faced with drought and low prices simply released their deer. There are now new releases of deer throughout the whole state. These animals, being far less wary and far more familiar with built up areas, have brought deer and deer related issues into the public arena.

There are now releases of additional species including Javan rusa, Moluccan rusa, sambar (plus hybrids of all three species) red/elk hybrids and blackbuck antelope. These populations will soon be evaluated as part of the RIDGE group GIS mapping program, scheduled for completion in early 2004.

Attitudes towards wild deer

a) Landowners

The attitude of landowners towards deer has always been changeable, with feelings ranging from indifference through to outright hatred. Some landowners changed from an attitude of dislike for the deer, which were competing for their pasture with domestic stock, to one of vigorous protection once they were seen as being valuable to the deer farming industry. Most landowners have always accepted or tolerated the presence of wild deer as long as their numbers were at a manageable level.

Negative attitudes have been shown towards deer due to:

- their ability to carry and transport cattle ticks
- their ability to become a significant feral pest.
- them becoming future vectors of diseases

b) Deer Farmers

There remains strong confidence in the deer farming industry amongst its supporters. These people recognise that increased support for their industry and improvements in market prices would herald immediate demand for additional breeding stock which could be sourced from wild or newly released populations.

c) Hunters

The attitude of hunters towards deer has generally been more constant, with an overwhelming desire shown for their continued presence as a game species. This can be attributed to the long and constant link that many Australian families have with deer and deer hunting, especially amongst those of European or Celtic decent. In some cases, traditional hunting practices linked with wild deer go back at least five generations in this country, with an unbroken European tradition stretching back further than can be traced.

Some hunters have felt that they possess an unwritten right to hunt deer wherever they can be found. When faced with what was seen as unworkable restrictions imposed by government during the organised hunting seasons, this attitude has led to the establishment of a recognised subculture of poaching (McGhie and Watson 1995).

This feeling of disenchantment with government over hunting and the management of deer has led to the level of new releases of deer now seen across Australia. The vast majority of deer hunters now are comfortable with the idea of game management, which would include the need to obtain permission for access from landowners and to pay fair compensation for animals harvested.

d) Government departments - general overview

Since wild deer were proclaimed as ‘Introduced Fauna’ under the *Fauna Conservation Act 1952* the attitude of government departments towards them has changed significantly, due mainly to the attitudes of the different political parties in power at the time and the personal feelings of individual ministers. Red deer were once held in such regard as to be place on the Coat of Arms for Queensland.

Deer have been fully protected since 1952 and severe penalties were in place for anyone apprehended for taking deer illegally; however, a recognised illegal harvest continued (Parker and Searle 1982).

During 1976, an ‘open season’ for hunting was trialed with limited success.

In 1979 a regular hunting season was instigated with hunters required to complete an application form for both a permit and for deer tags before being issued with a licence. This required landowners to state that there was damage being caused by deer, which required their removal under a section 25 permit. This caused many landowners to feel that they were making a false declaration, creating reluctance and negative attitudes towards the system.

Department of Environment and Heritage
In July 1991, the then Minister for Environment and Heritage, the Hon Pat Comben stated '… deer will remain protected fauna in this State for the foreseeable future' (Boyland 1991).
By September 1992, however, the decision to exclude deer from the new *Nature Conservation Act* was released to the media: '… my department will not be treating this kindly animal anything like the very destructive feral pig or feral cat' (Comben 1992).
In a letter to a landowner in June 1992, the Executive Director, Department of Environment and Heritage, Dan Gillespie stated:
'I share your view that there are benefits to be realised from the promotion by responsible hunting organisations of ethical hunting practices' (Gillespie 1992).
In a letter from the premier's office in November 1992, the assurance was given that 'There are no plans for Government agencies to eradicate deer on Crown lands in Queensland' (Mickel 1992).

Shire councils
There has always been a high level of support for a sustainable approach towards wild deer management within shire councils throughout the historic wild deer areas. Prior to wild deer being excluded from the *Nature Conservation Act 1993,* considerable support was offered by councils for some protected status remaining on wild deer within historic boundaries as defined by QNPWS (Order in Council 1985)
Mayor of Kilcoy Shire, Mr A Brown stated: 'It is ludicrous in the extreme to say that lifting all protection on deer will have no great impact' (Brown 1994).

Department of Primary Industries and Forestry
As there has never been any hunting allowed on forestry in Queensland, as it has been in other states like Tasmania and Victoria, wild deer have been seen as a nuisance or even a threat to young tree plantations. Against advise from the premier's office, the DEH and QNPWS, widespread culling of deer escalated in forestry areas after the *Fauna Conservation Act* was changed. The actual damage caused by wild deer in these areas has never been quantified, but could be seen as more economic than environmental.
It is estimated that between 30–40 percent of the core historic red deer area is either forestry or forestry leasehold country.

Department of Lands
Under DPI and Department of Lands Legislation, deer were not allowed to be farmed above the 17th parallel, nor adjacent to dorestry areas or national parks, due to the concern with deer escaping and creating feral populations (Dept of Lands 1992).
The attitude of government ministers was extremely negative towards wild deer. In a letter to the Hon Molly Robson, Minister for the Environment and Heritage 1993, the then Minister for Lands, Mr G N Smith said 'the economic and environmental risks posed by feral deer outweigh any beneficial uses … [they] are considered to be minor pests at present, with certain species possibly having the potential to become more costly and destructive pests in the future' (Smith 1993).

Strategic plan - research

Over the past 10 years, since its inception, the RIDGE group has been working towards an overall management strategy for wild deer, realising that such a strategy must be backed up by accurate, realistic and sensible research.

The areas that RIDGE has identified as the most pertinent for research include:

- herd size and population densities
- natural increase
- sex ratios
- predation and limiting factors
- nutritional, parasitic and health status
- migration and seasonal habits
- age distribution
- genetic diversity
- value to the community
- problems associated with new releases

- law and order

Methodology

To achieve accurate results, in the shortest possible time, with limited funding, RIDGE has utilised both the scientific community and private individuals, in conjunction with government departments and organisations, to compile data.

Research coordinator
RIDGE research has been coordinated by Dr Graham Hall, Head of the Game Unit, Department of Primary Industries, Water and Environment, Tasmania. Dr Hall's role has been to assess the list of research topics, prioritise and set parameters. Dr Hall compiles data gathered by hunters, landowners and compares it with aerial surveys.

Environmental Ssientist
The environmental scientist used by RIDGE for GIS mapping and landowner surveys is Mr Ted Pedersen.

Landowners and hunters
RIDGE recognises the important role landowners and hunters can play in the collection of relevant data. Specially designed data collection forms are carried into the field by each hunter after they have gone through a training session conducted by members of the RIDGE executive.

Research topics

In the following are details of each area of deer research conducted by RIDGE to date. Additional details not included in each section are referenced and can be found at the end of this paper.

Herd sizes/population densities

a) Landowner and hunter data

RIDGE has sourced information from landowners and hunters over the past eight years, on properties across the Brisbane, Mary and Burnett river systems. The aim has been to accurately estimate:

- a historic growth rate
- the overall herd size
- movement patterns

Some families have lived on or around their present properties since deer were first released and their notes and recollections give a good basis for estimations. This data has been collated by Dr Graham Hall taking into consideration inherent problems with anecdotal opinions.

b) Wave Expansion

It appears certain that red deer populations expanded across these watersheds in what is commonly called a 'wave'. Populations would build up in a certain area, usually around a creek system, before moving reasonably rapidly into another, leaving behind a resident population. This would continue until a natural or manmade barrier was reached. Which animals are more likely to move, what age group and which sex, are questions RIDGE's research aims to provide the answers to.

c) Peak Density

Red deer populations appear to have reached a peak between 1960 and 1970, before dropping back in the face of escalating pressure from trapping and hunting. Once deer trapping stopped, pressure from hunting continued to increase, especially since deer were rejected from the *Nature Conservation Act.*

d) Drought

Severe drought sequences, over the entire red deer range from 1991 to 2003, have also had a considerable effect on deer numbers, and have forced them into far more confrontation with landowners due to feed shortages.

e) Natural Boundaries

Compared to the early 1900s, there are now more definite natural boundaries for red deer due to residential expansion along the east coast and around the outskirts of Brisbane, Ipswich, Gatton and Toowoomba. More heavily cultivated and cleared country from Oakey, through to Dalby, Kingaroy, Murgon, and to the top of the known range at Ban Ban Springs, has made any expansion into these areas extremely difficult.

f) Population Estimate

RIDGE estimates put wild red deer numbers close to or slightly above the 1970 peak at 10 000–15 000 across a total range of less than 1.5 million hectares. It is estimated that over 95 percent of the total wild red deer population live in an area less than 750 000 hectares. It is also recognised that there are clear differences in herd densities within this area, caused by towns, heavily cleared areas, major dams, and also areas that can remain without good feed or water reserves for extended periods.
This suggests a realistic core area of around 500 000 hectares and an overall population density of between 1:30–1:40/ha, within the core area.

g) Helicopter Surveys

A Robinson R44 helicopter has been used to verify ground based data collected from hunters and landowners. An independent assessor makes deer density estimations on selected quadrats of approximately 1000 ha. The estimates are based on existing data and kept confidential from the helicopter pilot and observers. These quadrats are then flown using successful aerial capture methods developed over these same areas between 1980 and 1991. All animals sighted are video taped and left undisturbed, giving a very high success rate on sightings. Presently, RIDGE is compiling this data on an overall GIS mapping program, which will eventually give the most accurate estimation of wild red deer numbers ever.

Sex Ratios

a) Hunter preferences

Sex ratios also fluctuate across the whole range, which seems to be a factor associated more with pressure from hunting and meat shooting than any other. Due to a preference by hunters to shoot more males as trophies, a preference by meat shooters for ‘spikers’, or younger aged stags, and a possible ability for females to live longer than males, in many areas there can be far more females than males.

b) Juvenile sex ratio

Data collected from capture operations, deer hunters and deer farmers both in Australia and New Zealand, as well as Europe, suggest that the sex ratio of new born fawns is usually close to 50/50, with some seasonal fluctuations each way. There is a possibility that there is a higher level of juvenile mortality amongst males than females and this is an area presently under research by RIDGE (Snavely, 1997).

c) Herd viability

Just what effect a low level of male deer within a herd has on the overall performance is not entirely clear. Research suggests that the best sex ratio is 1:2 or even 1:1 (one male to one female), but in areas of high juvenile mortality, questions remain . In many areas, RIDGE is promoting a reduction in female numbers and a reduction in young stag harvesting.

d) Sex ratios recorded

During the last eight seasons, data collected suggests sex ratios within research areas are of between 1:1 and 1:5 stags to hinds. Hunter accuracy with data collection is seen as quite high,

as most sightings are during a time when animals are highly visible. The main observation asked from hunters is to count antlered and non antlered animals, as this is the most obvious distinction between the sexes. Counting known age stags with their first antlers or 'spikes' provides another very accurate gauge of the number of male progeny that has survived from the previous year.

Predation and limiting factors

a) Predation

The main recognised predators of wild deer apart from man, are:

- Dingo (*Canis familiaris dingo*)
- Wedge-tail eagle (*Aquila audax*)
- Scrub tick (*Ixodes holocyclus*)

A comparison of fawn survival rates of red deer in countries or islands without predators, to those witnessed in Queensland, indicates differences (McGhie and Watson 1995). Aerial counts conducted by RIDGE so far have shown the lowest fawn survival rates in areas where the most dingos were seen (Hall 2000).

There is considerable anecdotal evidence from farmers and hunters to substantiate these claims, however it is possible that more than one 'predator' may be involved at any one time. For example, a young fawn weakened by ticks may be more vulnerable to a dingo or eagle.

Areas burnt by landowners just prior to the fawning season of red deer will attract hinds. Often fawns are born into areas of low cover, which provides a perfect hunting ground for predators.

b) Drought

Areas suffering from drought will have far greater concentrations of heavily pregnant females and newly born fawns around remaining water supplies. Older females are often in a weakened state, have lower lactation produces weaker and often out of season fawns.

c) Trophy hunting

Historically, there has been a growing harvest of deer by hunters throughout the red deer range since their releases in the late 1800s. This harvest has escalated since 1970, due in part to increased awareness of deer areas amongst the general public as a result of coverage in magazines and books.

The inception of hunting clubs and trophy scoring systems heralded the start of competitions and trophy registrars. When this is combined with far better access into deer areas, better four wheel drive vehicles, rifles, GPS systems and the lessening of penalties for illegal shooting, we are now witnessing the highest ever harvest of wild deer for trophies by recreational hunters.

d) Personal use of venison

Harvesting of venison for personal use has also become far more popular over the past 20 years and is also now at its highest level. Most venison animals are now taken with the consent of landowners but there is a recognised illegal trade in 'black-market' venison.

e) Game meat harvesting

Game meat harvesting of deer is legal in Queensland by licensed operators but has been limited by low market prices and lack of supply. The majority of harvesting so far has been carried out on the chital deer at Charters Towers, as well as some fallow deer at Stanthorpe and a small quantity of red deer also.

f) Environmental effects

Climatic conditions and feed types have long been considered as possible limiting factors on wild deer compared to survival rates in their native environment. This has not been found to be overly significant under deer farming conditions but RIDGE has instigated research into this possibility under wild conditions.

g) Genetic effects

Research conducted in Scotland has suggested that levels of inbreeding can have significant negative effects on reproduction (Slate *et al.* 2000).
How this relates to wild populations is not clear but it is suspected that many areas of the red deer range have some level of inbreeding due to the limitations of the original release animals and hunter selection. RIDGE has instigated research into wild red deer by collecting samples for DNA testing.

Nutritional, parasitic and health Status

a) Cattle tick research

Following concerns raised by landowners in 1998, with regard to the possibility of red deer posing a significant threat to cattle producers by spreading and hosting cattle ticks (*Boophilus microplus*), RIDGE decided to instigate a research program.
The Gatton College at the University of Queensland was commissioned to carry out the research, with Prof Gordon Dryden as supervisor and Neal Finch as research assistant. RIDGE group provided the funding and RIDGE balloted hunters helped with the collection of samples (Finch 1999).
This research found that although red deer do carry cattle ticks, it is at a lower level than cattle and could be linked with the level of cattle husbandry on the properties they cohabit on (Finch 1999). Previous research carried out by the CSIRO and DPI suggest that deer are a low level host and that tick viability on deer is also far lower.
Research in America found that cattle ticks can be eradicated from an area without the need for existing deer populations to be removed (George 1997).

b) Nutritional status study

During 2002, a study was again commissioned through the University of Queensland Gatton College to look at the nutritional status of wild red deer.
This research was supervised by Prof Gordon Dryden, with Neal Finch as research assistant. Neal was conducting this study as part of his Honours degree and it was funded jointly by Gatton College and funds raised by RIDGE group.
Research so far has shown that wild red deer carry low levels of parasites, free from any known disease and are nutritionally on par with any other population in the world (Finch 2000).

Migration and seasonal habits

a) Local opinions

Opinions vary amongst landowners and hunters as to how far wild deer travel and what sex or age group of animals are likely to do so, and why. Anecdotal evidence from hunters suggests that wild deer can move many kilometres at times to raid a ripening grain crop, while at other times they can be seen perishing through lack of feed or water without attempting to shift.
Migration of older aged red deer stags and the homing desire of older aged hinds are commonly talked about but have never been quantified, and it is in this area that RIDGE has been conducting research since 2001.

b) Radio collaring program

During May 2002 the first red deer stag was captured, collared and released under the RIDGE Wild Red Deer Radio Tracking Program. The protocol for this program was developed by RIDGE Research Coordinator, Dr Graham Hall, DPIWE, Tasmania (Hall 2001).
A further two stags were collared during late 2002 and their movements recorded on a weekly basis. A further seven animals will be collared by January 2004 at regular intervals across the centre of the red deer range. All deer collared will carry transmitters made by Sirtrack Industries with frequencies from ten to 100. Signals are received with a three-piece Yaggi antenna and receiver and recorded on a GPS.
The aim is to:

- radio collar ten male red deer
- provide a continuos supply of information on their habits, genetic ability and movement patterns

- compile data over a five year period using GIS mapping strategies

This information will be collated by Dr Graham Hall and the program will be funded by RIDGE. It is hoped to be able to extend this research to include fallow and chital deer as funding allows.

c) Initial results - collared stags

The second and third stags collared were 2.5 and 3.5 years old and have lived in an area of less than 1.5 km radius since release. These animals were observed repeatedly showing no disruption or irritation from the collars they were wearing (Hall 2003).

The original stag collared was 5.5 years old when released back to the wild and he stayed in an area of less than 1 km radius for exactly one year with a group of other younger aged stags. This animal then moved quickly across an area of agricultural land and took up residence two kilometres away, with other stags of his own age or older, in a similar area of habitat (Hall 2003).

It is suggested that mature stags will roam a seasonal route sourcing better feed supplies before returning to their mating areas in early March.

d) Tagging program

When the RIDGE group first began, a number of red deer females were captured, tagged and released back into their home range. These animals were made known to landowners and hunters and their sightings were recorded.

Since then, other groups of females were also tagged and placed with permission on landowners' properties. The habits and fate of these animals has also been noted and forms the basis for recording methods to be used for the Red Deer Tracking Program.

e) Initial result — tagged females

The tagged red deer females have shown a reluctance to move more than three kilometres in any direction from their starting point with most travelling less than two kilometres. The vast majority have spent the majority of their time in one watershed, some spending ten years on the one range.

A RIDGE hunter shot a red deer hind for venison in 2003, in the same gully system where she was caught, tagged, photographed and released during late 1987. This animal was tagged as part of the Australian Deer Association, Calf Tagging Program, which was instigated in 1976.

It is felt that hinds will move if necessary to source better feed, during mustering operations, in periods of intense hunting pressure, or during fires, but that they are normally very sedentary.

Age Distribution

Research in America suggests that when a predominance of older animals or same sex animals occurs, it can have a marked effect on the level of younger animals that remain in an area (Snavely 2002).

It seems possible that if a concentrated level of hunting has occurred for both trophy stags and young spikers for venison, it can eventually lead to an abundance of adult females and old males of poor genetic quality. Prior to fawning, mature hinds will exert extra pressure on the remaining spikers to leave the area and old aged stags will keep up constant pressure on them as well, compounding the problem further.

RIDGE data collected so far suggest a predominance of older aged females and older aged 'cull' stags in areas that are past their prime, ie were at their best 20–30 years prior. Data collected from both male and female deer by RIDGE hunters, suggest an average age of 8.7 years.

In the case where a landowner may wish to earn an income from wild deer, it may not be viable due to a significant excess of female deer and poor quality stags, which can lead to a situation of no management, overgrazing and problems for neighbours.

It is suggested that a herd with an even sex ratio and an even age distribution will cause less trouble and be far more productive (Hall 2003).

Natural increase

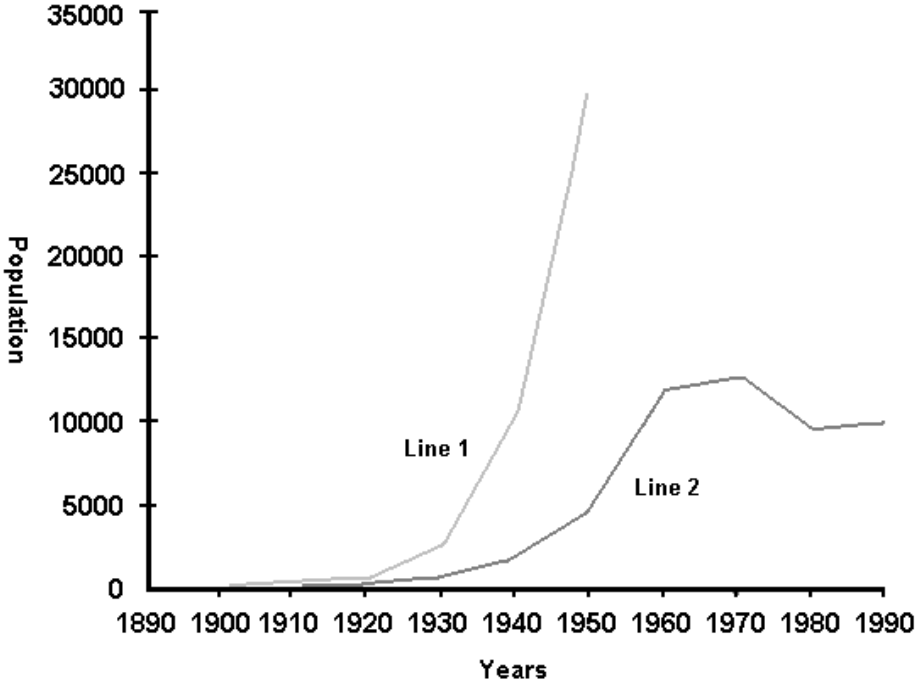
a) Natural increase estimates

Insufficient data has been collected so far to give an accurate estimation of the natural increase within fallow, chital or Moluccan rusa herds in Queensland but it is felt that an initial estimation can be achieved for red deer.

b) Population growth

Research carried out during 1995 suggests that red deer in Queensland have increased since their release date in 1873 at a rate less than ten percent per annum (Line 2). In contrast, red deer in New Zealand have increased at a rate of at least 15 percent to 20 percent per annum, which explains the contrast in numbers that have been harvested in that country compared to Queensland (Line 1) (McGhie and Watson 1995).

Figure 4. Estimated population growth of red deer herds based on conditions in New Zealand (15% annual growth); and Queensland (10% annual growth).



c) Helicopter and ground data

Data collected so far suggests a fluctuating fawn survival rate that in some areas can be as high as 95 percent and as low as 10 percent in others. RIDGE research is investigating all possible reasons for this, such as predation, feed stress, climatic conditions, parasites, possible diseases and inbreeding, to name just a few.

Initial estimates suggest an average annual fawn survival rate to maturity of between 30 to 40 percent of the total female herd.

d) RIDGE estimation of wild red deer natural increase.

If a baseline estimation of the present wild red deer population was accepted as being 12 000 head (see section 8.7b), an estimate of the over natural increase can be formulated using the following parameters;

- A sex ratio of one male to three females.
- A conception rate at 75 percent of total female herd per annum comprised of:
    - o two percent of the 1500 weaner females conceiving (Finch 2000)
    - o 70 percent of the 1200 yearling females conceiving
    - o 95 percent of the 5000 mature conceiving
    - o 85 percent of the 1300 aged conceiving

- A fawn survival to maturity at 47 percent of the total conceptions (35 percent of the total female herd per annum)
- A natural aged and accident mortality of five percent separate from fawn mortality (5% of 12 000 = 600)
- A 30 percent male deer harvest, and five percent female deer harvest annually by hunters.

e) Quantity Harvested by all methods

Red deer

Information gathered from local taxidermists and from hunters in the major towns throughout the area suggests:

- There has been an annual harvest of red deer exceeding 1000 head since pre-1960.
- The estimated harvest of red deer in the historic red deer range in 1995 was 700-1500 per annum.
- 500-600 mature stags were harvested as trophies during 2003.
- 1200-2000 females and young stags were taken for venison during 2003.

Present day harvest of trophy and venison animals could now be as high as 1500-2500 per annum (McGhie and Watson 1995).

f) Summary

A combination of limiting factors suggests that wild deer numbers are presently keeping to a low rate of natural increase.

These factors include:

- natural geographical limitations
- predation
- increased hunting
- better management strategies
- drought
- Game meat shooting.
- localised eradication programs in forestry areas

Genetic diversity

The information existing about the initial releases of deer into Queensland is quite sketchy as to the actual bloodlines or strains and their origins.

In the case of the chital and Moluccan rusa, which stem from just a few individuals (presumably from the same base herds) the problem of inbreeding is not as big as with other species, due to their natural ability to outcross.

a) Breeding rotation of deer under minimal hunting pressure

Red and fallow deer only mate once a year on a very regular timeline. In herds living in a totally closed natural state, a mature stag will command a herd for a number of years before being displaced. For example, some stags have been observed holding 50-70 females for up to four weeks before being overwhelmed by another stag, but the original will return at the same time to the same females the following year. Stags, which exhibit the best combination of body weight, temperament, antler weight and style, have the best chance of mating.

b) The Queensland situation

Due to continual and very selective hunting pressure in some areas, it has been noted that often stags or bucks with the least desirable genetic traits are the only mature males left to mate. Young males of the best genetics are taken before they are old enough to challenge for females, which can lead to the situation where lower genetic males gather and mate with the same group of females for a much longer period before being replaced by another low quality animal.

This leads to a high level of inbreeding in areas where there is little migration of young females and results in the overall devaluation of the herd from both a trophy and an economic viewpoint.

c) DNA sampling

RIDGE has already collected sufficient samples from wild red deer across the majority of the wild deer range to undertake research into the level of genetic diversity with the overall herd. As funds allow, the research can extend to the other deer species as well.

d) Hybrid vigour

During 1993 and 1994, RIDGE attempted to look at the positive benefits from the strategic infusion of additional genetic animals into the Queensland red deer herd. Proven breeding stags, of the same genetic lines as the original releases, were selected from existing deer farms and mated to wild red deer females that were temporarily displaced from their home range. Once mated, these females were tagged and allowed to return to their areas, where their movements and habits were recorded.

Special attention was paid to their progeny once born, to ascertain if there was any noticeable hybrid vigour exhibited. Observations from RIDGE hunters were very consistent, with a marked increase in body size apparent and a very noticeable increase in antler quality on the young stags.

Some young spikers carried far better 'heads' (sometimes with 7-8 points), than had been recorded within the herds for many years. Unfortunately, due to their increased trophy potential, illegal hunters targeted these stags over the next few years, which ended any further observations.

e) Displaced farm stags

Over the entire red deer range there have been incidences of imported bloodline stags escaping from deer farms. Without exception, these animals have continued to exhibit their genetic potential, some growing the best heads ever seen in the wild in this country. This fact is seen as an indication that feed supply and quality in the Queensland bush is sufficient to achieve maximum growth, if the genetic quality is present in the animal to start with.

Value to the community

RIDGE has always maintained the opinion that a well managed and controlled deer herd, existing in country already radically changed by man, has little if any, additional negative environmental impact. Importantly, the herd can provide a significant cultural and economic benefit to the community.

a) Economic benefit

The economic benefit derived from wild deer is linked directly to herd quality. For this reason, RIDGE has encouraged landowners and hunters to manage wild deer in a responsible fashion. In 1990 the total economic value of deer hunting in Australia was estimated at over $77 million per annum.

(Cause 1990)

A balloted hunting program for wild red deer was instigated by RIDGE during 1996, with the aim of developing a sustainable hunting system, unique to this state.

This system is:

- self-funding
- self-regulating
- Mindful of environmental and public concerns
- Able to satisfy the wishes of hunters and landowners

Since its inception:

- Approximately 500 hunters have participated in this system.
- There has been total gross return to landowners of over $500 000.
- The total expenditure by participating hunters, including additional expenses such as camping and hunting equipment, vehicles, fuel, food, airfares, communications etc, would be in excess of $250 000 annually or $2 million since 1996.

b) Cultural benefits

The cultural significance of wild deer to the rural communities within the historic deer areas of southern Queensland is quite clear. Emblems and motifs of wild deer adorn everything, from council and property signs to football teams and place names.

Every year during March and April, large numbers of local families prepare for the oncoming 'rut', or 'roar' as it is affectionately known, as they have done in some cases for close to 100 years. It is not uncommon for three generations of hunters to venture into the bush, onto properties they have hunted for generations, often for weeks at a time.

The main difference that is noticeable between Queensland hunters and those from countries with well recognised hunting traditions lies in the fact that the majority of all hunting in this state was carried out prior to recognised legal seasons and therefore was seldom discussed.

New releases of deer

a) Associated problems

There are inherent problems with new release herds of wild deer. RIDGE group has never supported the release of new herds of deer outside the recognised historic feral areas.

RIDGE recognises:

- the desire that exists amongst some landowners and hunters to have their 'own' herd of deer on their own private properties.
- the need to accommodate other landowners who may not share the same view.
- their responsibility to the environment and to other agricultural industries.
- that new releases of deer can be a positive asset to a new area, as long as all concerns are addressed.
- the implementation of Property Based Management Plans, which include an Environmental Impact Assessment, would be a minimum standard before any release occurred.
- there are many areas of Queensland far less suited to having wild deer present than the existing historic areas.
- that some areas should always remain free of deer or other wild animals.
- that wild deer are generally very hardy and disease free animals.
- The concerns government departments have for wild disease control if deer were allowed to spread in an uncontrolled manner.
- during recent outbreaks of foot and mouth disease in the UK, very little emphasis was placed on wild deer as they were not considered to be a high risk host.
- the present data collection systems used by RIDGE can be a positive asset to government departments by providing a simple and effective monitoring system.

Law and order

Although wild deer were declared as 'feral' the government's ownership of this asset was never vested so wild deer may still remain as property of the Crown. Wild deer are in a state of 'limbo', with no clear title or position except for remaining on the Coat of Arms of Queensland. If deer were suddenly to become extremely valuable once more, there would be little talk about eradication.

Presently there remains considerable uncertainty as to:

- what laws apply, and who should implement them
- who actually owns a deer,
- how feral deer are distinguished from farmed deer

There is also uncertainty as to how to handle the:

- increase of new releases,
- complaints between landowners,
- indiscriminate shooting and poisoning
- loss of value of a potential asset

Legal liability

If deer are declared as a pest species, it may place the government in a position whereby they are responsible and liable for any damage caused on a landowner's property. Precedents have been set where it could be proven that the government had not exercised its full duty of care in

the control and management of an animal that they had introduced or gave permission to be introduced.

Summary

RIDGE believes that wild deer:

- have been present for long enough in Queensland to be seen as an integral part of the tradition and culture of this state.
- command a significant level of public sympathy and support.
- possess huge social and economic potential.
- do minimal additional damage to the natural environment.
- can do damage to specific crops and pastures if not controlled.
- pose little threat as a vector of wild diseases, if managed.

RIDGE recognises the potential for:

- serious civil unrest and disregard for government policies if all stakeholders in the deer issue are not considered.
- the erosion of existing cooperation from most hunters and landowners.
- a sensible solution occurring if all parties are brought together to achieve common objectives.

RIDGE supports the principals of Sustainable Use Management of any wild species that can demonstrate economic values well in excess of potential problems.
RIDGE feels that the optimum herd size within the historic red deer area of Queensland would be between 10 000 to 12 000 head, run under Quality Deer Management principles.
RIDGE is willing to convene a series of meetings between interested participants in the wild deer debate, to look into the points raised by this discussion paper.

Options paper

Management Alternatives
The alternatives for wild deer management in Queensland can be defined as:

- do nothing
- eradicate
- declare them as a pest
- class them as wild stock.
- reclassification as introduced fauna.
- class them as a game animal

Option 1 - Do nothing
This is what has happened since the wild deer were removed from the *Nature Conservation Act 1992*.
RIDGE believes that it would be irresponsible for all parties to allow this situation to continue, when there are other options.

Option 2 - Eradicate
This is an attitude put across by only a limited amount of people and portrays an inflexible and uncooperative approach to the problem when there is no clear reason to take this stance.
To mount a government sponsored and funded program to eliminate all deer out of this state would be a multi million dollar venture, similar to the BTEC (Brucellosis and Tuberculosis Eradication Campaign) program in northern Australia, which cost in excess of $800 000 000 and never totally eradicated the disease (Byme 1998).
There is national and international evidence to suggest that when a wild species becomes established, eradication has never been successful in Australia, eg foxes, rabbit, feral pigs etc.
A program such as this would cause a huge negative response from the public and could raise the level of illegal releases of deer and other species into pristine areas. These new releases still remain as the main issue to be addressed.

Option 3 - Declare deer a pest species
This option could receive a negative public response from landowners and hunters in the traditional wild deer areas. Some councils would be pressured into declaring deer as significant

pests in their shires, effectively pitting one landowner against his neighbour in areas where there are mixed sentiments.
Possible problems include:

- laws concerning trespass and stock theft are so ill defined as to cause serious problems for landowners presently managing wild deer on their properties under sensible and sustainable methods.
- an escalation of claims and legal challenges against private individuals, local shires and other government departments.
- an escalation of deer shot for pet food and human consumption across the whole state, allowing some operators to abuse the rights of landowners, including forestry and national parks.
- an increase in releases of deer and other species into new areas.

RIDGE strongly believes that there are far better alternatives available than a 'pest' listing for deer.

Option 4 - Class deer as wild stock

In North America, there have been many releases of non native species, including chital, red, fallow and rusa deer, blackbuck and nilgai antelope, and mouflon and aoudad sheep.
Whilst there is extremely good management of native and non native species in the USA, RIDGE recognises the need for management systems based on Queensland conditions. It is felt that we can learn much from the USA's mistakes and successes (Muir 1988).
A classification known as 'wild stock' is used in Texas USA, for non native species. This classification:

- puts the onus on landowners to control and manage wild game animals on their properties.
- allows for these species to remain free ranging.
- means if an animal passes across to a neighbouring property, then the ownership of that animal also changes.
- means if the animals are on government land, they are property of the government.
- requires any landowner who wishes to retain positive ownership to fence their boundaries to limit any movement.
- limits illegal activity by giving positive ownership to the property on which they preside and therefore clearer implementation of the law.

If a species is causing damage in an area, landowners can either:

- control the problem by fencing and conserving the resource or
- join with neighbours to reduce and manage numbers. (In the US this has generated a high level of cooperation between all parties and some of the best-known management systems in the world.)

RIDGE believes that a 'wild stock' classification could hold many positive possibilities for future wild deer management in Queensland. The following are examples of how this status could work in this state.

'Wild stock' in Queensland

Historically, in Queensland, most landowners have regarded the wild deer on their properties as their own, to catch, hunt or control, despite their 'Introduced Fauna' classification.
During the period when deer prices were very high (1978–1991) landowners were reluctant to comply with trapping laws imposed on them by the QNPWS (McGhie and Watson 1995).
Hunters have also shown an attitude of noncompliance with laws governing deer hunting because many were either landowners in the deer areas or were cooperating with landowners in some way. There was little reason to comply with existing laws when there was an established history of avoiding them (Searle and Parker 1982).
A classification of 'wild stock' would mean:

- a clear recognition of landowners as herd managers
- legal support and advise against stock theft could be given by police in cooperation with government departments
- provision of the support necessary to Property Based Management Plans, such as those working effectively in Tasmania
- a simple and effective extension of the 'move easy' permitting systemfor stock movement already in place in Queensland could be implemented at minimal cost to allow for self-regulation of the industry.

Option 5 - Reclassification as 'Introduced Fauna'

Although a reclassification as 'Introduced Fauna' is seen as an option, it has gained very little support during discussions held so far by the RIDGE group with representatives from many of the concerned parties.

There could be considerable resistance to this classification from landowners, (both pro and anti wild deer) and also from hunters.

It is recognised that the system in place from 1952 to 1995 clearly was not working and would require:

- considerable changes to relevant Acts and laws.
- the establishment of vehicles, office equipment and staff to administer the system.
- considerable support from participants to raise the funds to administer the system unless government was willing to back it financially in the interim period.

RIDGE believes that although it may have been an option to continue the classification as 'Introduced Fauna' at the time of the changes to the *Nature Conservation Act 1992*, now that the changes have been made it would be difficult and unrealistic to bring the classification back.

Option 6 - Classification as a game species

Wild deer have long been regarded n all European countries as a game animal, although their pursuit was often only available to royalty or aristocracy. When deer were first introduced to Australia, it was done for food and the enjoyment of the settlers of this country (Bentley 1998).

Wild deer in Victoria and Tasmania have a long and continuos history as a game animal and there are sound management policies in place to control both the animals and the hunters. Hunting is allowed on much of the crown land in these states and there is very good participation and support shown by hunters and landowners (Department of Primary industries Water and Environment Tasmania 2003).

New South Wales has recently introduced the *Game and Feral Animal Control Act 2001* through parliament and have established the Game Council. The Game Council will be responsible for wild deer within NSW and will draw its funding from the sale of licences to hunters and landowners.

Wild deer as game in Queensland

The idea of wild deer as 'game' in Queensland has strong support from hunters and from many landowners but there is also opposition from some quarters.

Some landowners' questions include:

- Will it undermine their authority on their own country?
- Will it disrupt already established management plans and harvest systems?
- Will deer become the property of the Crown or become the property of the landowner?
- What guidelines and laws would be in place to allow any system to work?
- Would there be the required resolve on the part of government departments to allow the system to work?
- If a landowner wished to remove all the deer from their property, without having to pay any licence fees or employ government shooters, could they demand the right to do so?
- How to convince neighbouring landowners or hunters that they needed to obtain permission or pay for licences when others did not?
- How would sufficient capital be raised to cover administration?
- Would this come from the sale of licences?
- As property of the landowners, how would existing private management schemes fit in with an overall game management policy?
- If wild deer were classified as 'wild game' and became the property of the landowners on whose properties they resided, could a self-regulating system be set up similar to that suggested earlier under the section Option 4, 'wild stock'?

RIDGE believes that there are considerable benefits to be gained from a 'wild game' classification for all people involved with wild deer in this state, however, unless there was sufficient resolve shown by all participating parties, in reality it could be a more complex way to get to the outcome outlined in Option 4.

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The Australian Deer Research Foundation Ltd

Geoff Moore
Director, Australian Deer Research Foundation

An initiative of the Australian Deer Association (ADA), the Australian Deer Research Foundation (ADRF) is an independent non profit company formed in 1987 to promote the status, conservation and sustainable management of wild deer in Australia. Its objectives include undertaking and encouraging research into the biology and behavioural aspects of deer species and their relationships within the Australian environment. Although independent, the ADRF works cooperatively with its founder.

The most prominent of the deer species in Victoria were of Asiatic origin and there was a paucity of information available on these species, so the need to develop knowledge on how these species fitted into the Australian environment was recognised by some members of the hunting community. While a similar need existed for the deer of European origin, the ecology of these species had already been extensively researched and documented, so the knowledge gap was not as great as with the Asiatic species. The recognition of this knowledge gap prompted the formation of the ADRF.

Attempts by ADRF to interest two Victorian universities in promoting interest in deer research projects failed — on the one hand due to the 'exotic' status of deer, and on the other to a total lack of interest. It would appear that nearly 20 years later, the need for this knowledge has finally been recognised.

Lacking the resources to carry out research at a tertiary level itself, the ADRF initially concentrated on building the sound capital basis required to support its objectives. In doing so, ADRF established a small business publishing books on deer, hunting and related activities; subjects that are generally avoided by mainstream publishers. Additional to providing a funding avenue for the Foundation, this service has also provided an opportunity for authors who would otherwise have found difficulty in having their works published due to the relatively small special interest niche into which they fall.

Works published to date include:

- two major reference titles, including a history of deer in Australia and a world first — a definitive book on the hog deer
- two biographies: one by a wellknown deerhunter, the other by a former wildlife officer
- seven books on deer hunting written by wellknown and experienced hunters
- four works of a technical nature written in support of deer and deer management related studies
- a catalogue of the Cetacean Collection in the National Museum (Victoria)
- one book of an educational nature, including a revision and second reprint
- four books covering poetry, an antlered game exhibition and game preparation and cooking (2)
- an information booklet on the wild deer of Australia

Supporting the publishing business, the ADRF is an importer of overseas titles, has established a retail mail order facility, and supplies books to retail outlets.

The ADRF has also established a debenture issue which asks interested persons or organisations to lend the Foundation a minimum of $100 for periods of two or more years. The money is placed in secure investments with the ADRF retaining the interest. These funds are not utilised in the general running of the Foundation, but are being set aside for use in future deer management projects that require substantial funds. To date, many debenture holders have generously allowed their funds to roll over into further terms, while others have lodged their funds in perpetuity, a significant demonstration of their commitment towards improving the status of wild deer in this country.

Research and management

It has long been considered by the Foundation that a partnership between research institutions and management operations is not only desirable, it is essential. Researchers can formulate and answer many legitimate and interesting questions without the results necessarily focusing on the priority needs of managing wild deer. Management, on the other hand, does not always seek definitive answers before attempting to resolve real or perceived problems. ADRF believes that for the best possible results, it is incumbent on management agencies to raise questions for researchers to answer — focused questions designed to address legitimate management needs, not merely to support dogma that might not have any realistic basis.

ADRF policy is to financially support only such research projects that have genuine management application.

ADRF initiatives and projects supported to date

The importance of literature in the field of hunting is often underestimated. Since its inception, the ADRF has provided an ongoing means by which realistic information is made available to the wider community. Additionally, through its mail order retail system, it provides access to a wide range of books on deer and other wildlife, deer management, conservation and wildlife research.

A major initiative was the introduction of an American wildlife biologist to deer interested people and authorities in Tasmania. This led to the eventual three-year employment of an American game biologist and the formation of a Game Management Unit within the Tasmanian agency responsible for wild deer management. The project introduced the concept of the Property Based Game Management, which successfully operates today in four states, and which overcame many of the problems previously being experienced. ADRF also provided financial support to the project.

Financial support has been provided to the ADA Bunyip Sambar Project, and interest free loans have assisted the Quality Deer Management Association in the USA and the purchase of land by the south east branch of the ADA in South Australia. Self help projects such as these are very attractive to the Foundation.

ADRF assisted in funding the preparation and production of detailed information on reproduction in both hog and sambar deer. The hog deer data was presented at the Biology of Deer Congress in Quebec (2002) in a poster session, and both hog deer and sambar data were presented at the Wildlife Management Congress in New Zealand in 2003. These posters were the first time that detailed information on hog and sambar deer in Australia have been available.

ADRF is a long term supporter of hunter education and has produced, printed and displayed material specifically designed to complement the ADA Victorian Hunter Education Course at Rawson in Victoria. It has also made available educational booklets for similar courses in Queensland, New South Wales and Tasmania.

Reference material

A reference library, which is continually being expanded, has been established by the ADRF and this has been valuable in furthering the Foundation's objectives and also in assisting studies by a range of secondary and tertiary students.

Aside from its own needs, the Foundation sees this reference library as an avenue in which it can assist other researchers, organisations and students in accessing specific deer related and deer management topics.

Additionally, because the members of the Foundation are selected for their range of deer and deer management expertise, and their various contacts with people expert in deer and deer management programs throughout the world, the Foundation is well placed to assist with management enquiries.

Introductions to deer and deer behaviour can be of great practical value to students undertaking deer research projects, and the Foundation has provided this facility on request for a number of

students, regardless of the direction of their studies. It has noted that in several studies conducted in recent years, an initial lack of understanding of the animals and their behaviour has led to flaws in final results.

The Foundation stands ready to assist students in any way possible.

Our logo

The sambar population in Australia is significant by world standards, while the hog deer, despite its limited range and smaller population, also has claim to this status. Given this, it may seem strange to some people that the Foundation has chosen red deer antlers for its logo. The reason for this was the instant recognition of the red deer for what it is — a universal representative of the deer species — for it or its close relatives are found in many countries throughout the world.

Position statement: Sporting Shooters Association of Australia

Bill Woolmore
Sporting Shooters Association of Australia

It is obvious that attendees at this Conference will see the deer issue from many different points of view and no doubt there will be opposing opinions. Laying our cards on the table will do much good and hopefully, by the end of this conference, we will find there is much more common ground than we believed possible.

The SSAA supports the ethical hunting of deer and the proper management of existing deer populations as a most important cultural and recreational asset in Australia. We also support the culling of deer where this can be shown to be necessary.

In some circumstances deer are capable of overpopulating an area and the rusa deer in the Royal National Park are a case in point. This characteristic is by no means unique to deer. Koalas have been a serious problem on Philip Island in Victoria; macropod populations are a real problem in many parts of Australia both within and outside national parks; elephant populations have periodically been a serious concern in the Kruger National Park in South Africa and heavy culling has been necessary. Where deer in Australia are concerned, population and management problems are often exaggerated. There is no continent wide fix available that covers all situations, and deer need to be considered using the following basic guidelines:

1. Any action must be research and EVIDENCE BASED and not be dictated by anecdotal evidence or philosophical hang-ups.
2. Management decisions must be STATE OR LOCALLY BASED.
3. Management decisions must be SPECIES BASED.

Before going further, there is one concern we must raise here and that is the tendency by some agencies to use the emotive term ‘feral pests’ in regard to deer. This appears to be developing into an industry. It is inappropriate and we take exception to it. It is fraught with danger and can lead to massive squandering of government funds trying to achieve an end that is neither desirable nor achievable.

Deer are not ‘feral’ in any dictionary sense of the term, and nor are they ‘pests’. Certainly there can be overpopulation problems in certain situations where they have enjoyed deliberate protection from hunting, sometimes for more than 100 years. Populations are not ‘out of control’ and a ready solution has been at hand. Only minor aberrations have, in recent years, followed releases from failed deer farms, but these deer are only a perceived problem if protected. Some temporary concentrations of sambar have also occurred following massive bush fires.

In this country unrestricted hunting has always ensured very low and isolated populations and this is also inappropriate. As has been demonstrated in Tasmania and in parts of Victoria, notably Blond Bay and Sunday Island, good deer management can have a positive outcome for all parties,

Quality of research is another matter that this wildlife ‘name-calling’ may impact on. Undergraduate and postgraduate students researching in this area could be excused for believing that their future employment prospects might hinge on their production of evidence against, or at least a negative attitude to, deer.

The attempt to nominate deer as a ‘potentially threatening process’ in Victoria, and the Scientific Advisory Committee’s preliminary recommendation approving it, certainly caused disquiet. After studying all the relevant references provided with the nomination we realised that we were up against a philosophical, not a scientific problem. We, and others, were able to demonstrate to the Scientific Advisory Committee that the nomination was unsound and was littered with ‘feral’ science (if we too can be allowed to join the game). Contrary to what happened in NSW, the Scientific Advisory Committee in its final recommendation rightly declared that the nomination, satisfied none of the criteria necessary to list deer as a ‘potentially threatening process’. Perhaps there is room to revisit the matter in NSW.

It may well be premature to discuss positive deer management in some states at this point. However, we are here to listen and to learn and hopefully we can take enough back with us to put minds at rest.

Issues for the management of wild deer in Australia

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Introduction

There can be no doubt that deer are an introduced species in Australia but this fact should not preclude discussion on their management, as has so often been the case in the past. The deer are here, they are established as part of our environment, and they should be managed to provide the best result for the environment and the community. The habitat in which they live has been so drastically altered by more than 200 years of European civilisation that arguments about their possible negative effect are meaningless. Every living creature has an effect on the environment. The question is whether that effect is serious and detrimental. If it is, then the species should be managed to limit the damage to an acceptable level. In various parts of the country, native species such as kangaroos have responded positively to agricultural changes with the result that their numbers have increased dramatically with subsequent damage to their environment. In such circumstances, their numbers have had to be managed. Deer populations should be managed in similar fashion to avoid or minimise any serious effect to their environment.

Managing deer

At some time in the mid to late 1970s, the conservation commissioners of each state made an agreement that there should be no new releases of deer into areas apart from those containing the various herds that were recognised at that time. This, then, provides a starting point to identify the legal long-established herds from the populations that have resulted from deer farm escapees or unlawful releases.

The objective for management of the illegal deer should be either total extermination or management of populations to achieve a desired low level of environmental impact. In most cases, total extermination is unlikely and extremely expensive and it should only be contemplated in the case of small and recent releases.

The objective for management of the legal deer should be to achieve a desired low level of environmental impact while, at the same time, meeting community expectations for recreational opportunity and enjoyment. It should be remembered that although there are a number of vocal anti deer critics, both in the bureaucracy and in the community, there are a great number of people who gain great pleasure from the sight of wild deer.

There are two problems with managing the legal deer herds. One is the natural increase in range occasioned by such species as the sambar, which are slowly colonising southern New South Wales. This is a natural expansion that has been given impetus from the creation of very large national parks in Victoria. These parks act as sanctuaries for sambar and, as in any species whose major predator has been removed, the deer have responded by increasing their numbers. Sambar have a built in social framework that avoids high population density, so their response is for the younger animals to find new home ranges.

The second problem, already alluded to, is the creation of large national parks. Not that there is anything wrong with a park, but setting aside a large area of public land and banning or severely restricting such activities as hunting inevitably results in an increase in the target species that live there. This fact has been ignored in Victoria for more than 30 years with the result that Parks Victoria has now identified a possible problem with deer numbers. One of the first questions to be asked is: ‘How many deer are there?’. There is very little value in pursuing the answer to this question. To do so is time consuming, expensive and inconsequential. The question should be: ‘Are the deer having a serious impact on the environment?’. If the answer can be proven to be in the affirmative then some form of management should be carried out. Another question worth asking is: ‘What is happening to the deer numbers? Are they stable, increasing or decreasing?’.

To answer this question, some form of regular monitoring must be ongoing.

Control of numbers

There are various ways to control deer numbers but the cheapest and most effective is to enlist the services of deer hunters. Wherever possible a regulated season should be provided, with hunters able to enjoy the challenge of hunting while at the same time reducing deer numbers. In areas where a hunting season is not an option hunters should be used in a game management role with specific objectives. It should be remembered that the culling of females is much more effective in population control than indiscriminate culling. If it is left entirely up to the hunters, then most will opt for taking a male deer because most hunters subscribe to an 'antlers only' theory if they are not given good reasons for thinking otherwise. Good communication and public relations with hunters can result in the harnessing of a powerful and effective ally in the world of deer management.

Specifics

In most circumstances, where large areas of public land are involved, hunters with high powered rifles can effectively and safely reduce deer numbers. There will be some areas which are smaller or near built up areas where the use of high powered rifles would be clearly inappropriate. In such circumstances, bow hunters shooting from high seats can achieve good results without any adverse reaction from the public.

Not all deer are on public land and, wherever there are significant or unwanted populations of deer, the property owners should be encouraged to engage with the Australian Deer Association in a Property Based Game Management agreement to achieve the landowner's desired result.

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