Deer Management Plan 2005-2008

for Royal National Park and NPWS Parks and Reserves in the Sydney South Region

September 2005

Published by the NSW Department of Environment and Conservation in conjunction with the Royal National Park Deer Working Group

September 2005

ISBN

Table of Contents

Foreword

The Royal National Park deer management program commenced in February 2002 and has been successfully implemented over the past 3 years. The program has removed over 500 deer from sensitive environments within the park, developed and implemented a number of 'best practice' deer management techniques, and trained over 50 staff from 5 agencies in animal handling techniques.

The fundamental reason for conducting deer management in Royal National Park is to ensure that the National Parks and Wildlife Service meets its legislative obligation to protect the conservation values of parks and reserves, such as Royal National Park, from the negative impacts of pest species. The implementation of the program resulted from research which indicated that deer have a variety of negative impacts on the conservation values of Royal National Park, notably upon certain key ecological communities such as littoral rainforest, coastal heathland and freshwater wetlands. The recent listing of deer as a key threatening process under the *Threatened Species Conservation Act* 1995, highlights the growing awareness of the environmental threat posed by deer. Support for the continuation of research and monitoring on the impacts of deer remains an important priority for the Deer Management Program.

The deer management program has operated under the auspices of a Deer Management Plan. The Plan was approved for an initial three-year period. Both the original Plan and this revision have been prepared with the assistance of the Royal National Park Deer Working Group. The Working Group includes representatives from the National Parks Association of NSW, Nature Conservation Council, RSPCA, NSW Animal Welfare League, Sutherland Shire Council, Wollongong City Council, Moss Vale Rural Lands Protection Board, University of Sydney, Australian Deer Association and NPWS. This revision of the Plan has now been endorsed by the Royal National Park Deer Working Group and approved for the next phase of deer management operations over the period September 2005- December 2008

This next phase of the deer management program aims to build on the program undertaken over of the last three years through ongoing refinement of deer management techniques. This has been achieved as a result of an improved understanding and operational focus on those environments, which are the most sensitive to the presence of deer. During this next phase there will also be exploration of complementary deer control techniques to further improve the efficiency of the program.

I would like to especially thank the Royal National Park Deer Working Group for their tireless commitment to conservation and for the contribution of their time and expertise in the development and review of this Plan.

Dr Tony Fleming
Head, National Parks and Wildlife
Deputy Director General
Department of Environment and Conservation

Executive Summary

Research indicates that the Rusa deer population in Royal National Park has increased to such an extent that it is having significant negative impacts on native flora and fauna, especially vegetation communities currently under threat, such as littoral rainforest and coastal heathland. The management of deer populations is therefore essential for the protection and conservation of the ecological integrity of this important protected area.

The Plan also acknowledges the social impacts that deer have on the community, such as increasing risk of collisions with motor vehicles, rail transport and damage caused to gardens and property.

While this Plan focuses primarily upon Royal National Park, it also extends to other NPWS reserves in Sydney South Region where deer populations have expanded, notably into the Illawarra Escarpment State Conservation Area. The Plan summarises the history of Rusa deer in Royal National Park, the impacts of deer on natural ecosystems, the biology and ecology of deer and the need for populations in conservation areas to be managed. All available control options are discussed.

The aim of the Plan is to manage deer populations to minimise impacts on the natural environment and to minimise socio-economic impacts on the community. The Plan has six key objectives:

1. Review the operation of the deer management program over the last three years and identify options for improving the efficiency of the program;
2. Reduce the number of deer in populations which impact negatively on the natural environment of Royal National Park and other reserves managed within the Sydney South Region;
3. Foster cooperative approaches for the management of deer on and adjacent to the reserves managed by the National Parks and Wildlife Service;
4. Improve community and stakeholder appreciation of the issues related to the management of introduced animals and the urgent need to manage deer populations in conservation areas;
5. Foster research on deer including studies on effective, humane and safe methods of population control; and
6. Establish mechanisms for monitoring and evaluating the Plan.

The major control technique employed over the last three years has been ground-shooting undertaken by appropriately trained shooters from the Moss Vale Rural Lands Protection Board. This program has followed an approved animal welfare and safety protocol and has been undertaken at night to maximise the effectiveness of the program. This has proved a safe and effective means of removing deer and is retained as the primary deer management technique in this revised edition of the Deer Management Plan.

However, it is also recognised that there are inherent limits in the ultimate capacity of ground shooting to exert the desired level of control over deer populations in Royal National Park. For this reason, one of the priorities during this second three year operational phase is to explore complementary deer control techniques that could be used to improve the effectiveness of the control program. Approval is not sought for the implementation of any additional deer control techniques as part of this Plan, and hence any proposals would require a separate process.

1. Background

1.1 The Significance of Royal National Park

Royal National Park is an iconic park in the history of conservation being dedicated as a national park in 1879, the world's second national park after Yellowstone in the United States. Therefore the stewardship role of the NPWS in demonstrating sound conservation management practices is very much on display to the world. The ongoing health of the park is dependent on managing its natural and cultural values in a sustainable manner.

The vegetation communities of Royal National Park have been well documented and studied. A wide range of plant associations are found in the park, including coastal woodlands, heathland, rainforest, freshwater swamp and estuarine wetland. These create a richness of floristic variation rarely found in temperate Australia. Along with sections of the Western Australian sandplains and the South African Fyndbos heathlands, Royal National Park is among the most floristically diverse areas of its size in the world. Well over 1000 plant species have been recorded, including many, which are listed as nationally rare or threatened.

A rich native fauna is supported by the diversity of habitats in the park. Native vertebrates recorded include 43 species of mammals, 241 species of birds, 40 species of reptiles and 20 species of amphibians. Each of these groups includes a number of threatened species.

1.2 Rusa Deer in Royal National Park

1.2.1 History

Indonesian Rusa deer (*Cervus timorensis*) were introduced into Royal National Park in 1906 for exhibition purposes by the previous park trustees. Acquired from a shipment of deer bound for New Zealand from New Caledonia, seven Rusa deer were released into a fenced peninsula called Deer Park. The deer soon escaped from their enclosure and began to multiply and spread through the park and adjacent areas.

Deer numbers within the park are thought to have fluctuated considerably over the past 50 years. The population of deer in the park during the early 1980s was thought to be small. However, by the late 1980s, the population had increased significantly. While the January 1994 bushfires had the effect of reducing the population in the park to approximately 150, anecdotal evidence suggests many deer temporarily moved out of the park into adjacent reserves and suburbs. A detailed, systematic study of deer in the park estimated the population to be 2500 animals in 1999. The deer in Royal National Park are considered to be part of a population extending along the coast and adjacent ranges from Sutherland and Grays Point in the southern suburbs of Sydney, south to Ulladulla on the mid-south coast of NSW.

The NPWS (and its predecessor – the Park Trust) has attempted to cull and remove deer from the park prior to the commencement of the Deer Management Plan in February 2002. Previous attempts to shoot deer within the park had raised animal welfare concerns in some sections of the community, while attempts to trap deer in enclosures for relocation were of limited success due to the trap-wariness of the deer and the lack of suitable farms to accept the animals.

A summary of the first phase of the deer management program and its impacts on the population of Rusa Deer in Royal National Park is presented in section 2.1.

1.2.2 Biology, ecology and population dynamics

Rusa deer are a medium to large deer species native to Indonesia. A mature stag stands about 100 cm high at the shoulder and weighs 100-160 kg. Females (hinds) are smaller: 90 cm at the shoulder and generally less than 80 kg at maturity. Only male Rusa deer produce antlers and these are shed once a year. During the rutting season (generally May-August) the stags compete savagely for mates and often inflict deep, sometimes fatal, wounds on each other. Females are capable of breeding at two years of age (40-50 kg). Males are capable of breeding at 18 months but rarely get to mate until they are large enough to compete for females. Generally, males may live to ten years of age; females to 14 years, successfully raising four calves in their lifetime. The gestation period is eight months. Calving can occur in any month, but most breeding occurs in July-August and most calves are born in March-April.

The population of Rusa Deer within Royal National Park was estimated at 2500 when the program commenced in February 2002. The available data would suggest that, in the absence of predation or other population controls, a population of Rusa Deer will increase at a rate of approximately 10% per annum.

Taking into account this rate of increase and the number of animals removed under the deer management program (c 500), the estimated population in February 2005 is approximately 3000 animals.

Estimating the size and rate of change of the deer population in the park was necessary to understand the magnitude of the problem and to guide future management. During 1999-2002, annual population estimates were made by conducting scat (dropping) counts. This method is internationally recognised as one of the most accurate methods for surveying populations of large mammals, particularly elusive, cryptic species such as deer. The method uses many replicates to produce an index, which can be converted into a density estimate, depending on the habitat type. Royal National Park was divided into 15 grid squares (10 km x 10 km). The grid squares were divided into a maximum of 24 possible habitat types and scat counts were conducted along six transects (1 m x 100 m) in each habitat type in each grid square.

Population estimates for the three survey years ranged from 2522 in 1999 to 2877 in 2001. The density of deer was highest in areas where larger cleared, grassed areas were present and numbers did not change significantly in each area over the three survey years. Estimation of the rate of increase for the population showed that in the year 1999/2000 deer numbers increased 1.10 times and in 2000/2001 increased by 1.04 times. The observed exponential rate of increase for the population over the three-year period 1999 to 2001 was estimated to be 10%. These results indicate that the population is relatively stable and likely to be at or close to carrying capacity. In the year 1999/2000 the population was estimated to increase by 1.10 or 9.60%. Similarly in the year 2000/2001 the population was estimated to increase by 1.04 or 4.16%. These estimates represent population doubling times of 10 years (1999/2000) and 24 years (2000/2001).

1.2.3 Environmental Impacts

Deer are considered to be a significant pest in many parts of the world. Environmental, agricultural and social impacts have been well studied for many deer species. For example, in the USA, the white-tailed deer (*Odocoileus virginianus*) is a native species, but it is a serious agricultural pest and traffic hazard in some locations. In New Zealand and other

Pacific Islands, introduced deer including Rusa deer have been shown to have significant impacts upon threatened vegetation communities and as a disease vector.

In Australia, there has been limited scientific research undertaken on wild deer populations. Tuck in 1970 and Hamilton in 1981 conducted previous studies of Rusa deer in Royal National Park. These gave information on diet, which focused on grasses, and distribution and movements. This information is now dated and of limited value.

Deer in Royal National Park are considered to impact on the natural environment in numerous ways. Evidence indicates that deer can impact significantly on:

- Vegetation communities through browsing and trampling
- Native fauna through competition for resources and habitat degradation
- Water quality of creek and river systems through erosion and faecal contamination

Deer in and around the park also have socio-economic impacts on surrounding communities by:

- Damaging residential gardens and fences
- Causing traffic hazards and motor vehicle accidents
- Attracting illegal hunting
- Carrying diseases and parasites which may be transmitted to humans
- Impacting on agriculture

Currently, there are two research projects being completed on deer in Royal National Park.

In January 2005 deer were listed as a Key Threatening Process under the *Threatened Species Conservation Act*. The reason for the listing was that the NSW Scientific Committee considered that deer pose a significant risk to a range of threatened species, populations and ecological communities. In the case of Royal National Park, there are a number of Endangered Ecological Communities, which are known to be subject to impacts. These include Littoral Rainforest and Sydney Freshwater Wetlands.

1.2.4 Recent research on impacts of deer upon biodiversity in Royal National Park

In other research, Keith & Pellow (2004) have shown that deer have major impacts on endangered Sydney freshwater wetland communities in Royal National Park. As an example of the impacts deer are having on the wetland, 75 per cent of the stems and foliage of the threatened plant species, *Syzygium paniculatum,* was removed by deer. *S. paniculatum* is a rare plant species restricted to littoral rainforests.

Between 1999 and 2002, the University of Western Sydney undertook a study on the ecology and environmental impact of Rusa deer in Royal National Park. This research was sponsored by NPWS and other research partners to gain a better understanding of the impacts of the deer on the biodiversity in the park to aid in managing the population more effectively.

The environmental impact of Rusa deer in Royal NP was determined by monitoring the biodiversity of plant species in fenced and control plots at high and low deer density sites over a three year period, by examining the diet of shot or found deer in different areas of the Park and by determining the dietary overlap between deer and the swamp wallaby (*Wallabia bicolor*). Results of the exclosure experiment showed no differences between the biodiversity of plant species in fenced plots compared to control plots at individual sites. However, large differences existed between plots located in high deer density locations compared to low deer density locations for the habitats of littoral rainforest (54% less understorey species at high deer density sites), sandstone gully forest (33% less understorey species at high deer

density sites) and sandstone heath (27% less understorey species at high deer density sites).

Analysis of deer diet showed that they consumed a total of 18 native plant genera and 155 native plant species. These plants included a variety of trees, shrubs, climbers, creepers, ferns, orchids, herbs, grasses, rushes and sedges, including two endangered species, nine vulnerable species and 13 regionally uncommon species. Seasonal variation of dietary intake showed that many deer switched from introduced grass consumption to more native plant consumption in winter. Diet modelling showed that the volume of deer rumen increased in winter and that the deer population consumes around 36 million litres of native plant material per year.

Results of four dietary overlap studies between deer and wallabies showed that overlap ranged from 24% in autumn in a heath habitat to 60% in winter in a cleared/mosaic habitat. Modelling of deer and wallaby density as a combined herbivore unit showed that one deer is equal to around 3.88 wallabies (based on stomach and rumen volumes) and that herbivore unit density (including deer) was two to three times greater than the density of other similar sized herbivores along the east coast of Australia.

1.2.5 Current research on fertility control

The NPWS has supported research by Macquarie University into fertility control of Rusa deer. The project commenced in late 2000, using contraceptive implants on a small captive population of Rusa deer taken from Royal National Park. While it is not expected that this current research will provide any fertility control solutions in the short-term, it will provide background information on the reproductive physiology of Rusa deer which may be useful in the development of this technique in the future.

A review of the potential for using fertility control to manage deer in Royal National Park is given in Appendix 1.

1.3 Relevant legislation

The Director General has statutory obligations under the *National Parks and Wildlife Act 1974* and the *Threatened Species Conservation Act 1995* to manage parks and reserves to protect and conserve native plants and animals, Aboriginal cultural heritage and historic heritage. Deer are an introduced species which are members of the Order Artiodactyla (cloven hoofed animals) and they are listed as unprotected under Schedule 11 of the *National Parks and Wildlife Act 1974*.

The *National Parks and Wildlife Act 1974* states that the Director-General shall: "… *in the case of every national park, historic site, nature reserve and Aboriginal area … arrange for the carrying out of such works as he considers necessary for or in connection with the management and maintenance thereof* …". Management control programs for introduced animal species such as deer are considered to be such works.

The *National Parks and Wildlife Act 1974* also requires a Plan of Management to be prepared for each national park and reserve. Plans of management have as one of their objectives the conservation of critical habitat, threatened species, populations and ecological communities. The Plan of Management for Royal and Heathcote National Parks and Garawarra State Recreation Area identifies the control of deer as a priority management issue. The Deer Management Plan was prepared as a contribution to meeting the policies in the Plan of Management.

Deer are listed as a Key Threatening Process under the *Threatened Species Conservation Act*. It is possible that a Threat Abatement Plan will be prepared and require certain actions in regard to deer management at priority sites such as Royal National Park. The NPWS will need to ensure that this Deer Management Plan remains consistent with any future Threat Abatement Plan.

1.4 Why control deer?

The research indicates that large numbers of deer inhabit the Royal National Park and adjacent areas. Deer are browsing on rare and threatened plants species and are having significant impacts on the diversity of threatened ecological communities within the park. There are also socio-economic issues associated with a large population of deer on the edge of Sydney, including motor vehicles colliding with deer, illegal hunting, damage to gardens and transmission of disease. Together, the conservation and community issues emphasise the need for an effective program to control deer numbers and reduce the impacts of the deer population.

The option of doing nothing to control deer in the Sydney South Region is inconsistent with the statutory obligations of the NPWS and may implicate the NPWS in damage caused by deer to persons, property and conservation areas.

1.5 Community involvement and consultation

The *Plan of Management for Royal and Heathcote National Parks and Garawarra State Recreation Area* was published in February 2000 after a period of public consultation. The Plan of Management requires the NPWS to prepare a Deer Management Plan.

In July 2000, the Royal National Park Deer Working Group was established in conjunction with the NPWS to assist with the development of the Plan and to improve community appreciation of the issues related to the management of deer.

The Working Group membership comprises the National Parks Association of NSW, Nature Conservation Council, RSPCA, NSW Animal Welfare League, Sutherland Shire Council, Wollongong City Council, Moss Vale Rural Lands Protection Board, University of Sydney, Australian Deer Association and the NPWS. This Plan was drafted by the Working Group.

The draft of the 2001 Deer Management Plan was released for public comment at community workshops and by written submissions. The draft was then amended in response to the issues raised through the public consultation process.

1.6 Deer management techniques

1.6.1 Non-commercial Hunting

Hunting is an activity commonly associated with the presence of deer populations in Australia. In some states, the hunting of deer is regulated by state conservation agencies. However, the *NSW Game and Feral Animal Control Act, 2002* specifically excludes hunting on NPWS managed lands, as there are significant conservation, visitor and other public safety issues relating to the hunting of deer in public reserves. Recreational hunting is not an appropriate method for controlling deer populations in reserves with high visitation and surrounded by extensive urban development. It will not be used to control deer in the Sydney South Region.

1.6.2 Trap and relocate

The use of fenced enclosures to trap large pest animals has increased since the 1970s. The use of traps has generally been confined to small and medium control areas or areas where animals congregate such as waterholes in arid Australia. However, trapping is an expensive and time-consuming method. Locating the traps in suitable areas is essential for this technique to be effective. Relocation depends on a commercial demand for live animals. This option was used at two locations in Royal National Park in 1999 and 2000, however only 30 animals were removed over this period. The method does not provide an effective long-term solution to deer management in the Sydney South Region, but may be appropriate in some locations.

1.6.3 Baiting

Poisoning with 1080 baits is the most widely used method for the control of small to medium-sized feral animals, such as rabbits, wild dogs, foxes and feral pigs, but is not registered for use on feral deer in Australia. Over the last few years, there has been considerable interest in the exploration of species-specific baits for feral animals such as feral cats and feral pigs. Should any new suitable bait or sedative be proposed that may improve the effectiveness of current management strategies then they will be considered for inclusion in this plan. Additionally, the plan may also consider supporting any trial or research opportunity that also offers real or potential benefits to this plan.

1.6.4 Fertility control

There is no fertility control technique currently available for deer. Details of the potential for using this method are given in Appendix 1. There is considerable scientific and public interest in fertility control as a means of reducing feral animal numbers and any developments in this technique that improve the effectiveness of current management strategies will be considered for inclusion in this Plan. NPWS is sponsoring research in this technique. Developments will be closely monitored by the NPWS so that techniques proven to be safe, humane and cost-effective can be incorporated into the Plan.

1.6.5 Fencing

Exclusion fencing has been successful in keeping wild animal populations out of small conserved areas, which can be easily accessed for maintenance. However, it is not commonly used to control feral animals on public land because it restricts public access, affects the movement of native species, is expensive and requires a high level of maintenance. The method does not provide an effective long-term solution to deer management in the Sydney South Region.

The fencing of specific assets or easements directly impacted upon by deer may be considered on a one to one basis through out the life of this plan.

1.6.6 Ground shooting

Ground shooting is recognised as a humane method of controlling large vertebrate pests. This is acknowledged in the RSPCA's *National Policy on the Management of Feral Animal Populations*. The method is strategic in that specific areas and species can be targeted for maximum effect. Shooting does not impact on non-target species and is appropriate for remote or isolated areas where large numbers of pest animals are having significant impacts on the natural environment.

Shooting programs under the Royal National Park deer management program have been specifically located and timed to ensure public safety with minimal disruption to park visitors and adjacent landholders. The program has targeted herds at priority locations where the negative impacts of deer are most significant. Where possible, the program has targeted hinds to reduce the potential for future population growth.

Critical to ground-based shooting programs is the implementation of tight operating protocols and the use of trained shooters to ensure a humane, safe and effective approach. The NPWS developed a shooting protocol to govern all operations as part of the deer management program. This protocol has been reviewed and endorsed by both the NSW Police and the NSW Firearms Safety and Training Council.

1.6.7 Aerial shooting

Experience in a number of States (NSW, Queensland, Northern Territory and Western Australia) has shown that aerial shooting from helicopters is very effective in rapidly reducing feral animal populations e.g. feral pigs (Choquenot *et al*. 1996); feral goats (Parkes *et al*. 1996). In New Zealand, aerial shooting from helicopters has been effective in culling large numbers of deer (Caughley 1983). If aerial shooting were to be used, in addition to the "on-going" ground shooting program, it would be to significantly increase the culling rate to more than 500 animals annually. The control program in Royal National Park would then have a far greater impact on the deer population over a few years rather than decades as would probably be the case with ground shooting only.

Another major advantage of aerial shooting is that it allows culling to occur in areas that ground shooters cannot access readily. In some of these areas, aerial shooting is a more humane method of culling feral animals than ground shooting.

The use of aerial shooting in feral animal programs is closely regulated under the FAAST (Feral Animal Aerial Shooting Team) protocols that apply to all NSW government agencies. These protocols ensure that aerial culling can be conducted without any compromise to public safety or animal welfare.

1.7 Recommended control technique

The Working Group has concluded that ground shooting remains the most appropriate primary control technique to reduce deer numbers in Royal National Park. However, it is recognised that achieving the desired net reduction in deer numbers (see 2.1 below) will not be possible without improvements in the performance of this program.

Increases in the number of shooting operations or better selection of control sites are the best options to achieve improvements. However it is also likely that there are inherent limitations in relying upon ground shooting as the only control technique. Limiting factors include access to sensitive areas, herd avoidance of sites subject to shooting and diminishing returns on effort.

For this reason, it is anticipated that supplementary techniques, such as fertility control techniques, aerial culling or the use of sedatives, may be recommended for implementation in the medium to long term to assist the existing ground shooting program. It is proposed to explore the feasibility of such supplementary options during the term of this revised Plan. The NPWS will also seek public comment on any proposals to introduce new control techniques.

2. Aim and Objectives of the Deer Management Plan

The aim of the Plan is to manage deer populations to minimise negative impacts in Royal National Park and other conservations areas in the Sydney South Region, and to minimise other socio-economic impacts on the community. This will be achieved through six key objectives:

1. Review the operation of the deer management program over the last three years and identify options for improving the efficiency of the program;
2. Reduce the number of deer in populations which impact negatively on the natural environment of Royal National Park and other reserves managed within the Sydney South Region;
3. Foster cooperative approaches for the management of deer on and adjacent to the reserves managed by the National Parks and Wildlife Service;
4. Improve community and stakeholder appreciation of the issues related to the management of introduced animals and the urgent need to manage deer populations in conservation areas;
5. Foster research on deer including studies on effective, humane and safe methods of population control; and
6. Establish mechanisms for monitoring and evaluating the Plan.

Objective 1: Review the operation of the deer management program over last three years (2002-2004) and identify options for improving the future efficiency of the program.

The initial objective of the deer management program was to demonstrate that it was feasible to conduct a deer control program in Royal National Park with no compromises to public safety, staff safety or animal welfare. The program has been subject to ongoing, expert monitoring of these issues, by the RSPCA in regard to animal welfare and the Firearms Safety and Training Council in regard to safety. The operational systems have been refined and staff are well trained to perform the required duties.

The effectiveness of the program in removing deer has steadily improved over the first three years. This has included a higher proportion of animals removed from more sensitive habitats within the park, maximising environmental outcomes.

The actual number of deer removed in the first three years of the program was approximately 500. Given the starting population of 2500-2900 in February 2002 and the natural rate of increase of 10% per annum, this means that the program has not, to date, kept pace with the increase in the deer population. The practical effect of the program has been to reduce the rate of increase from the 10% per annum down to around 4% per annum. This is a worthwhile outcome, however it needs to be assessed in the context of the long term objective of the deer management program, which is to reduce the deer population in the park to fewer than 1000 animals.

Objective 2: Reduce the number of deer in populations which impact negatively on the natural environment of Royal National Park and other reserves managed by the NPWS Sydney South Region

The Deer Working Group has recommended that ground shooting is the most appropriate control option currently available. Shooting programs will follow the shooting protocol outlined in this Plan (see Appendix 2). Trapping may be used to complement the ground shooting program.

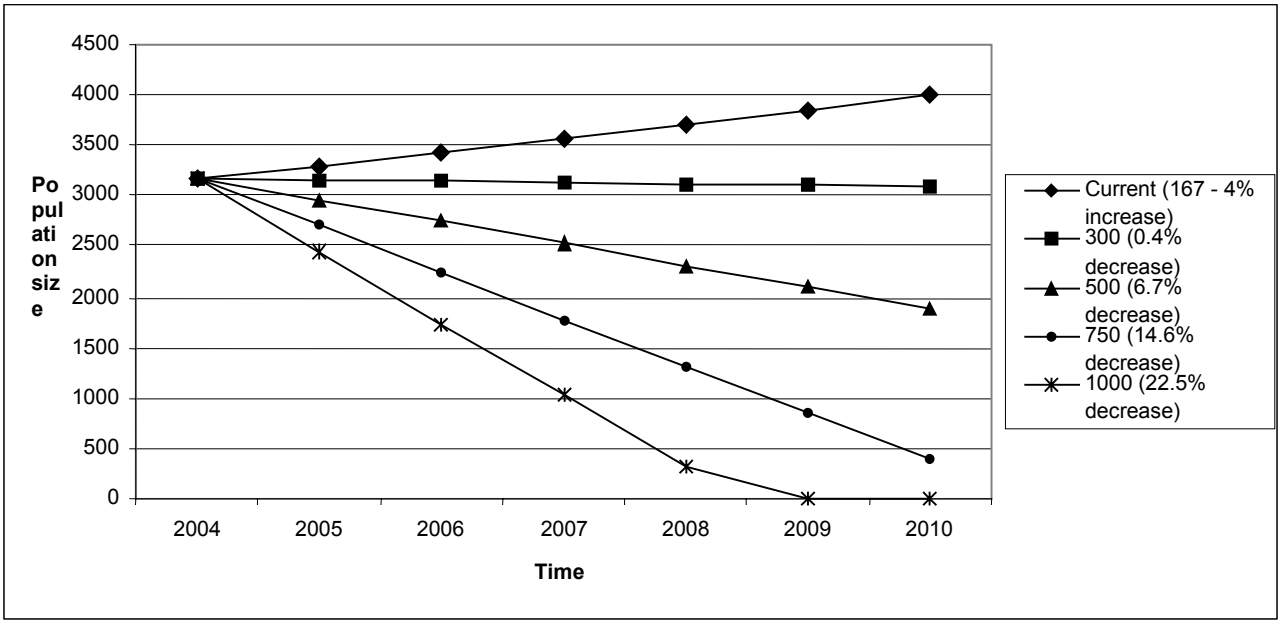
Priority will be given to sites where large numbers of deer congregate at night and where the impacts of deer are greatest. Protection of threatened plant communities will be the primary focus. Areas where deer are likely to move onto adjoining lands or where they are likely to impact on local urban communities will also be a focus for operations.

To reduce the impact of the program on park visitors and prevent the spread of disease and the contamination of the park's environment, carcasses will be removed immediately from the site or as soon as practicable following each shooting operation. To minimise potential waste-disposal impacts and costs, carcasses will be donated to Mogo Zoo wherever possible.

The primary long term objective of the deer management program is to reduce the number of Rusa Deer in Royal National Park to a total of fewer than 1000 animals. The key performance measure for the next phase (2005-2008) of the deer management program will be the net reduction in deer numbers within Royal National Park.

Figure 1 graphs the projected deer population under different culling rates. It shows that, in order to achieve a net reduction in population, a minimum of 300 animals per annum need to be removed from Royal National Park.

Figure 1: Population estimates 2004-2010 following the removal of 167, 300, 500, 750 or 1000 animals per year



Objective 3: Foster cooperative approaches for the management of deer on and adjacent to the reserves managed by the NPWS Sydney South Region

The NPWS will work with all stakeholders to foster the development of a regional approach to managing deer in the areas covered by this Plan. The NPWS will develop joint programs and initiatives to manage the impact of deer, for example the installation of warning signs on roads in the Sutherland Shire area. The Working Group will also continue to advise the NPWS on other issues related to the management of deer. For example, NPWS and Sutherland Shire Council are currently working on a protocol for the care and/or disposal of deer injured in collisions with motor vehicles or through other means.

The NPWS commissioned Assoc. Prof. Tony English from the University of Sydney to develop and deliver a course for staff dealing with injured deer and other fauna. This course provides appropriate training for staff responding to deer involved in accidents as well as assisting any staff actively involved with culling operations. Over the past 3 years this course has been delivered 3 times and staff from 5 agencies have been trained.

NPWS staff have worked closely with Sutherland Shire Council to provide advice in the development of Council's draft Feral Animal Policy. This policy will assist the development of future joint control programs between Sutherland Council and NPWS.

In January 2005 the Illawarra Deer Management Working Group was formed with the primary function of coordinating deer management on private lands. Membership included a NPWS pest management specialist who is also a member of the Royal National Park Deer Working Group. Under objective 2.3 this association will provide both technical advice and linkages with best practice developed from this and other similar control programs.

In August 2005 NPWS and Sutherland Shire council commenced a joint deer control program on a number of sporting fields in the Loftus and Grays Point area. These lands are owned by NPWS but under the management of Council.

Objective 4: Improve community and stakeholder appreciation of the issues related to the management of introduced animals and the urgent need to manage deer populations in conservation areas

The NPWS has undertaken an education and awareness program to encourage community understanding of the Deer Management Plan. This program utilises fact sheets, media releases, briefing sessions and meetings to inform key stakeholders and the community.

Wollongong Council is actively involved in the Royal National Park Deer Working Group and along with Sutherland Council, Moss Vale Rural Lands Protection Board, Local Police and NPWS provided input for the development of a new policy called the Injured Deer Protocol. This document establishes a framework of cooperation in responding to injured deer in both Sutherland Shire and Wollongong City to ensure injured animals are managed in a manner to minimise suffering.

Objective 5: Foster research on deer including studies on other effective, humane and safe methods of population control

The NPWS will continue to support and sponsor research that leads to other effective, humane and safe control methods for introduced deer populations.

The NPWS has supported research by Macquarie University to evaluate the effectiveness of a contraceptive implant as a means of fertility control in deer. The Working Group recognises that the high cost and low chance of success of fertility control precludes its use for the management of deer in the foreseeable future.

The NPWS will continue to undertake collaborative research with institutions into the ecology and impacts of wild deer and methods of controlling wild deer and their impacts.

The Working Group will liaise with the Fertility Control Group which is established as part of the Australasian Invasive Animals Cooperative Research Centre. NPWS in cooperation with this CRC has secured a post graduate studentship to undertake a detailed evaluation of the effectiveness of the Royal National Park Deer Control Program.

Objective 6: Establish mechanisms for monitoring and evaluating the Plan

Adaptive management principles will be used to ensure that the Plan is effective in achieving its objectives. The Deer Working Group will monitor and evaluate the implementation of the Plan and make recommendations to the NPWS on its effectiveness.

The NPWS aims to establish specific monitoring programs to measure changes in the abundance and impacts (environmental and community) of deer in the Sydney South Region. These programs will initially define acceptable levels of the impacts of deer and then be used to measure impacts against established criteria, in order to test whether the objectives of the Plan are being met. The results of the monitoring will be used to modify the Plan (Section 4).

Reports will be provided to the Deer Working Group, Sydney South Region Advisory Committee, NPWS Executive and Minister for the Environment as required. Detailed annual reports will be produced each year to document the progress of the Plan. The annual reports will be available to the public.

3. Operations

3.1 Key Infrastructure

To implement an effective and safe culling operation, various assets were purchased. These included:

- A 75,000 litre mobile chiller
- Firearms and visual aids
- Protective clothing and handling equipment
- Course development and delivery
- Lifting apparatus for carcass collection.

3.2 Culling Procedures

The focus of operational events for the first three years of the program was to develop safe and humane culling procedures. This approach resulted in the preparation of detailed protocol and highly trained staff (see Appendix 2).

A specialist course was developed for both NPWS and other staff on procedures to safely handle injured fauna, including deer. This course was developed in conjunction with the University of Sydney. To date, approximately 50 staff from 5 agencies have successfully completed this course.

3.3 Operational events

Each year there were over 30 operational nights in Royal National Park. In the first year an average of 4 to 5 deer were culled per night but by the third year this had increased approximately ten. While this was an average figure, there were many nights when well over 30 animals were removed which reduced the cost of removal per animal.

It is anticipated that in the next phase of the program there will be approximately 30 operational nights per year. Other control techniques will be explored to increase culling rates to supplement the continued ground-shooting program.

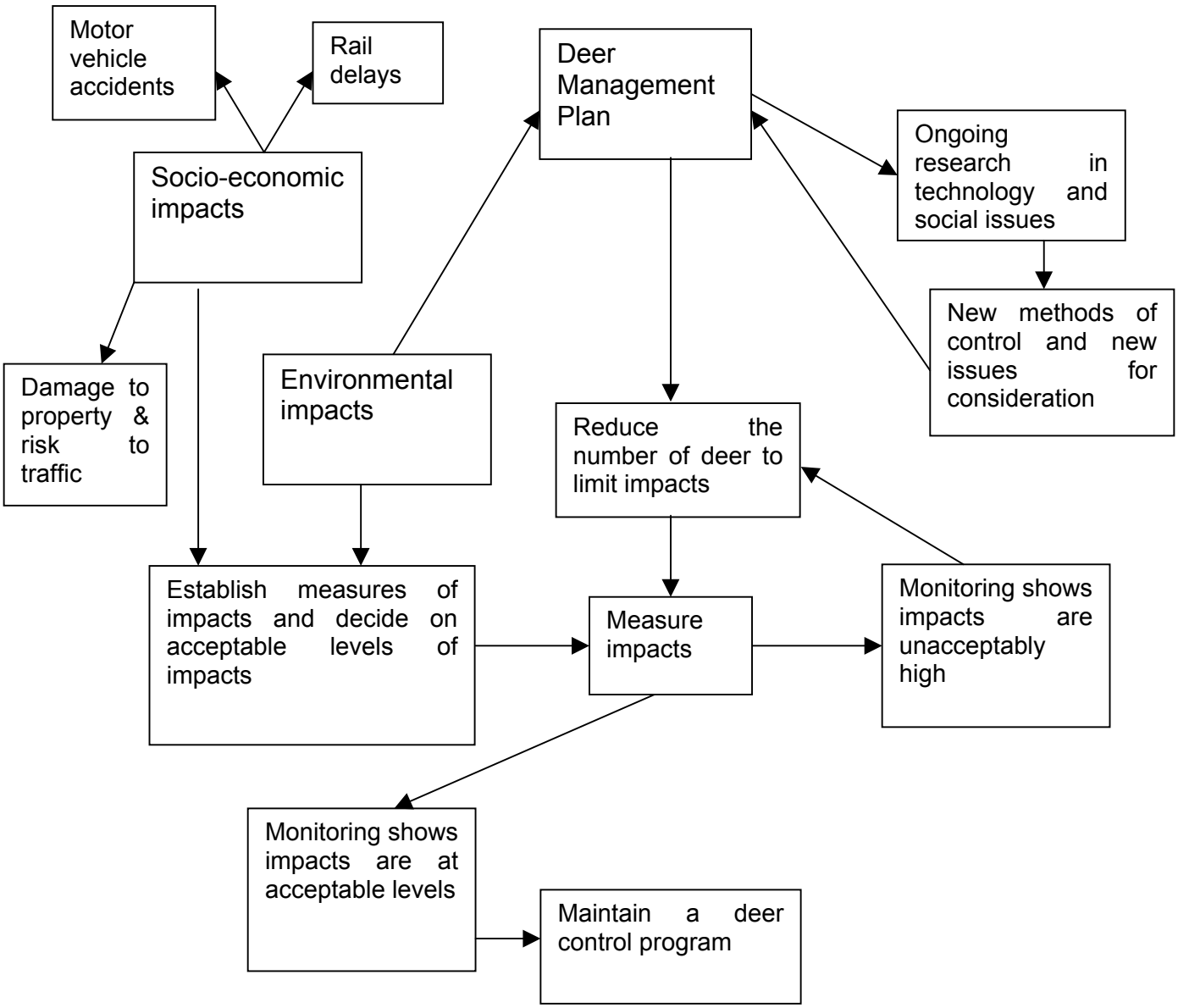
4. Implementation of the Plan

4.1 Life of the Plan

This Plan will be implemented over the period September 2005 to December 2008. The Plan will be reviewed in late 2008.

4.2 Adaptive management to control the impacts of Rusa deer

The diagram below outlines the elements of adaptive management for the Deer Management Plan and their relationship with each other.



5. Bibliography and Further Reading

Allen, R.B, Payton, I.J. and Knowlton, J.E. (1984). Effects of ungulates on structure and species composition in the Urewera forests as shown by exclosures. *NZ J Ecol.* 7:119-130.

Caughley, G. (1983) *The Deer Wars*. Heinemann Publishing: Auckland.

Choquenot, D., McIlroy, J. and Korn, T. (1996). Managing Vertebrate Pests: Feral Pigs. Bureau of Resource Sciences, Australian Government Publishing Service, Canberra.

Cooper, D.W. and Herbert, C.A. (2001). Genetics, biotechnology and population management of over-abundant mammalian wildlife in Australasia. *Reproduction Fertility and Development.* 13:1-8.

Department of Conservation NZ. (1997). A public discussion document. Issues and options for managing the impacts of deer on native forests and other ecosystems. Department of Conservation NZ.

Department of Conservation NZ. (1997). Summary and analysis of submissions. Issues and options for managing the impacts of deer on native forests and other ecosystems. Department of Conservation NZ.

Giles, J.R. and McKenzie (1973). The ecology of Javan Rusa in Royal National Park. Unpublished report, NPWS.

Hamilton, C.A. (1981). Rusa deer in the Royal National Park. MSc thesis, University of Sydney.

Hamilton, C.A. (1979). Aspects of the ecology of feral Rusa deer in New South Wales. *Proc. Post. Grad. Comm. Vet. Sci*. 49:85-92.

Keith D. and Pellow B. (2005). Effects of Javan rusa deer (Cervus timorensis) on native plants in the Jibbon-Bundeena area, Royal National Park, New South Wales. *Proceedings of the Linnean Society of NSW.* Vol 126, 2005. 99-110.

Kirkpatrick, J.F., Turner, J.W.Jr.,Liu, I.K.M., Fayrer-Hosken, R. and Rutberg, A.T. (1997). Case studies in wildlife immunocontraception:wild and feral equids and white-tailed deer. *Reproduction Fertility and Development.* 9:105-110.

Kraus, P. (1991). Differences in the influence on vegetation exerted by red deer (*Cervus elephus*) and Fallow deer (*Cervus dama*) with special regard to population density. Bobek, B., Perzanowski, K. and Regelin, W. Global trends in Wildlife Mangement. Swiat press, Poland.

Mahood, I. T. (1978). The Royal deer herd. *Parks and Wildlife.* 2:52-53.

Mahood, I. T. (1981). Rusa of Royal National Park. *Australian Deer.* 15 –22.

Miller, S.G. and Bratton, S.P. (1992). Impacts of White-tailed deer on endangered and threatened vascular plants. Natural Areas Journal. 12:67-74.

Moriarty, A.J. (2004) The liberation, distribution, abundance and management of wild deer in Australia. *Wildlife Research*. 31: 291-299

Moriarty, A.J (2004) Wild deer herds in Australia's urban fringe: issues, management and politics. *In: Urban Wildlife: more than meets the eye.* Lunney, D. and Burgin, S. Eds. Royal Zoological Society of NSW, Mosman, NSW

Olsen, P. (1998). *Australia's Pest Animals: New Solutions to Old Problems*. Bureau of Resource Sciences and Kangaroo Press, East Roseville.

Parkes, J., Henzell, R. and Pickles, G. (1996). Managing Vertebrate Pests: Feral Goats. Bureau of Resource Sciences, Australian Government Publishing Service, Canberra.

Rose, A. and Platt, K.H. (1987). Recovery of Northern Fiordland Alpine Grasslands after reduction in the deer population. *NZ J Ecology*. 10:23-33.

Ross, B. (1970). Effects of long term deer exclusion on a *Pinus resinosa* forest in north central Minessotta. *Ecology*. 51:1088-1093.

Stagl, W.G. (1991). "Trakterhebungsmethode" - a method to estimate the tolerable game numbers by evaluation of the vegetation. Bobek, B., Perzanowski, K. and Regelin, W. Global trends in Wildlife Mangement. Swiat Press, Poland: pp. 123-124.

Stewart, G.H. and Burrows, L.E. (1989). The impact of white-tailed deer (*Odocoiles virginianus*) on regeneration in the coastal forest of Stewart Island, NZ. *Biological Conservation*. 49:275-93.

Stewart, G.H., Wardle, J.A. and Burrows, L.E. (1987). Forest understorey changes after reduction in deer numbers, Northern Fiordland NZ. *NZ J Ecology*. 10:35-42.

Tilghman, N.G. (1989). Impacts of white-tailed deer on forest regeneration in North western Pennsylvania. *J Wildl. Man*. 53:524-32.

Tuck, M. (1971). Javan Rusa deer (*Cervus timorensis*) in the Royal National Park - Habitat utilisation and distribution. Unpublished BSc (hons) thesis, University of Sydney.

Wilson, G., Dexter, N., O'Brien, P. and Bomford, M. (1992). Pest animals in Australia - a survey of introduced wild mammals. Bureau of Rural Sciences and Kangaroo Press Sydney.

Appendix 1
Potential for using fertility control to manage feral deer populations in Royal NP

Fertility control agents have strong support from some who seek a benign, non-lethal approach to population management and their use has been reviewed recently by Cooper and Herbert (2001). The intent is that reducing the fertility of the population will result in a lower pest density and hence, less damage. However, even among animal welfare groups there is opposition to some forms of fertility control (Grandy and Rutberg 2001). Except in specialist applications, the use of fertility control techniques for pest animals in the wild is not feasible at this time (Olsen 1998; Environment Australia 1999a; 1999b, 1999c; 1999d). Even if proven effective, the decline in the pest population will be slow as it is a function of the efficacy of the agent and the biology of the pest (reproductive rate, life span etc). In addition, infertile animals will continue to have the same negative impact in conservation areas.

There are three ways in which the fertility of wild animals can be regulated:

1. Surgical techniques

The use of surgical techniques to prevent fertilisation in males (vasectomy or castration) or females (ovariectomy or tubal ligation) requires that animals be captured and restrained. All surgical operations on animals in national parks must be undertaken by a veterinarian. The large number of wild deer (> 2,500), the difficulty of their capture and the associated animal welfare considerations, as well as the cost of such an operation, prevent this technique from being a practical option for controlling wild deer in Royal National Park.

2. Infertility inducing chemicals

Research is being undertaken to develop chemicals (drugs) that interfere with the normal reproductive processes in animals. One such drug is deslorelin, which is being developed for the domestic animal market by Peptech Animal Health Pty. Ltd, Australia. Deslorelin interferes with normal hormonal levels to prevent ovulation (and spermatogenesis in some species). When formulated into a proprietary slow release implant, it acts as a temporary contraceptive.

The implants are administered subcutaneously into the dorsal region of the neck, usually with an implantation needle. The use of darts (a projectile syringe) has been investigated but there are limitations to their use on wild pest animal populations due to the restricted range of the firearms used to project the dart and the difficulty in getting sufficiently close to the target animal.

The period over which the chemical remains effective varies with the dose and the animal species and repeat treatments are required. Thus, animals must be regularly captured and this prevents the use of this technique for managing pest animal populations in the wild, unless a delivery mechanism other than surgical implantation can be developed.

The NPWS is funding research by Macquarie University in a joint venture with Peptech to evaluate deslorelin as a means of controlling Rusa deer (Webley *et al.* 2004). The Deer Management Plan acknowledges that this is a longer-term option that should be evaluated further and has recommended that the NPWS support further research (Royal National Park Deer Working Group, 2002). However, after evaluating all of the information available, the Working Group considered that such a drug is not likely to be available for the control of wild deer in the foreseeable future and that such a drug may never be available for wild deer

populations. Hence, this technique is not currently a practical option for controlling wild deer in Royal National Park.

3. Immunocontraception

This technique involves the use of a virus, or some other vector, such as a bait, to carry an agent that induces an auto-immune response in the pest animal that renders it sterile (Cooperative Research Centre for Biological Control of Pest Animals 2003). Considerable effort has been directed to the evaluation of immunocontraceptive vaccines as a means of controlling pest animals. Research has concentrated on developing fertility control for rabbits, foxes and mice, although the technique may have application to other pest animal species such as wild deer. Promising results have been obtained for these species but there are a number of problems to be overcome before this control option becomes feasible (Cooper and Herbert 2001; Reubel et al. 2001; Saunders and McIlroy 2001). Hence, immunocontraception is currently not a practical option for controlling wild deer.

4. Conclusion

Olsen (1998) argues that to be effective, fertility control will have to overcome the following obstacles:

- lack of an effective delivery mechanism (failure to treat enough animals and inability to administer repeat doses)
- behavioural and biological flexibility of the pest
- humaneness of fertility drugs
- specificity to the target animal
- cost effectiveness, especially in remote and inaccessible areas and for cryptic species
- public acceptability

If and when fertility control provides a humane and cost-effective means of controlling wild deer populations, the NPWS will adapt the Plan to include it as a technique for use in the Deer Management Plan.

References

Cooper, D.W. and Herbert, C.A. (2001). Genetics, biotechnology and population management of over-abundant mammalian wildlife in Australasia. *Reproduction Fertility and Development.* 13:1-8.

Cooperative Research Centre for the Biological Control of Pest Animals (2003). Annual Report 2002-03. Cooperative Research Centre for Biological Control of Pest Animals, Canberra.

Environment Australia (1999a). *Threat Abatement Plan for Predation by Feral Cats*. Biodiversity Group, Environment Australia, Canberra.

Environment Australia (1999b). *Threat Abatement Plan for Competition and Land Degradation by Feral Rabbits*. Biodiversity Group, Environment Australia, Canberra.

Environment Australia (1999c). *Threat Plan for Competition and Land Degradation by Feral Goats*. Biodiversity Group, Environment Australia, Canberra.

Environment Australia (1999d). *Threat Abatement Plan for Predation by the European Red Fox*. Biodiversity Group, Environment Australia, Canberra.

Grandy, J.W. and Rutberg, A.T. (2001). Wildlife contraception: The animal welfare view. Proceedings of the 5th International Symposium on Fertility Control in Wildlife, Kruger National Park, South Africa. pp. 10-11.

Olsen, P. (1998). *Australia's Pest Animals: New Solutions to Old Problems*. Bureau of Resource Sciences and Kangaroo Press, East Roseville.

Reubel, G.H., Pekin, J., Wright, J., Webb-Wagg, K., Venables, D., Zabar, S and Hinds, L. (2001). Towards an immunocontraceptive vaccine for the red fox, *Vulpes vulpes*. Proceedings of the 12th Australasian Vertebrate Pest Conference, Melbourne. pp. 165-68.

Royal National Park Deer Working Group (2002). *Draft Deer Management Plan for Royal National Park and NPWS Reserves in the Sydney South Region*. NSW National Parks and Wildlife Service, Hurstville.

Saunders, G. and McIlroy, J.C. (2001). Fertility control of foxes using immunocontraception – Ecologically feasible? Proceedings of the 12th Australasian Vertebrate Pest Conference, Melbourne. pp. 169-72.

Webley, L. (2004). Long-term contraceptive implants as an alternative management option for wild deer near urban environments. Proceedings of the World Deer Veterinary Congress, Queenstown NZ 21-24 February 2004.

Appendix 2: Shooting Protocol

All targeted animals will be killed quickly and humanely.

All shooting will be undertaken in accordance with a Shooting Plan approved by the NPWS Regional Manager.

A copy of the current approved Shooting Plan and shooting protocols have be provided to the NSW Police Service for endorsement. This will ensure that the shooting program addresses and is consistent with Section 93G of the *Crimes Act 1900*.

Shooting activity will occur in accordance with the NPWS Firearms Policy (March 2002) and the "Handbook on Firearms Safety Awareness" published by the Firearms Safety Awareness Council and all parts of the program are subject to inspection and audit by the RSPCA and NSW Animal Welfare League.

Staff and Equipment

The firearm chosen for each operation will be decided by the accredited shooter, who will choose the firearms appropriate for the location and target;

- .22 calibre rifle (appropriately silenced) to be used for hinds, yearlings and juveniles
- .223 calibre rifle (with projectiles appropriate for the target) standard firearm.
- .308 calibre rifle (appropriately silenced) for larger animals and adjacent to built up areas

All shooters will be appropriately trained and accredited as competent (see NPWS Firearms Policy, March 2002 for standards) in the use of firearms, marksmanship and the humane killing of ungulates (deer and goats).

Any approved shooter engaged by NPWS who is not an employee of the Rural Lands Protection Board (RLPB), will be assessed for competency by an appropriate officer of the RLPB.

Shooters will be issued with the relevant consent to use and discharge firearms on NPWS managed lands under the *National Parks & Wildlife Act 1974* to ensure compliance with the *Firearms Act, 1996.*

Shooting Period

Shooting will not occur during school holidays, public holidays or Friday and Saturday nights unless the NPWS is satisfied that sections of the parks can be closed to visitors and all potential safety issues can be addressed

Shooting will be undertaken at night in parts of the Park which have been closed to public access by locked gates or notices.

Late afternoon/evening and early morning shooting may occur at specific sites where the Regional Manager is satisfied that remoteness, signage and pre-shoot checks limit access by the public to such sites.

Notifications

Prior to each shoot – specific notifications

- Relevant Police Duty Officer
- Nominated RSPCA Officer
- Regional NPWS Duty Officer
- Park Security Company
- On-park resident adjacent to any proposed shooting site.
- Regional Manager
- Visitor Centre Manager
- Area Manager

The shooting coordinator will log the date and time of each notification in the deer management program diary.

Prior to each shooting period (each 6 to 10 week work period) the following notifications will occur;

- Sutherland Shire Council and Wollongong City Council will be notified.
- General notification either by public notice in the local paper or through local community groups.
- The placing of temporary signage at major walking entrances to the Park adjacent to the urban fringe, stating the general period and indicating that the Park is closed after dark to the public.

Prior to each shooting operation, warning signs will be erected at public access points. NPWS officers will be stationed at all appropriate locations to prevent any unauthorised entry or advise shooting teams of unauthorised persons.

Locations

Shooting will be undertaken in the park at locations and times when the public are excluded.

The sites where shooting will be undertaken will be chosen by the shoot coordinator for the night based on priority areas identified in the Incident Action Plan (shoot plan) and areas where deer are known to congregate.

Shooting near camping locations will only occur with prior notification and knowledge of campsite bookings and following a site check for campers immediately prior to any shooting activity.

Shooting operations will only occur on NPWS managed lands. The direction of shooting will be away from any habitation, property, road or foot track.

Procedure

Shooting will follow a detailed shooting operations Plan which will incorporate the following procedures;

- Required notifications
- Pre-shoot operations briefing of staff and any RSPCA audit officer or researcher accompanying the activity
- Pre shoot site check to ensure that no person has accessed the site
- The shooting activity will be under the direction of the accredited shooter with overall control by the nightly shoot coordinator
- A NPWS firearms accredited officer will be part of the team
- A person qualified in first aid will be present in each shooting team
- Each targeted animal will be identified by spotlight.
- The shooter prior to giving the all clear for other members of the shooting team to approach the animal will check each animal shot.
- Following clearance by the shooter, carcasses are to be immediately removed from the target area by NPWS staff.

Reporting

On the morning following each shooting activity, the nightly shooting coordinator will complete a post shoot report which will include

- The sites visited
- The general weather and environmental conditions
- The number of deer seen at each site, the number of rounds fired
- The number, sex and age class of each animal culled.
- The number of deer that required more than one round
- Any incidents, injuries or issues encountered

The post shoot reports will be available to the RSPCA, NSW Animal Welfare League and members of the Deer Working Group.

After every shooting event, the Regional Manager and/or Regional Duty Officer will be notified of any non-scheduled activity that occurred.

An annual report will be prepared for the Director General of the NPWS and provided to the Deer Working Party.

The NPWS will, with the assistance of the Deer Working Group, continually monitor and evaluate these shooting protocols. Through adaptive management, the protocols will be refined to ensure high levels of public safety and humane management of the deer culling operations.