SYMPOSIUM 1

Wildlife Management in Southern African landscapes: challenges for the future

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Southern Africa and in particular South Africa with their enormous diversities of plants, animals, charismatic megafauna as well as the progenitors of modern man are of international importance to the conservation community. The ancient savannah biomes present a uniquely challenging prospect for ecological management and protected areas such as the iconic Kruger National Park apply some of the most modern adaptive management processes to this challenge. This given that South Africa itself is the 3rd most diverse country on the planet with 10% of the global plant, fish and bird diversity and 6% of the mammal and reptile diversity on less than 1% of the surface area. The grassland biome of South Africa is under enormous pressure from mining, agriculture, forestry and water abstraction whilst the unique Cape "fynbos" with its plethora of endemic species faces increasing challenges. Conservation and wildlife management take place in a political backdrop of corruption, nepotism and paranoia ranging from the poorest economies such as Mozambique to a failed Zimbabwe, stable Botswana and Namibia and South Africa with its unique post apartheid challenges.

Given the excellent reputation of South Africa's conservationists, wildlife managers and scientists and their record of creating protected areas with large numbers of white and black rhino, black wildebeest, bontebok and many other species brought back from the brink of extinction in the last century and the re-building of conservation in neighbouring countries, organizations such as the Southern African Wildlife Management Association (SAWMA) have an enormous facilitatory role to play in extending expertise into Africa. At the same time population growth, land restitution and negative socio-economic conditions require innovation from SAWMA and its members to maintain South Africa's conservation reputation whilst maintaining and expanding protected areas and integrating the private sector's approximately 17% of land under game ranching into the biodiversity conservation fold.
In this paper some of the conservation history of the sub-region, paradigm shifts in conservation and wildlife management philosophies, the current status of programmes, organizations, people and threats will be presented as well as the unique role that SAWMA will have to play in the future of wildlife management in the subregion.

Evolutionarily significant units for conservation across landscapes: phylogeography of the brush-tailed rock-wallaby

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Little is known about the phylogeography of south-eastern Australia and the implications of long-term environmental fluctuations on contemporary population structure and therefore management. We assessed the distribution and abundance of genetic diversity within the brush-tailed rock-wallaby (*Petrogale penicillata)* using 11 microsatellite loci and sequence variation at the mitochondrial control region, from 279 individuals from 31 colonies throughout the species' range. We found extremely high levels of genetic structure throughout the range and at multiple spatial scales with all sampled populations being genetically unique. The mtDNA data revealed three well supported, distinct lineages, corresponding to populations in discrete geographic regions (northern NSW/southern

Queensland; central NSW; Victoria), with lineage divergence dated to the late Pleistocene. There was little evidence for structure within each lineage. While the break between the Northern and Central lineage corresponds to a known geographic barrier, the separation of the Central and Southern lineages does not. Differentiation at nuclear microsatellite loci was high for comparisons between populations from different mtDNA lineages (mean Fst=0.337), while differentiation amongst populations within lineages was more moderate (mean Fst=0.196). Nuclear genetic distances amongst colonies also revealed multiple well supported clusters. These data confirm the existence of three evolutionarily significant units (ESUs) within *P. penicillata*.

Endangered species as flagships for landscape conservation

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Flagship, umbrella and keystone species can play an important role in helping to achieve broad conservation outcomes, particularly when resources are limited. The endangered African wild dog (*Lycaon pictus*) has been successfully utilised as a flagship species for large scale habitat conservation in Zambia. The wild dog is a highly mobile species and the African Wild Dog Conservation project takes a metapopulation management approach to increase habitat connectivity and mitigate anthropogenic threats. By working to conserve the large areas required for a viable population of this species, conservation efforts benefit many other species, particularly other mobile mammals. Alongside implementing ongoing ecological research to inform management, the project works in partnership with local government agencies and other NGO's to coordinate in-situ conservation activities, carry out community education and build ecotourism opportunities. The structure and concepts behind this successful flagship project are applicable internationally and can be adapted to a range of diverse ecosystems and species. This paper describes how the same model is being initiated locally in the Otway Ranges area of Victoria, focussed on the Tiger Quoll as a flagship species.

Conservation across landscapes at the Australian Wildlife Conservancy using Scotia Sanctuary as a case study

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The Australian Wildlife Conservancy (AWC) is a non-government conservation organisation whose mission is the effective conservation of Australia's wildlife and its habitats. To this end, AWC has acquired 21 sanctuaries covering over 2.5 million hectares and supporting 27%, 69%, 60% and 29% of Australia's threatened amphibians, birds, mammals and reptiles respectively. As a relatively young organisation, the acquisition policy has evolved and has been affected by opportunity costs (e.g. the purchase of Earth Sanctuaries sites and land values in northern Australia). AWC's conservation strategy relies on intensive management directed by solid science and monitoring by a predominately field-based staff. Using Scotia Sanctuary (64,563 ha) as an example, we discuss the translocations that have occurred, the feral eradication and control programme, and the interactions with surrounding landowners. Scotia has two 4000 ha fenced and feral-free exclosures where seven previously extinct species have been reintroduced, and numerous other threatened species persist. An experimental translocation of bridled nailtail wallabies has been initiated into the broader landscape to assess the feasibility of having critical weight range fauna coexisting with introduced predators at low densities. This is fundamental if they are ever to evolve strategies to coexist with foxes and cats.

Dingoes: Managing for ecosystem resilience and pastoral productivity

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There is growing recognition worldwide of the important roles played by predators in regulating ecosystems and sustaining biodiversity. In Australia, we have suffered substantial biodiversity and economic losses through the effects of predators, most notably cats (*Felis cattus*) and red foxes (*Vulpes vulpes*) and to a lesser extent, the dingo (*Canis lupus dingo*). We argue that the impacts of the first two species could be reduced significantly by a new management philosophy with respect to the dingo. Recent studies show clear and consistent evidence that the ongoing persecution of the dingo, Australia's sole remaining terrestrial top-predator, is linked with outbreaks of cat and fox populations ('mesopredator release'), as well as overabundant herbivore populations and increased attacks on stock by dingoes. With reference to these studies, and our own, we outline the functional role of the dingo and how this species could be better managed to maximise biodiversity and economic benefits. With the recent introduction of the red fox and concurrent decline of the devil in Tasmania, and evidence for increasing rabbit and cat populations and declining native mammals in northern Australia, there is clearly an urgent need to reassess predator management in Australia.

Invasive species management: towards an integrated landscape approach

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Management of invasive species is rarely conducted at a landscape scale. More typically, pests are managed intensively in specific areas that are judged to be of high importance, with little or no management in the surrounding landscape. This may lead to persistence of some native species only in areas where pests are controlled, perhaps with periodic dispersal between patches. This is known in ecological theory as a metapopulation. If a local population becomes dangerously small or even disappears, immigrants from neighbouring patches can provide a 'rescue effect'. The likelihood of extinction of the metapopulation is therefore much lower than that of a single, isolated population.

How can we apply a metapopulation paradigm to improve the outcomes of pest management for native biodiversity? Starting with a synthesis of the literature on metapopulation theory, conservation planning and landscape connectivity, we ultimately aim to establish integrated networks of pest management zones that facilitate dispersal of native species through landscapes. Conversely, control programmes could be designed to reduce connectivity for invasive species. The goal is to improve the timing and location of pest control to promote metapopulations of native species, re-establish large-scale ecosystem processes, and hence provide greater overall benefits for biodiversity.

Harvesting kangaroos across NSW: balancing conservation and economics.

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Kangaroos have been commercially harvested in NSW, within the context of a management plan, for over 30 years. The plan ensures the conservation of kangaroos across landscapes by limiting commercial harvesting through annual

quotas. Kangaroo population sizes are monitored annually with standardised, accurate and precise aerial surveys. Population estimates are used to set conservative annual harvest quotas. However, over the last 20 years, the harvest has utilised just 66% of the available quota, equivalent to 8.4% of the estimated population. Concurrently, kangaroo populations have fluctuated with drought and flush conditions irrespective of the extent to which the quota has been utilised.

Why does the commercial harvest fall short of the available quota? Economics. The commercial harvest is about generating profit within the industry: harvesters will only shoot animals if they can sell the carcases; processors will only buy the carcases if they can sell the products. There are limited markets for kangaroo products, and potential supply is generally greater than the demand. Conservation of kangaroo populations in the commercial harvesting regions of NSW is assured because of the conservative limits imposed by the annual quota and because the actual annual harvest is governed by weather conditions and market forces.

OPEN SESSION 3

Enumeration of European rabbits on Robben Island, Western Cape, South Africa.

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Robben Island holds a very significant place in the National psyche in South Africa due to its association with recent political history. It has become an ecotourist haven and as with many islands its ecology has been severely disturbed by the introduction of exotic fauna and flora. Its classification as a world heritage site, with the commensurate regulations on the removal of exotic species has seen its elevation to the political football in the struggle between preservation and conservation in the tabloid press and emotional outbursts with reference to removal of exotic fauna.

Rabbits were introduced to Robben Island by passing sailors in the seventeenth century and today together with other alien fauna and flora pose a serious threat to the unique vegetation and associated fauna (particularly marine avifauna) of the island. European rabbits (*Oryctolagus cuniculus*) are considered alongside the ship rat (*Rattus rattus*), feral pig and cane toad to be amongst the biggest threats to environments where they have been introduced. Foremost amongst these examples was that of their introduction to Australia in the mid nineteenth century and subsequent efforts at their eradication.

Distance sampled night spotlight counts of rabbits were undertaken in December 2009 and in June 2010. Coefficients of variation of the order of 6.4 to 7.3% were attained and numbers of the order of 3097 and 2648 respectively at a density of 4.9 to 7.5 individuals per hectare. The method shows great promise for the monitoring of this population in the face of previous estimates ranging as high as 25 000.

Rabbit impacts on landscape restoration

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Extensive and costly revegetation programs are widely undertaken to restore degraded landscapes. The impact of rabbits on planted native vegetation and on natural regeneration for many landscapes is largely unknown though probably significant. We describe early results from a large-scale restoration project near Ballan, Vic, where livestock grazing has been removed and rabbits have been managed to revegetate 110 ha of land adjoining the Werribee River. An experiment has been included to assess the impact of rabbits on planted seedlings. Extensive rabbit control resulted in >93% reduction in the rabbit population across the 781 ha property. Baiting with 1080 oats reduced the population from 85 to 6 rabbits per spotlight km. Heavy earth moving equipment ripping to a depth of >60 cm then destroyed ~1400 warrens at a density of 6-11 warrens ha^{-1}. Follow up fumigation of warrens is ongoing. Five small pockets were not ripped, deliberately leaving areas of higher rabbit density (cf. controlled densities) to assess the impact of rabbits on the growth and survival of three species (*Allocasuarina verticillata*, *Acacia pycnantha*, and *Eucalyptus viminalis*) of planted seedlings. A sample of seedlings was also guarded to completely remove browsing by vertebrate herbivores. The initial impact on the seedlings is discussed.

Managing feral goats through manipulating their access to water

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Feral goats are a recognised threat to biodiversity in Australia. Throughout the arid and semi-arid rangelands of New South Wales, their populations appear to be contiguous, in part because of a proliferation of artificial watering points (AWPs) that has allowed them to expand further than would otherwise be the case. Feral goat control is often only effective in the short term, as goats rapidly immigrate from surrounding areas. We investigated the effectiveness of closure of AWPs and discontinuous goat-proof boundary fencing strategically built in areas close to water on neighbouring properties to reduce goat abundance and impacts on conservation reserves. Effectiveness was evaluated through dung and ground cover transect surveys and GPS collars placed on feral goats. The surveys showed that twelve months after completing fence construction, goat dung significantly declined and there were significant changes in ground cover. The GPS collar data showed that feral goats were strongly tied to specific watering points. Average distance to water was 1.6km and average maximum distance from water was 3.4km. After AWPs were closed, goats relocated to adjacent AWPs. These results have specific relevance for management of feral goats in rangeland conservation areas and neighbouring lands.

The Warragamba Special Area Feral Pig Project

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Feral Pigs (*Sus scrofa*) in Australia are regarded as having a significant impact on the environment, with extensive effort expended on the management of these animals across the country each year. Feral Pigs are prevalent in the Warragamba Special Area (WSA), the largest water storage facility for the population of Sydney, approximately 75km west of Sydney's Central Business District (CBD). Feral Pigs are known to destabilise soils, alter vegetation communities, increase the spread of weeds and decrease water quality. Despite years of active control of Feral Pigs in the area, little is known of their biology, ecology or genetics and the efficacy of control measures has never been quantitatively assessed.

A project was implemented within the WSA to collect information that would inform the management of Feral Pigs in the area. Genetics, environmental impacts, abundance and patterns of movement, and the potential for pigs to act as vectors for the transmission of zoonotic diseases were investigated.

Data from this study indicated that while current management techniques appear to be effectively suppressing Feral Pig populations in the WSA, refinement of some control measures could further suppress these populations.

Ecological processes behind wildlife management patterns; Twenty-five years of feral pig research

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Feral pigs occur in Namadgi National Park, ACT. Poisoning has been used for decades to try to reduce pig density and potential effects on biodiversity. Over more than 20 years there was no long-term trend in pig density (r = 0.07 per year +/- 0.08 SE) and no trend (R^2 = 0.03, df=22) in frequency of ground rooting by pigs. The ecological processes generating observed patterns have been derived and evaluated for (i) damage/density relationship, (ii) trends in pigs alive after start of poisoning, (iii) short-term effect of ground rooting by feral pigs on plant species richness, (iv) effects on density of natural (non-toxic) and toxic (poison) food eaten, and (v) effects of poisoning on non-target

species (birds). The derivations of the ecological processes will be described and compared to observed data. The management implications are described.

Protecting agriculture and threatened species internationally through the use of a human food preservative?

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In 2005 the Pest Animal Control CRC discovered the potential of sodium nitrite, a common meat preservative that prevents botulism, to be a quick acting, low residue and reversible toxicant for feral pigs. Pigs are particularly sensitive to nitrite-induced methaemoglobinemia as they have a pharmacological weakness in low levels of methaemoglobin reductase, the enzyme required to reverse the effects of nitrite toxicosis. Over the last five years a great deal has been achieved in obtaining funding and a patent to continue and protect the research, formulating nitrite, conducting pen and field trials, assessing the humaneness of the toxicosis, predicting primary and secondary poisoning hazards to non-target species and compiling a registration dossier. Collaboratively and simultaneously nitrite is being developed for feral pig and possum management in New Zealand, and is currently being pursued for wild hog management in America. As nitrite possess most of the ideal properties of a modern toxicant - human safety, highly toxic to target species, bait deliverable, humane, low/no residues, biodegradable, reversible (antidote), affordable, comprehensive toxicology data available and publicly acceptable - it is currently being investigate for a range of invasive species worldwide. This talk will detail progress to date and future plans.

STUDENT SESSION 2

Do rope bridges prevent possums from being squashed on roads and re-connect their habitats?

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My PhD project aims to assess the efficacy of rope bridges in mitigating the negative impacts of roads on the western ringtail possum (*Pseudocheirus occidentalis*) and the common brushtail possum (*Trichosurus vulpecula*) in south-west Western Australia by:

- examining the genetic structure of groups of possums historically separated by a high-use road;
- incorporating microchip readers and motion activated cameras on bridges to monitor the use of bridges by individual microchipped possums;
- monitoring the change in movements before and after installation of rope bridges by using radio-telemetry techniques;
- monitoring changes in road mortality of the possums before and after the installation of rope bridges; and
- investigating whether rope bridges facilitate breeding between the separated groups of possums once they are linked by rope bridges.

Prior to rope bridge installation, no radio-collared possum appears to have crossed the road, even though some are regularly observed in trees adjacent to the road. Other key preliminary findings, including the survivorship and home range of the possums prior to the bridge installation, will also be presented.

Interactions between predators and their prey in the Greater Blue Mountains World Heritage Area

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The Greater Blue Mountains World Heritage Area (GBMWHA) provides habitat for a suite of native and exotic predators. This study investigated the interactions between members of the predator guild and the prey populations upon which they depend within the World Heritage Area. A particular focus of the study involved the endemic canids, the wild dog (*Canis lupus*) and fox (*Vulpes vulpes*), but included data relevant to native mesopredators and scavengers.

Predators were shown to influence intraguild competitors occurring sympatrically through a range of exploitative (i.e. resource utilisation) and interference (i.e. predation) competition. The predator guild also exerted top-down pressure on prey populations through predation and by altering the behaviour of prey species. Bottom-up effects also had an influence on the dynamics of predator-prey interactions, as demonstrated when apex predators switched prey dependence following changes to relative abundance and activity of prey populations.

This study showed that careful management of apex predators, particularly canids, will be vital in the maintenance of biodiversity in the GBMWHA.

The response of woodland-dependant birds to scattered paddock tree densities in Western Victoria.

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As major drivers of land-use change, global agricultural systems often result in landscapes containing remnant habitat patches within fragmented systems. Despite these changes to natural ecosystems, many native fauna persist across rural landscapes. Agricultural systems in western Victoria, Australia, were investigated for their conservation value to woodland-dependant birds, taxa considered sensitive to land-use change. Species diversity and a variety of behavioural responses were measured within high and low paddock tree densities, to ascertain the importance of these aging vestiges.

Species diversity was greater in high density compared to low density paddock trees, and site characteristic anomalies between high and low tree densities suggested an influence on the presence of some woodland-dependant species. Birds exhibited shorter gap distance flights in high density trees, where available gap distances were also shorter. Overall, most species differentiated their energies between tree densities, giving most time to foraging in low density trees, and vigilance behaviour in high density trees.

High paddock tree densities were found to have a greater conservation value for an array of woodland-dependant species, in particular, small to medium sized insectivores Other species however, were able to utilise both tree densities similarly, such as the Crimson Rosella and Striated Pardalote, providing a consistent presence across all sites.

The distribution of three nocturnal bird species across a suburban-forest gradient

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On a global scale, urbanization has a profound effect on the distribution of wildlife. Here we seek to test the effects of urban encroachment on the distribution of three key members of the Australian nocturnal bird community (Tawny Frogmouth *Podargus strigoides*, Southern Boobook *Ninox novaeseelandiae*, and Australian Owlet-nightjar *Aegotheles cristatus*). Species distribution was recorded in three landscape types (suburban, urban-fringe and forest), with the level of urbanization classified according to both landscape and site-level attributes. The effects of urbanization on individual species were determined by a comparison of broad landscape attributes and species distribution. Site level attributes were modeled to determine their influence on species presence. While all three species occurred at high levels in the urban-fringe landscape, the presence of the Tawny Frogmouth, a species with more generalist habitat requirements, increased in response to increasing levels of urbanization. Habitat specialists, the Southern Boobook and Australian Owlet-nightjar, demonstrated a corresponding decrease to increasing levels of urbanization. Whilst all three species appear to tolerate the level of disturbance in urban-fringe environments, these areas are also at risk of further degradation. It is critical that continued research is focused on urban-fringe environments to investigate species-specific demographic responses to urban gradients.
Keywords: Suburban-forest gradient, nocturnal birds, urbanization, urban ecology

Ecomorphology of fox skulls in southwest Western Australia

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Ecomorphology examines the relationship between morphological variation and ecology. Cranial morphology is strongly influenced by both diet and feeding behaviour, which are tightly linked. Foxes are introduced predators in Australia and are controlled because of their detrimental effects upon native wildlife and livestock. Their impact is particularly severe in the biodiversity hotspot of the southwest. We collected samples from over 500 red foxes from 16 locations during culls carried out as part of the 2010 Red Card for the Red Fox program, coordinated by the Department of Agriculture WA. We investigated the relationship between skull morphology (size, shape, mass, tooth

wear, and deformities), demographic characteristics (age, sex), body mass and size, body condition, diet (from stomach contents) and geographic distribution. By far the majority of animals that were shot by hunters were juveniles that are dispersing from their natal sites; adults are either less common or (more likely) more difficult to track and shoot than the juveniles. Adult foxes have significantly more robust and heavy skulls than juveniles, whilst most other dimensions are in proportion with skull length (scale isometrically). Adults have a more varied diet, including a greater percentage of plant, invertebrate, and small vertebrate food. This may reflect the increased bite force and load bearing capacity associated with larger, more robust skulls.

Parasites and pests: Helminth fauna of red foxes (*Vulpes vulpes*) and feral cats (*Felis catus*) in southwest Western Australia

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The red fox (*Vulpes vulpes*) and feral cat (*Felis catus*) are widely distributed across Australia and present throughout a range of habitats and landscapes. These pest species are both highly invasive and destructive costing Australia an estimated $370 million a year in economic and environmental damage. In addition to these impacts, they harbor a wide range of parasites, many of which potentially have important conservation and agricultural repercussions. In order to investigate the parasite status of these pest species, intestinal tracts were collected from 146 red foxes and 47 feral cats that were culled throughout southwest Western Australia. Intestinal contents and linings were examined under a dissecting microscope to identify helminth parasites present. Overall 58% of foxes and 81% of cats were harboring helminths within their digestive tract. Many of the helminth species detected in red foxes were also detected in feral cats. Commonly occurring helminths included *Dipylidium caninum, Toxocara canis,* Taenia spp., Roundworm spp. and *Spirometra erinaceieuropaei*. *Echinococcus granulosus* was not detected in this study. Many of these parasites have the potential to adversely impact upon domestic livestock and/or native wildlife. Results of this work are discussed with reference to host demographics (age, sex, location) and body condition (condition scoring, coat scores).

A Preliminary Study Assessing Risk to Tasmanian Devils from Poisoning for Red Foxes

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The recent introduction of red foxes (*Vulpes vulpes*) to Australia's island state of Tasmania represents a major threat to native fauna. In response, the Tasmanian government has begun a fox eradication program using Foxoff®, a bait containing the poison sodium monofluoroacetate (commonly known as 1080). The bait is potentially attractive to native Tasmanian carnivores as well as to foxes. Of particular concern is the endangered Tasmanian devil (*Sarcophilus harrisii*), which is already at risk from an emergent infectious disease, Devil Facial Tumor Disease. In both a captive and a field study using nontoxic Foxoff bait, we assessed bait palatability and possible effects of demographics, hunger level, bait age, and bait burial method on the likelihood of bait uptake by Tasmanian devils. Captive devils showed varying interest in the bait, but wild devils appeared to find it uniformly palatable. In the captive study, males and younger, captive-born animals were more likely to excavate and remove bait. Subterranean burial at 15 cm was the most effective deterrent to bait excavation; effectiveness decreased at shallower depths and with surface-level bait buried beneath soil mounds. Our findings suggest that the current fox-

baiting campaign may negatively impact individual devils. More extensive study is necessary to assess potential risk at the population level.