Executive summary

Invasive pest animals cause enormous damage to Australia's economy, environment and society. They impact on primary production industries, cause land degradation, threaten biodiversity, contribute to human health problems and damage our dwindling water resources.

Previous estimates suggest that about 73 invasive pest animal species (comprising mammals, birds, fish, reptiles and amphibians) have established wild populations in Australia (Bomford 2003). Many species were introduced during the 1800s, such as rabbits, feral deer, foxes, camels and feral pigs. However, a number of new pest species have emerged as pests in our changing environment such as common starlings, red-eared slider turtles, Indian myna birds and tilapia. In most cases, the impacts of pest species in Australia have not been fully identified, and there is ongoing risk that new invasive species (such as alien fish) could establish in the wild. As a result, we urgently need mechanisms to prevent and respond to pest incursions.

Invasive pest animals in Australia are estimated to cause losses in excess of one billion dollars per year through environmental and economic damage (McLeod 2004, Tracey et al 2007). The main culprits are feral pigs, rabbits, foxes, feral cats and pest birds. Apart from the direct losses associated with damage caused by invasive animals, there are additional costs associated with their control. These are estimated to exceed $60 million per year, with a further $20 million per year allocated to essential research.

Significant gaps in research knowledge, especially regarding social impacts (Norris et al 2006), combined with the fact that many of the impacts of invasive animals are long term, limit our ability to accurately estimate the total impact cost of invasive animals in Australia. As a result, although current national estimates of impacts provide an insight into the scale of the invasive animal problem, these are conservative estimates of the real damage caused by invasive animals each year.

Feral pigs (*Sus scrofa*) are a major agricultural and environmental pest (photo by Glen Saunders)

Not surprisingly, invasive animals are also particularly destructive to Australia's wildlife and the environment. They are listed in the top three greatest threats to threatened species and ecosystems, riparian environments and important wetlands of Australia (Tait 2005). Their significance is duly reflected in the Commonwealth's environment and biodiversity conservation legislation (*Environment Protection and Biodiversity Conservation Act 1999*), in which 7 (41%) of the 17 listed 'key threatening processes' for nationally listed threatened biodiversity are invasive animals. In New South Wales (NSW) alone, invasive animals pose a risk to 40% of threatened biodiversity, representing 388 listed threatened species and 157 nationally listed threatened species.

Invasive animals are also known to threaten many of Australia's Matters of National Environmental Significance. These pests seriously impact on threatened species and ecological communities, and listed migratory species (eg little tern predation by foxes). They threaten marine species and environments (eg grey-headed albatross on Macquarie Island), and wetlands of international importance (eg feral pigs in the Macquarie Marshes Ramsar wetland in NSW). Invasive animals are a notable major threat in almost all World Heritage Areas in Australia, ranging from cane toads in Kakadu to rabbits on Macquarie Island to feral pigs in the wet tropics.

Intended audience and overall objective

This Assessment is intended for managers within government, regional groups, and non-government bodies who are responsible for invasive animal monitoring, reporting and evaluating activities, and related management programs. It presents, for the first time, consistent national information on the distribution and abundance of significant invasive animals in Australia as a baseline for ongoing monitoring and reporting activities. Continued collection of data to address gaps will provide improved information for future assessments. Where available, information on trend was collated and is reported, and potential distribution information was modelled for species that are still spreading.

Key findings

Ten nationally significant invasive animals were addressed as part of this Australia-wide Assessment under the National Monitoring and Evaluation Framework (National M&E Framework). The 10 significant invasive animals are feral pigs, feral goats, feral deer, rabbits, foxes, wild dogs (including dingoes), feral cats, common starlings, common carp and cane toads.

This Assessment reports on indicators of the extent and impact of these species, which have been compiled from existing datasets using nationally agreed monitoring protocols and data standards.

This Assessment of 10 of Australia's significant pest species indicates that:

- Invasive animals are a national issue because they inhabit all state and territory jurisdictions and all natural resource management (NRM) regions.
- They cause damage valued at more than one billion dollars per year through economic, environmental and social impacts (McLeod 2004, Tracey et al 2007).
- The highest concentrations of invasive animal species occur in the eastern regions of Queensland, NSW and Victoria, where more than 7 of the 10 nationally significant invasive animal species occur.
- All areas of mainland Australia contain a number of nationally significant invasive animals and four nationally significant species — foxes, rabbits, wild dogs and feral cats — inhabit more than 70% of the country.
- Feral deer, cane toads, common carp and common starlings are all colonising new areas, and modelling predictions suggest that many other species are still capable of invading new areas throughout Australia. Thus, management authorities need to remain vigilant.
- The rapid spread of cane toads across northern Australia in recent years towards the Western Australian border requires a nationally coordinated response (such as a national cane toad management strategy) to minimise further invasion by cane toads and lessen their impacts, particularly to species of conservation significance.
- Many coastal and offshore islands contain large populations of invasive animals, many of which threaten native species and communities.
- The adverse impacts of invasive animals are significant at the national scale, but are generally not well identified.
- Impact case studies report that invasive animals threaten 40% of biodiversity in NSW, are a major threat to environmental assets, cause significant production losses, prevent recovery of native vegetation, and threaten native fauna. All NRM regions in NSW contain threatened species at risk by invasive animals.

- There is a significant overlap between where invasive animal populations are located and nationally important environmental assets in all states and territories of Australia.
- There are significant gaps in knowledge that must be addressed for future reporting activities.

Key findings for each species are summarised in Table 1. See Chapter 3 for detailed information on the distribution and abundance of these 10 invasive pest species and Chapter 4 for case studies on the impacts and monitoring of some of these species.

Table 1 Summary of extent, trend, potential range and impacts of invasive species

Invasive animal	Extent	Trend	Potential range	Impact	Other information
Feral pigs	Occupy 45% of Australia All states and territories, and some large islands Most abundant in NSW, Qld and NT	Limited information at the national scale	Have expanded beyond their predicted limits, possibly because of access to water sources and land use practices	$106.5 million per year (McLeod 2004) Impacts reported to newborn lambs, sugar cane, banana crops, threatened sea turtles Occur at high densities where environmental assets are abundant	Listed under the EPBC Act as a 'key threatening process'. Pose a serious exotic disease management threat, damage sensitive wetlands through wallowing and rooting, and are a risk to numerous threatened plant and animal species
Feral goats	Occupy 28% of Australia All states and territories and many offshore islands; most abundant in NSW, Qld, SA and WA Can reach very high densities	Limited information at the national scale, some information at local scale, possibly decreasing in SA	Suitable climate in most of the mainland Limited by occurrence of predators (wild dogs and dingoes), land use practices and human activity	$7.7 million per year (McLeod 2004) Degrade native vegetation and compete for pasture Occur at moderate densities where environmental assets are abundant	Listed under the EPBC Act as a 'key threatening process' Can withstand drought for extended periods and can increase in number rapidly when food is available Commercial resource and valuable meat and fibre source (Ramsay 1994)
Feral deer Six species assessed: fallow deer, red deer, sambar, rusa, chital and hog deer	Occupy 9% of Australia All states and territories, and on some islands Widespread in parts of Vic, Tas, Qld and SA	Largely unavailable at the national scale Reported as increasing in SA, Tas and NSW	Not determined Tend to occupy medium to high rainfall areas in temperate Australia Some prefer northern Australian climates (eg rusa deer in the NT)	No annual estimated cost of impacts Can carry livestock diseases, can damage native vegetation and crops, and are a motor vehicle hazard	Listed under some state and territory legislation as a 'key threatening process' Also present a serious risk for exotic disease maintenance and transmission, such as foot-and-mouth disease

Table 1 Continued

Invasive animal	Extent	Trend	Potential range	Impact	Other information
Wild dogs, including dingoes	Occupy 83% of Australia All states and territories except Tas Common throughout most of range and most abundant in arid and northern areas	Limited information at the national scale Stable in SA and the NT, possibly stable throughout entire range Numbers fluctuate locally with prey availability	Have possibly reached their limit in Australia Restricted by the wild dog/dingo fence	$66.3 million per year (McLeod 2004) Main impact is predation and injury of livestock and native fauna Primary host of hydatid parasites	Potential transmitters of rabies if introduced to Australia, and have been known to be a threat to humans in some situations
Rabbits	Occupy 70% of Australia Occur in all states and territories, and some islands Mainly absent north of the Tropic of Capricorn Moderate densities where abundant environmental assets exist in Vic, SA and WA	Limited information at the national scale Research indicates their numbers declined as a result of RHD but are recovering in many regions	Expected to have been reached throughout the country	$113.1 million per year (McLeod 2004) Reported to prevent regeneration of mulga and threatened acacias Recognised threat to 157 threatened species (121 plants, 17 birds, 13 mammals, 4 reptiles, 1 fish and 1 insect species) (DEWHA 2008b) Occur at moderate densities where environmental assets are abundant	Major agricultural pest Listed under the EPBC Act as a 'key threatening process' RHD in 1996 reduced numbers in many areas, allowing regeneration of native species and revealing many new rabbit impacts Serious risk to threatened bilbies in western Qld
Foxes	Occupy 76% of Australia Occur in all states and territories; recently illegally introduced to Tas Abundant throughout most of their range Mainly absent north of the Tropic of Capricorn	Limited information at the national scale Stable in SA and the NT, possibly throughout most of the country Increasing at northern limit of distribution in the NT	Expected to have been reached throughout the country, except in Tas	$227.5 million per year (McLeod 2004) Significant impact on lamb production Reported to impact on native fauna, including potoroos and bandicoots in Vic, and shorebirds in NSW	Major agricultural pest Listed under the EPBC Act as a 'key threatening process' Cause significant declines and regional extinctions of native wildlife (eg ground-dwelling and semi-arboreal mammals, ground-nesting birds and freshwater turtles)

Table 1 Continued

Invasive animal	Extent	Trend	Potential range	Impact	Other information
Feral cats	Occupy 99% of Australia Common throughout range and inhabit many islands Recently eradicated from Macquarie Island	Limited information at the national scale Increasing in Tas, stable in SA and the NT	Have most likely reached their limit Numbers fluctuate with prey availability	$144 million per year (McLeod 2004) Highly effective predators of 38 mammalian species, 47 bird species, 48 reptile species and amphibians (Dickman 1996) Cited in extinctions of small mammals and ground-nesting birds	Listed under the EPBC Act as a 'key threatening process' Contributed to failures in several endangered species reintroduction programs Stray and domestic cats are a threat to urban wildlife
Common starlings	Occupy 21% of Australia All states and territories except NT, and some islands Abundant in agricultural areas	Limited information at the national scale Increases noted in some areas of SA	Have not reached their limits Potential for expansion into WA and tropics, especially in agricultural areas	Contribute to $290 million per year loss to horticulture industries (Tracey et al 2007) Compete with native birds for nesting hollows Carry parasites and disease	Contained by intensive control programs in WA
Common carp	Occupy rivers in 11.5% of Australia Occur mainly in Murray-Darling Basin Isolated populations in Qld, WA and Tas	Limited information at the national scale Monitored closely at local level throughout Murray-Darling Basin	Climate predictions suggest most of southern half of continent suitable for expansion, but require suitable river systems	$15.8 million per year (McLeod 2004) Reduce water quality, alter fish species composition, cause bank erosion, reduce aquatic plant growth, elevate water turbidity levels	Can represent most of the fish biomass in rivers
Cane toads	Occupy 20% of Australia Occur in Qld, NT and NSW	Recently spread in northern Australia from east to west at 27–50 km/year Expected to reach WA by 2008–2010 (Peacock 2007)	Have not reached their limits Climate and habitat predictions suggest further spread into NSW, central Qld and northern Australia, including WA	Conservatively estimated to cause $0.5 million damage per year (McLeod 2004) Threat to wildlife and pets through toxins Impact on native predators (Molloy and Henderson 2006, Doody et al 2007) Prey on insects, reptiles and frogs	Listed under the EPBC Act as a 'key threatening process' Potential impact has prompted the Australian Government to allocate $18 million to research and control since 1985 Better estimates of impacts are needed

EPBC = *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*; NSW = New South Wales; Qld = Queensland; Vic = Victoria; Tas = Tasmania; SA = South Australia; NT = Northern Territory; WA = Western Australia; RHD = rabbit haemorrhagic disease

Functions of this Assessment

This Assessment provides valuable information on invasive animals and their impacts in Australia. The findings should be used as one of many mechanisms to evaluate investment programs, including NRM or future Caring for our Country initiative. Along with appropriate supporting information, the findings may identify priorities for future investment, control activities, management planning and research.

The case studies reported in Chapter 4 present a snapshot of information about impacts that may provide valuable reference points to help define the problems caused by invasive animals in Australia. Information on the distribution and abundance of invasive animals should be considered in this process.

This Assessment has developed consistent monitoring protocols for collection, collation and reporting of national-scale information. Although ongoing monitoring and reporting activities at the local and regional scale are needed to underpin information for national reporting, a process of consolidating data into state, territory and national formats is still needed, and should be developed through ongoing assessments.

Suggestions for implementation and coordination

There is a clear need for a coordinated effort between governments at all levels, research, industry groups, producers of innovative technology, landholders and the broader community to address the escalating problems caused by invasive animals in Australia. Further implementation of consistent national monitoring protocols and future assessments will provide improved information to assess the effectiveness of management actions and investment programs.

Commitment of resources to monitoring

Significant planning, coordination and resources are required to address the large-scale problems caused by invasive animals, and a commitment is required by state, territory and Australian governments to ongoing and improved monitoring of invasive animals and their impacts.

The fox (*Vulpes vulpes*) is a significant predator of native wildlife and causes substantial losses to lamb production industries (photo supplied by Invasive Animals CRC)

Further data collection

Fundamental information on the extent and impacts of pest species is necessary at the state, territory and national levels to guide policy, evaluate management, develop appropriate management and biosecurity strategies, and measure the effectiveness of investment to address the adverse impacts of pests.

Further research is required to identify the magnitude of impacts of invasive animals in Australia and to improve the tools and techniques to monitor these impacts. Management programs rely on accurate, timely and precise information on impacts, and monitoring is required where investment is allocated to evaluate the effectiveness of funding programs.

National information system for monitoring

A national information system is urgently needed for monitoring and reporting activities for invasive species under the National M&E Framework, and to address the needs of each state and territory government regarding reporting on invasive species matters. A national information system is also vital to address many additional needs, including information on new and emerging species, areas of investment,

Feral cats (*Felis catus*) are a major predator of Australian wildlife and inhabit the entire continent (photo by K Gillett)

control activities, impacts on assets, and areas of active management. There is also a critical need for consistency in the way information is collected and reported for delivery of meaningful state, territory and national products for decision-makers and policy development. A national information system for invasive animals may also provide a means for consolidating all state and territory data.

It is important to identify a clear strategy for the development (or adoption) of a national system for managing information about invasive species. To progress this, the Assessment's team and the Australian Vertebrate Pests Committee (VPC) recommended a detailed assessment of the suitability of existing systems for routine monitoring and reporting of invasive animals.

Future directions

We offer the following recommendations to address the problems of invasive species on the national, state, territory and local levels.

New and emerging species should be monitored

In future assessments, and as part of routine management programs, a more comprehensive range of established invasive animal species, as well as new and emerging species (including a range of alien fish and pest bird species) should be included in monitoring and reporting activities under the National M&E Framework.

To enable management programs to accurately target species and mitigate their impacts in Australia, it is critical that a representative group of species is included in monitoring and reporting. Monitoring of new and emerging species will help identify the mechanisms by which species are spreading and help to identify their short and long-term impacts.

Additional information should be collected in future assessments

Future national assessments will build on the achievements of this Assessment and, with adoption of relevant monitoring protocols, will provide

fundamental information on invasive animals and their impacts that is needed to evaluate the effectiveness of management programs and investment. Future assessments should include additional information on assets, investment, impacts, management actions, and the occurrence of new and emerging species. Although beyond the scope of this Assessment, coastal and offshore islands should be considered in future assessments because many islands are heavily populated by invasive animal species that impact on threatened and migratory species and other Matters of National Environmental Significance.

The next assessment should be undertaken before 2011

Future assessments should be undertaken as recommended by the relevant national coordinating committee, being VPC. As a guide, we recommend that the next assessment should be undertaken within two to three years to supply information for the 2011 National State of the Environment Report. At that time, the respective indicators and monitoring protocols should be reviewed for their capacity to assess the status of invasive animals and their impacts in Australia and to evaluate the effectiveness of management and investments over time.

All stakeholders should be engaged in the process

Relevant stakeholders, including state and territory authorities, regional NRM groups and experts need to be further engaged to incorporate detailed local- and regional- level information. This will ensure that an enduring process is accepted for ongoing monitoring and reporting in Australia. Adequate resources are required for stakeholders, particularly NRM regional bodies, to develop and implement invasive animal monitoring strategies.

Coordinated monitoring and reporting for cost-effective investment

Implementation of national monitoring protocols will provide detailed and consistent information on invasive animal populations and their impacts over time. Investment in coordinated monitoring and reporting will provide information for more cost-effective investment and will facilitate the evaluation of investment strategies. A commitment from all governments is required to implement consistent monitoring and reporting.

Monitoring and impact assessment can be improved

Monitoring the distribution and abundance of invasive animals in Australia can be improved with further adoption of field-based monitoring techniques at local and regional levels. Adoption of a finer reporting scale for monitoring and reporting activities will help to maintain accurate information in national datasets.

Impact monitoring is needed to assess the effectiveness of investments. Development of improved impact-monitoring techniques and an impact-monitoring framework will allow assessment of management programs and the effectiveness of investment. Further, it will help to set management priorities, increase the effectiveness of best-practice control strategies, and increase awareness of invasive animals and their impacts in Australia.

A national information system for invasive species to be used by states, territories and NRM regions will facilitate ongoing monitoring, evaluation, reporting and program improvement. Formalised data-access arrangements are required between the state and territory jurisdictions and the Australian Government for ongoing monitoring and reporting, and future assessments.

Government commitment is needed

To address the increasing problems caused by invasive animals in Australia, a commitment is required through government NRM programs, such as the new Caring for our Country initiative, to fund essential monitoring, evaluation, reporting and program improvement activities at state and national levels.

Funding of this Assessment

This Assessment was funded through the National Land & Water Resources Audit and the Invasive Animals Cooperative Research Centre. It was endorsed by VPC and was supported by all states and territories; the Australian Government Department of Agriculture, Fisheries and Forestry; and the Department of the Environment, Water, Heritage and the Arts.