

Australian Pest Animal Research Program



CARING
FOR
OUR
COUNTRY



Australian Government

**Australian Bureau of Agricultural and
Resource Economics and Sciences**

**National mapping of the abundance of established, new and emerging
pest animals to improve decision-making and the assessment of
government investment programs**

STAGE 1: PEST ANIMALS

FINAL REPORT

TO THE AUSTRALIAN BUREAU OF AGRICULTURAL AND RESOURCE ECONOMICS AND
SCIENCES, DEPARTMENT OF AGRICULTURE, FISHERIES AND FORESTRY

OCTOBER 2011



PETER WEST

VERTEBRATE PEST RESEARCH UNIT - NSW DEPARTMENT OF PRIMARY INDUSTRIES



**Department of
Primary Industries**



Invasive Animals CRC

Lead agency

The NSW Government – NSW Department of Primary Industries and the Invasive Animals Cooperative Research Centre (IACRC) coordinated this project with funding through the Australian Pest Animal Research Program (under Caring for our Country).

Cover page images

Feral cat (courtesy of K Gillett); fox (courtesy of G Saunders); feral pigs and rabbit (courtesy of NSW DPI).

For further information

Contact: Mr Peter West – NSW Department of Primary Industries

Ph: (02) 63913887. Email Peter.west@industry.nsw.gov.au

Data accessed:

A number of formalised datasets were accessed from organisations for this project including: the Tasmania Natural Values Atlas courtesy of the Tasmanian Department of Primary Industries, Parks, Water and Environment; Victorian Biodiversity Atlas courtesy of the Victorian Department of Sustainability and Environment; Queensland Annual Pest Distribution Survey, courtesy of Biosecurity Queensland; Atlas of NSW Wildlife, courtesy of the NSW Office of Environment and Heritage; data from the NSW Pest animals survey courtesy of NSW Department of Primary Industries; data from the NSW Department of Environment and Heritage on cane toads, pest animal occurrence data from the Department of Agriculture and Food WA, feral camel data from the Australian Feral Camel Management Project, feral deer data from Biosecurity South Australia, as well as records from several databases (including Feralscan) managed by the Invasive Animals Cooperative Research Centre.

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1. PROJECT INFORMATION

1.1 Project Name

National mapping of the abundance of established, new and emerging pest animals to improve decision-making and the assessment of government investment

1.2 Details of Applicant

(a) Organisation Details

Vertebrate Pest Research Unit
NSW Department of Primary Industries
Orange Agricultural Institute
Forest Road, Orange, NSW 2800

(b) Project Officers

| | |
|---|--|
| Peter West | Brian Lukins |
| Tel: 0263913887 | 0263913882 |
| Fax: 0263913972 | 0263913972 |
| Email: peter.west@industry.nsw.gov.au | brian.lukins@industry.nsw.gov.au |

(c) Project Supervisor

Glen Saunders
Tel: 0263913890
Fax: 0263913972
Email: glen.saunders@industry.nsw.gov.au

1.3 Collaborators / Third Parties

This project involved collaboration between NSW Department of Primary Industries, the Invasive Animals CRC, and the Australian Government – Australian Bureau of Agricultural and Resource Economics and Sciences. Collection and collation of data for this project involved many organisations and agencies administering databases and pest animal records. Assistance was provided by state and territory government agencies and regional groups with spatial databases on pest animals. Data was also supplied from the Australia Feral Camel Management Project. The project members worked closely with each state and territory agency to provide up-to-date records of for this project.

1.4 Period of Project

Commencement date: 1 February 2009

Completion Date: 30 December 2001 (extension granted to 31 October 2011)

1.5 Project aims and objectives

Baseline information on the distribution and damage caused by pest animals is required to apportion resources to where they are most required and at strategic times. Data on the damage caused by pest animals is rarely available across broad landscapes and management agencies (and landholders) are largely reliant on

information about the occurrence and numeric abundance of pests to guide management decisions and resourcing of on-ground pest control. Information on the distribution and abundance of pest animals is also used to evaluate the effectiveness of policies, programs and decision-making.

This project aimed to directly address the need for improved information on significant pest animal species at the national-level through 4 objectives:

1. To implement nationally endorsed monitoring protocols (at a finer-scale) to collect, collate and report information for established, new and emerging pest animal species throughout Australia (to complement existing national-scale datasets and information products)
2. To develop improved Australia-wide datasets for national priority pest animals for monitoring, evaluation, reporting and program improvement (MERI).
3. To centralise datasets for all species and produce consistent information products for all relevant regional, state/territory and national levels.
4. To deliver information products to relevant agencies, land managers and the community via government data libraries, portals, and stakeholder websites.

The project relates to species considered of importance in many state and territory jurisdictions, as identified in previous initiatives, pest animal workshops and guided by the Australian Pest Animal Management Project and the Vertebrate Pests Committee. The project addresses many goals of the Australian Pest Animals Strategy (APAS).

1.6 Acknowledgements

Thank you to the Australian Pest Animal Research Program (ABARES) for providing essential funding for this project, and to APARP coordinators for providing guidance during the project. A number of formalised datasets were accessed from organisations for this project including the Tasmania Natural Values Atlas courtesy of the Tasmanian Department of Primary Industries, Parks, Water and Environment; Victorian Biodiversity Atlas courtesy of the Victorian Department of Sustainability and Environment; Queensland Annual Pest Distribution Survey, courtesy of Biosecurity Queensland; Atlas of NSW Wildlife, courtesy of the NSW Office of Environment and Heritage; data from the NSW Pest animals survey courtesy of NSW Department of Primary Industries; data from the NSW Department of Environment and Heritage on cane toads, pest animal occurrence data from the Department of Agriculture and Food WA, feral camel data from the Australian Feral Camel Management Project, feral deer data from Biosecurity South Australia, as well as records from several databases (including Feralscan) managed by the Invasive Animals Cooperative Research Centre. Brian Lukins (NSW DPI) provided significant assistance with data processing and formatting tasks. The Spatial Information Unit (NSW DPI) assisted with various data management activities throughout this project.

1.7 Conclusions and recommendations from this project

This project undertook a series of activities to gather and centralise data on the extent and abundance of nationally relevant pest animal species. A series of face-to-face meetings were held in each state/territory jurisdiction, followed by a phase of data collation to source all available relevant spatial datasets for each species in the project.

Data were collected and collated for 23 nationally relevant pest animal species throughout Australia, many of which occupy several state and territory jurisdictions and represent a significant threat to agricultural productivity, food security, biodiversity, environmental and cultural values, social amenity, human health and exotic disease management.

Data reported provide an Australia-wide inventory of pest animals in each NRM region, and each state and territory. This information provides an up-to-date snapshot of the status of the extent of pest animals in Australia, and builds on previous initiatives of the Invasive Animals CRC, Australian Pest Animal Research Program, and the National Land & Water Resources Audit, to capture and report information on pest animals at a national scale with consistency and meaningfulness.

Previously applied reporting for pest animal data was at a scale of 0.5 degree (equivalent to approximately 50km x 50km). Reporting in this project was performed at an improved scale of 1/8th (0.125) of a degree (equivalent to approximately 12.5km x 12.5km) providing increased spatial accuracy of data for pest animals nationally. This improved reporting scale translates to a 16-fold increase in the size of the dataset for each pest species, and an equivalent increase in the value of the dataset in reporting on-ground variation in population distribution and abundance.

As the refined reporting units are also based on the 1:100 000 map-sheet tiles, the data is directly comparable to previous datasets and can be used in combination with other data gathered or reported at the 1:100 000 scale, namely current or forecast land-use conditions.

A range of existing databases and information systems were queried during this project for pest animal data, and outputs reported in the above reporting format. Outputs from the project build on previous knowledge and data at local/regional, state/ territory and national scales, to support management planning.

This project demonstrates that data gathering tasks can significantly help to identify trends in pest animal populations, and should be undertaken periodically to assist with pest management. However, this project also shows that there is a clear need for improved reporting procedures and mechanisms for targeted surveillance of new, emerging and established pest animals. Real-time reporting models can significantly value-add to current processes and increase early detection of species, increase response time to pest expansions and problems, and improve control efficiency by ensuring control activities are targeted and site-specific.

This project delivers improved national-scale information and maps on the extent of pest animals – which can be used to assess the effectiveness of current policy, pest management programs, investment, and on-ground control activities.

Recommendations from this project include the following:

- This project relied on collection and collation of data from independent data sources across all jurisdictions of Australia. We strongly support the concept of a nationally institutionalised process and clear mandate for gathering and reporting of established, new and emerging pest animal species data from across the state/territory and NRM regions of Australia to allow assessment of pest animal problems at the national scale. This will provide a means for accurately assessing the continued threat that pest animals pose to biosecurity, food production systems, natural resources, social values, cultural assets, infrastructure and human health. This will also identify opportunities for research and development, targeted investment, assessment of program efficiencies and sharing of responsibility for pest management across government, industry, community and business sectors.
- This project has developed an updated set of pest animal data and mapping outputs reporting information on 23 nationally significant pest animal species. We recommend the outputs of this project be disseminated directly to state and national authorities for biosecurity, pest management and animal health programs. This can be undertaken through existing networks, collaborations, pest animal information websites and web-portals. We also recommend the outputs of this project be disseminated directly to NRM regional groups and local government, to increase capacity of local authorities to integrate pest animal data in existing and future NRM management programs. Many pest animals occur in urban, peri-urban and rural interface area where pest control is imperative to reduce pest damage in adjoining agricultural, food production and urban landscapes.
- This project builds on previous initiatives and gathers data at a vastly improved reporting scale. Despite some datasets being well developed in most regions, others contain information gaps. We recommend building on datasets developed as part of this project for all species, and especially feral livestock, feral deer species, new and emerging species such as ferrets, water buffalo in northern Australia as well as feral horses and feral donkeys that are reportedly increasing in numbers throughout many regions. Feral camel data is being concurrently developed by the Australian Feral Camel Management Project. Integration of feral camel data with other large herbivore data will help to assess the landscape pressure from large herbivores in Australia and their impacts on the productivity of land, environmental values and social/cultural assets.
- Methods for data reporting can be streamlined and expanded. We recommend improving facilities and procedures for gathering of data from field-based land managers on the occurrence and abundance of pest animals. This could be in the form of further web-portals for online reporting on pest data, mobile technology for pest animal reporting by landholders and pest controllers (especially for new and emerging species), or improved channels for reporting to local pest authorities and upwards to state-administered real-time databases. This would provide a means of surveillance and early detection of

new pest animals in high priority areas, increase response time to incursions, improve control efficiencies by reducing wasted control effort, and reduce potential for pest populations to continue to expand.

- Data from this project reports the occurrence of six feral deer species and the number of deer species known to occur in problem areas throughout Australia. Further data on the abundance, movement and population trends of feral deer populations in each area will provide improved information for responding to future incursions of feral deer, expansions in the range of deer, and help to address the problems they cause. As feral deer pose an exotic disease risk, this information will also serve to inform management agencies responsible for biosecurity and animal health.
- Similarly, on-ground monitoring of feral deer and other new and emerging pest animals identified in this project will provide an improved capacity to respond to changes in populations, such as new incursions, as well as coordinating on-ground control for damage prevention. This data will also help to prevent populations from expanding further.
- Large herbivores (including feral livestock) are widespread and abundant across Australia. They present a livestock disease problem in grazing country, contribute to land degradation, and may present a biosecurity risk if exotic diseases such as foot-and-mouth were introduced to Australia. We recommend gathering of further data on the species of feral livestock known to occur across regions of Australia, and gather data on the abundance and movement of these species to accurately assess the likely threat they pose to production systems, natural resources and biosecurity.
- As concurrent work to develop data standards and an improved reporting procedure for pest animals is underway via the Joint AWC/VPC National Indicators Working Group (see Terms of Reference Appendix 2), we recommend consideration of National Data Standards for Reporting of Pest Animals once developed. This could permit consistent reporting of data across all management areas in alignment with other pest animal reporting, and translate to equitable apportionment of value control resources, and targeted control and investment to high priority areas regardless of jurisdiction and management responsibility.

2. PROJECT BACKGROUND AND SCOPE

2.1 Background

Australia has many wide-ranging pest animal species that threaten the viability of agriculture and primary production industries. The impacts of the main pest species have been estimated at over \$1 billion / annum. Previous monitoring and mapping initiatives have assessed the extent and abundance of a number of Australia's 73 established pest species. Many of the species assessed are well established and wide ranging species that inhabit all states and territories, and in some cases, are estimated to occur across the entire country. Other species are known to be expanding their range or are responding to favourable landscape conditions associated with recent rainfall in many parts of eastern Australia. There are also many new and emerging species (such as feral deer species) that present a risk to agricultural production, biodiversity, environmental values and human health. Maintaining up-to-date information on these species often relies on reporting from landholders to local authorities, and mechanisms for the community to communicate with local pest management groups/state government authorities.

Governments and land management agencies rely on accurate and timely information on pest animals to better support and coordinate on-ground management actions, target and evaluate management actions, and enable better apportionment of management effort for pest animals. The techniques for measuring pest animal populations at the local level are not necessarily cost-effective or practical for application at the regional or state scale (see Mitchell and Balogh, 2007). In fact, options for measuring and monitoring populations of pest animals often rely on local collection, collation and reporting of existing data and information, in combination with capturing local knowledge (best knowledge) from field-based staff and expert authorities. As a consequence, there are limitations in information reported from such approaches, and gaps in data.

Previous methods for gathering and reporting information at the national scale on the extent and abundance of pest animals includes a national monitoring protocol (previously endorsed by the Vertebrate Pests Committee and Australian Governments Audit Advisory Council) in 2007 (NLWRA 2007). This 'national monitoring protocol for the occurrence, distribution, abundance of vertebrate pests' was intended for use at state and national scales to guide data reporting on 10 nationally significant vertebrate pests.

The protocol recommended a data-driven method for classification of land units according to:

- Occurrence (present/absent) – Where are they?
- Distribution (localised/widespread) – What is their spatial pattern?
- Abundance (occasional, common, abundant) – How many are there?
- Trend (increasing, stable, decreasing) – How are numbers changing?
- Data quality (low, medium, high) – How reliable is underpinning information?

[Note: Further details of this method are outlined below].

The agreed scale for data gathering and reporting from this method was 0.5 degree (equivalent to 50km x 50km). This scale also aligned with concurrent national weeds datasets and reporting activities.

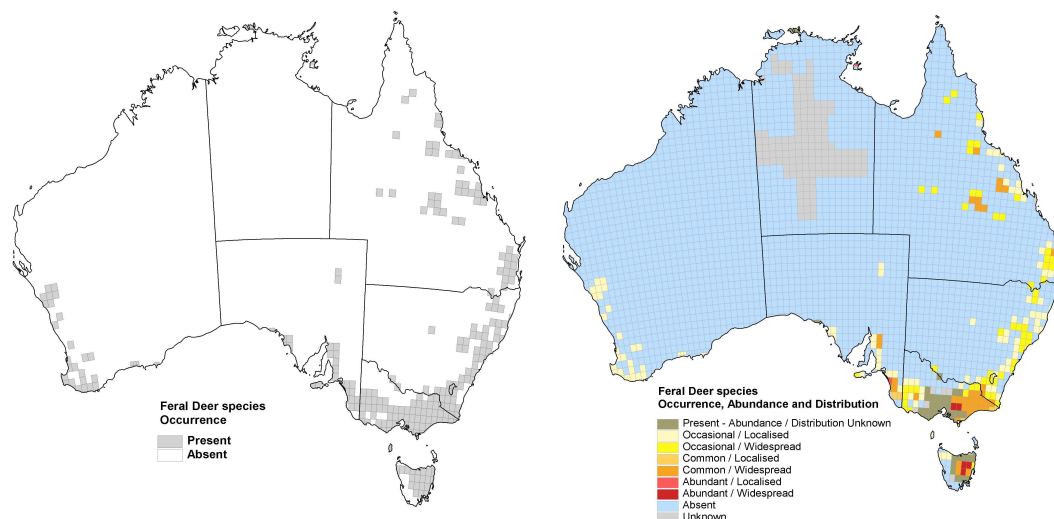
In 2006/07, the Invasive Animals CRC in collaboration with the National Land & Water Resources Audit, all state and territory governments, and the Vertebrate Pests Committee assessed the extent and abundance of 10 of Australia's established pest animal species using the above-mentioned endorsed protocol (West, 2008). The species assessed were identified by the Australian Vertebrate Pests Committee as national priority species, and many constituted (and continue to constitute) a key threatening process at the Commonwealth and state levels.

The project produced the first seamless national data layer for pest animals across Australia and its coastal islands using an endorsed repeatable reporting protocol (see figure 1 for feral deer).

The species assessed and reported on include feral pigs, feral goats, feral deer species (all species combined), foxes, rabbits, wild dogs and dingoes, feral cats, common carp, common starling and cane toads.

While this approach was suitable for the purposes of an initial national assessment of established pest animals, the participants of the project (including state/ territory government agencies, regional NRM groups, and Vertebrate Pests Committee representatives) acknowledged the need for improvements to the procedures to allow more accurate and timely reporting of a wider range of pest animal species. This work has subsequently been taken up by the Joint Australian Weeds Committee (AWC) and Vertebrate Pests Committee (VPC) National Indicators Working Group (see Terms of Reference – Appendix 2).

Figure 1: Example output from previous national reporting on pest animals. Maps report occurrence and relative abundance of feral deer species (6) based on best available data. Note: the previously agreed reporting scale for this method was 0.5 degree (equivalent to 50km x 50km) and aligned to 1:100,000 map-sheet series.



2.2 Recommendations from previous mapping initiatives and reporting activities

Participants of the previous national pest animal reporting projects, including representatives of the VPC, states and territories, Invasive Animals CRC, as well as the Australian Government agencies (DAFF and SEWPaC – formerly DEWHA) have provided recommendations for improving national methods for gathering and reporting pest animal extent and abundance data as follows:

1. Integrate more rigorous data collection methods to provide more reliable data outputs.
2. Report information at a higher resolution (ie, finer reporting scale) appropriate for detecting and reporting variation that is likely to result in pest populations associated with various management actions.
3. Streamline data collection and reporting to deliver accurate and timely information to decision-makers at all levels of government, and
4. Agree on minimum information requirement in assigning data values to land parcels.

Previous project collaborations have also recommended improvements to existing pest animal data including:

- Develop improved pest animal extent data for reporting at regional, state and national scales for a wider range of pest species);
- Adopt a finer, more suitable reporting scale for data (ie, improved reporting format);
- Gather and centralise data for a broad cross section of pest animals, and
- Provide improved information products to stakeholders at regional, state and national scales.

This project adopts the recommendations of the previous work to gather and report on the extent of pest animals and abundance data where available at a finer scale, and produce a series of improved pest animal information products for end-users at local/regional, state/territory and national levels.

2.3 Pest animal species considered in this project

This project addresses 23 nationally significant pest animal species as recommended by VPC and respective state and territory jurisdictions– including established, new and emerging species – see table 1 and table 2. Note: this project was tasked with gathering data for species listed in table 1, and many additional species have been included in the project to allow for greater comparison and assessment of pest animal information (particularly large herbivores) across Australia (see table 2).

Table 1: First set of pest animals addressed in project

| Common name(s) | Scientific name |
|---|--|
| Feral camels | <i>Camelus dromedarius</i> |
| Water buffalo | <i>Bubalis bubalis</i> |
| Feral horses | <i>Equus caballus</i> |
| Feral donkeys | <i>Equus asinus</i> |
| Banteng cattle / Bali Banteng | <i>Bos javanicus</i> |
| Fallow deer | <i>Dama dama</i> |
| Sambar deer | <i>Cervis unicolor</i> |
| Red deer | <i>Cervus elaphus</i> |
| Rusa deer | <i>Cervus timorensis</i> |
| Chital deer | <i>Axis axis</i> |
| Hog deer | <i>Cervus porcinus</i> |
| Indian palm squirrels | <i>Funambulus palmarum</i> |
| Red-eared slider turtles | <i>Trachemys scripta elegans</i> or <i>Chrysemys scripta elegans</i> |
| Pest birds {addressed in Project stage 2} | Addressed in project stage 2 |
| Pest fish (not included in the project on advice of APAMP). | N/A |

Table 2: Secondary set of pest animals addressed in project

| Common name(s) | Scientific name |
|--|--|
| Feral pigs | <i>Sus scrofa</i> |
| Feral goats | <i>Capra hircus</i> |
| Rabbits | <i>Oryctolagus cuniculus</i> |
| Wild dogs (incl. dingoes) | <i>Canis familiaris dingo</i> |
| Foxes | <i>Vulpes vulpes</i> |
| Feral cats | <i>Felis catus</i> |
| Cane toads | <i>Rhinella marina</i> (formerly <i>Bufo marinus</i>) |
| Feral livestock (feral cattle and feral sheep) | <i>Bos taurus</i> and <i>Ovis aries</i> |
| Brown hare / European hare | <i>Lepus europaeus</i> |
| Polecat / Ferret | <i>Mustela putorius furo</i> , or <i>M. furo</i> |

2.4 Pest animal species overview

Feral camels

Introduced to Australia during many periods from 1840. Large herbivores that are highly mobile, and estimated to cost economy and agricultural over \$10 million annually. Estimated to be between 1 and 1.2 million feral camels in Australia, and doubling in population size every nine years. Occur on WA, SA, NT, Qld and NSW.

Feral water buffalo

Introduced from Asia to northern Australia for meat in northern settlements. A large control campaign reduced numbers substantially between 1980-1990. Populations have since recovered. A major threat to freshwater wetlands in northern Australia (including Kakadu) associated with saltwater intrusion. A potential host of exotic livestock disease. Limited to northern Australia.

Feral horses

Introduced to Australia during European colonisation. Wild populations currently occur in most states and territories, and widespread and in remote areas. Known to cause significant damage in protected areas, and sensitive habitats, including Top End Aboriginal lands.

Feral donkeys

Widespread in many states, including WA, SA, and NT and often in remote areas and open plains country. Major impact through erosion and defoliation. Once occurred at very high densities in Kimberley region.

Banteng cattle

An introduced species of cow native to SE Asia. Introduced in 1845 and restricted to the Coburg Peninsula of the Northern Territory. No other known populations outside captivity in Australia. Known to cause serious environmental damage and a potential host of exotic livestock disease.

Fallow deer

Introduced and released around 1830 during European settlement. Widespread in south-eastern Australia. Can become serious pests when in high numbers as seen in New Zealand. A threat to biodiversity and a potential risk of exotic disease.

Sambar deer

Introduced to Victoria in 1860s. Originally from Asia and can cause environmental damage through grazing of vegetation and erosion. A threat to biodiversity and a potential risk of exotic disease.

Red deer

Introduced to Australia and native to Asia, Europe and North Africa. Known to cause serious habitat damage. In New Zealand, red deer have caused severe damage to vegetation and seedling recruitment. A potential host of exotic disease.

Rusa deer

Introduced from SE Asia to Australia. Can cause significant environmental damage. Well known to Royal national Park, NSW. Occur in QLD, SA and NSW. May be a potential risk of exotic disease.

Chital deer (also called spotted deer)

Introduced to Australia from Sri Lanka and India in early 1800s. Have increased in range in the wild substantially in the recent decade. Known to occur on some islands. A threat to biodiversity and a potential risk of exotic disease.

Hog deer

Introduced to Australia in 1860s by the Acclimatisation Society of Victoria. Originally from SE Asia and the smallest of the deer species in Australia. A threat to biodiversity and a potential risk of exotic disease.

Red-eared slider turtles

An introduced species from the United States. A few discrete populations occur in Queensland and NSW. Occasionally reported outside these areas. Illegally kept as pets in several Australian states/territories. A threat to biodiversity.

Indian palm squirrels

Very limited range in Australia, after escaping from captivity. Known to occur in one location in Perth and occasional reports in Sydney. A potential risk to biodiversity if they spread or become established.

Feral pigs

Introduced to Australia during European settlement. Abundant species in Queensland and wet tropics. A major threat to biodiversity and agriculture. Damage estimated to cost \$106 annually, and an exotic disease threat.

Feral goats

Introduced during European settlement and now occupy nearly all states and territories. Cause over \$7 million damage annually, but are a significant threat to biodiversity, such as rock wallabies, as well as native vegetation. A potential host of exotic disease.

Rabbits

One of Australia's most destructive pest species. Introduced to Australia during European settlement originally from Spain and southern France. Occupy all states and territories and off shore islands. Responsible for over \$206 million damage annually. A threat to agriculture and biodiversity.

Wild dogs (including dingoes and hybrids)

Introduced to Australia several thousand years ago. Currently responsible for significant livestock losses. May suppress other pest species (such as rabbits). Widespread across all states and territories, and a small area in Tasmania. A threat to agriculture and biodiversity. Production losses estimated at \$48 million annually.

Foxes

Introduced to Australia from Europe in 1871 for sport hunting. Occupy all states and territories. A major predator of native wildlife and responsible for significant losses to sheep graziers costed at \$227 million annually. A threat to agriculture and biodiversity.

Feral cats

A significant predator introduced to Australia during European settlement. Found across the entire country and offshore islands. A significant threat to biodiversity, and responsible for the extinctions of many native species.

Cane toads

Introduced to Australia to control cane beetles in Queensland in 1935. Occur in eastern states, and have spread rapidly westwards in recent years and across

northern Australia. Now well into Western Australia, and are considered a major threat to wildlife, domestic pets, human health, and cultural values.

Feral livestock (feral cattle and feral sheep)

Widespread throughout most states/territories, although poorly document. Closely associated with livestock grazing history. Unmanaged livestock (feral cattle and feral sheep) cause environmental damage. A potential host of exotic disease, such as foot-and-mouth disease, and a threat to livestock enterprises as carriers of livestock disease.

Brown hare / European hare

Introduced to Australia during European settlement. Species is reportedly closely associated with modified pastures and croplands. Known to cause damage in horticulture and viticulture. Not a commonly reported species despite widespread distribution in Australia.

Polecat /ferret

Domestic form of wild European polecat. They are often kept as pets and used to catch wild rabbits (ferreting). Illegally released or escaped ferrets pose a serious risk to native wildlife. Occasionally seen in the wild but highly elusive animals.

3. METHODOLOGY

3.1 Description of project methods and procedures

The overall goal of this project was to build improved pest animal extent and abundance (where available) data for a broad cross-section of pest species at a finer reporting scale than has previously been used to assist decision-making at all levels.

The objectives included:

1. Implement previously endorsed monitoring and reporting protocols (at a finer-scale) for established, new and emerging pest animal species throughout Australia (to complement existing national-scale datasets and information products)
2. Develop improved Australia-wide datasets for national priority pest animals
3. Centralise datasets for all species and produce consistent information products for all relevant regional, state/territory and national levels.
4. Deliver information products to relevant stakeholders using a variety of means.

To address these aims, this project involved 3 key activities:

Activity 1

State and regional scale engagement and consultation – This project consulted with each state and territory during the project term to identify and include all available datasets identified at the time of this project were included in this analysis. The project held a series of face-to-face meetings with representatives from each state/territory jurisdiction, followed by a series of activities following a work plan per region to source all available relevant spatial datasets for each species in the project. All available spatial datasets were identified and used in this project, however, some datasets were not obtained during this project due to resourcing reasons of the data custodian.

During consultation with NRM regional groups regarding suitable pest animal data for this project, it was revealed that there is little pest animal data administered or managed by the NRM bodies above-and-beyond that already available through other sources. Enquiries regarding datasets identified no regionally specific datasets for pest animals within the NRM organisations. Use of state-government datasets (such as pest animal survey outcomes of Atlas records) on pest animals was common practice by respective NRM groups. This project aimed to engage with regional bodies in developing datasets, however due to limited data managed by NRM groups, we consulted directly with the source of datasets, in most cases state government agencies (such as NSW Office of Environment and Heritage).

Note: As NRM regions remain a vital group in management of natural resources and rely on best-available data to support on-ground NRM programs, the project team agreed that at project end, a series of output products (digital data and customised

maps) would be supplied to each NRM regional body which would report the project outcomes, to complement invasive species and natural resource spatial datasets they may have access to. This provides the NRM regional bodies with an up to date set of information for future management planning and pest prioritisation.

Activity 2.

Data collection, collation, centralisation and reporting

Each state and territory lead agency for pest management was consulted regarding available data on pest animals and how that data is managed. Face-to-face meetings were held at project commencement regarding available data and access desirable project outputs. Follow-up discussions were held with the state groups to discuss access arrangements, licensing and data sharing agreement. All available data was collected and collated from databases and Atlas systems and centralised in a single ESRI GIS database of records.

Data access agreements were signed with some groups as needed for access of data. As data on pest animals is often managed by many groups, information was sought from a wide range of sources. A full list is provided in the Results section. Data was also sought from Australia-wide sources, including the Invasive Animals CRC which manages several pest animal databases including the FeralScan database.

Activity 3

Information products, reporting and delivery to end-users.

Development and delivery of data for each pest animal species was prepared at 3 formats and scale as follows:

1. National dataset – 1 dataset containing all pest animal records and data
2. State/Territory datasets – 7 datasets were prepared containing all pest animal occurrence records
3. NRM regional datasets – 56 datasets were prepared containing all pest animal occurrence records for dissemination to NRM regional groups

Information products (namely data and maps) were prepared for supply to relevant agencies, land managers, community-groups and regional NRM bodies as follows:

1. National maps of the occurrence of each species, and a cumulative tally of species known to be present in each reporting unit.
2. State/Territory maps – 7 sets of maps containing all pest animal data
3. NRM regional maps –species maps reporting occurrence for dissemination to NRM regional groups via the Invasive Animals.

More details about how these project outputs will be delivered to end-users is contained in section 3.7 below.

3.2 Previous reporting procedures and concurrent working group activities

Previously developed procedures for monitoring and reporting of pest animals were used as a guide in this project. The national pest animal extent and abundance reporting protocol (previously endorsed by the Vertebrate Pests Committee) for regional, state/territory and national assessments recommended the collection, collation and reporting of existing data and information, in combination with capturing local knowledge from field-based staff and expert authorities (NLWRA 2007), and classification of land units according to:

| | |
|---------------------|--|
| Occurrence | The presence status of a species within an area (ie present, absent or unknown) |
| Distribution | A measure of spatial pattern throughout an area (ie localised or widespread) |
| Abundance | A measure (in numbers or relative value) in density within a defined area (ie, occasional, common or abundant) |
| Trend | A measure of change in animal abundance over time for the area in question (ie, increasing, stable, decreasing, and unknown) |
| Data quality | A measure of data quality associated with underpinning data |

The reporting scale for that method was agreed to by VPC in 2006/07 and set at 0.5 degree (equivalent to approximately 50km x 50km). This project adopted a revised approach to reporting based on best available data for pest animals and included recommendations of a monitoring and reporting workshop held in September 2009 (West, 2010)

Concurrent work of the Joint AWC/VPC National Indicators Working Group to develop national data standards for pest animal and weed reporting has continued during the term of this project. However, as data standards and an endorsed monitoring and reporting protocol had not been finalised during the term of this current project, this project was not able to adopt any revised pest animal mapping methodology, and previously endorsed protocols were used as a guide. There remains no institutionalised procedure or mandate for partner agencies, such as state governments to report data in either the previously endorsed method, and as a consequence, this project was not able to follow the previous adopted protocol fully.

Since the original development of the Protocol, a National Pest Animal Monitoring and Reporting Workshop proposed clear recommendations for:

1. reporting of pest animal extent and occurrence at a finer scale than previously adopted,
2. reporting of pest animal distribution as a measure of spatial pattern across a given area, and
3. reporting of pest abundance data at an appropriate scale where known.

These recommendations were fully adopted in this current project.

Reporting in this project followed an interim agreed method of reporting against:

- Pest occurrence – confirmed and no confirmed evidence
 - Known occurrence records (data present)
 - No known occurrence records (no recorded data)
- Pest distribution – Total distribution of the species across a defined area.

Individual species data contained the number of records in a given area, and a measure of spatial pattern of data across management jurisdictions.

The previously applied reporting scale for pest animal data that method was set at 0.5 degree (equivalent to approximately 50km x 50km). This project reviewed this method adopted the recommendations of the national workshop to produce data at the scale of 1/8 degree, equivalent to approximately 12.5km x 12.5km (reported against an array developed on the 1:100 000 Australian map-sheet tiles (see Table 3).

3.3 Data reporting scale – improvements from previous methods

The project team agreed to adopt a finer scale reporting unit consistent with previously agreed national reporting format to allow better data to be collected and managed, without reducing the ability of the data to be up-scaled to a previously agreed 0.5 degree format if that was ultimately determined as a suitable national reporting scale for pest animals.

This refined scale allows for data from this project to be aggregated up to the 1:100 000 scale if that is the future recommendation of the Joint AWC/VPC National Indicators Working Group.

Reporting at the scale of 1/8th degree significantly increases the spatial resolution of reporting outputs and increases their value to end-users. Previously applied methods report 1 value per 50km x 50km, whereas the improved 1/8th degree scale allows reporting of 16 values per 0.5 degree map sheet area. This refined procedure improved reporting scale of data 16 x that previously applied.

Table 3. Improved scale adopted during this project for reporting data

| Data reporting description | Data reporting scale | Original of format |
|--|---|---|
| Former scale of data reporting under previous national mapping activities. | 1/2 degree (0.5 degree) equivalent to 50km x 50km grid array | Based on Australian map sheet grid |
| Reporting scale implemented under current project. | 1/8th degree (0.125) equivalent to 12.5km x 12.5km grid array | Based on Australian map sheet grid |

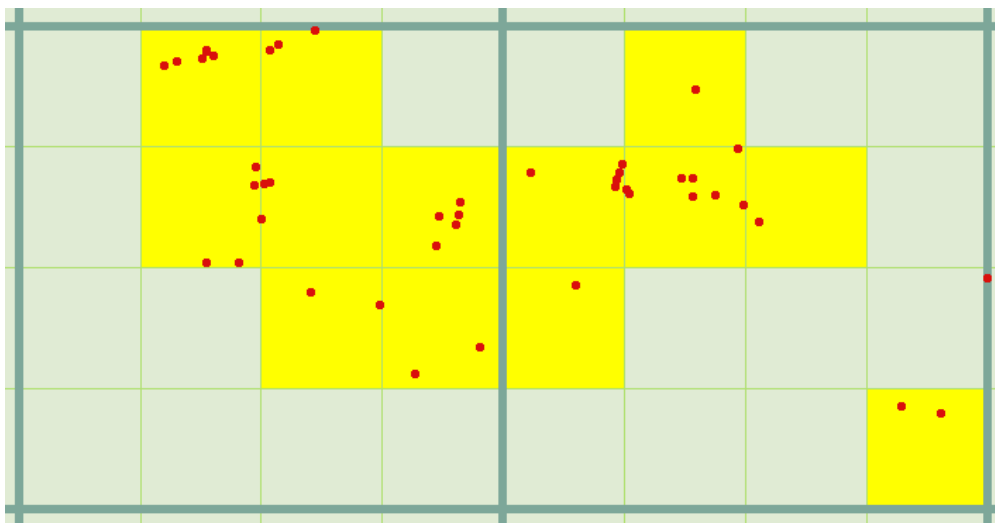
3.4 Representation of improved reporting units.

Reporting in this project was performed at an improved scale of 1/8th (0.125) of a degree providing increased spatial accuracy of data for pest animals nationally. Figure 2 below shows the original reporting scale adopted nationally for reporting pest animals, as well as the revised scale of data reporting. This improved procedure translates to a 16-fold increase in the size of the dataset for each pest species, and an equivalent increase in the value of the dataset in reporting on-ground variation in population distribution and abundance.

As the refined reporting units are also based on the 1:100 000 map sheet tiles, the data is directly comparable to previous datasets and can be used in combination with other data gathered or reported at the 1:100 000 scale, namely current or forecast land use conditions.

Figure 2: Improved spatial reporting scale adopted during this project

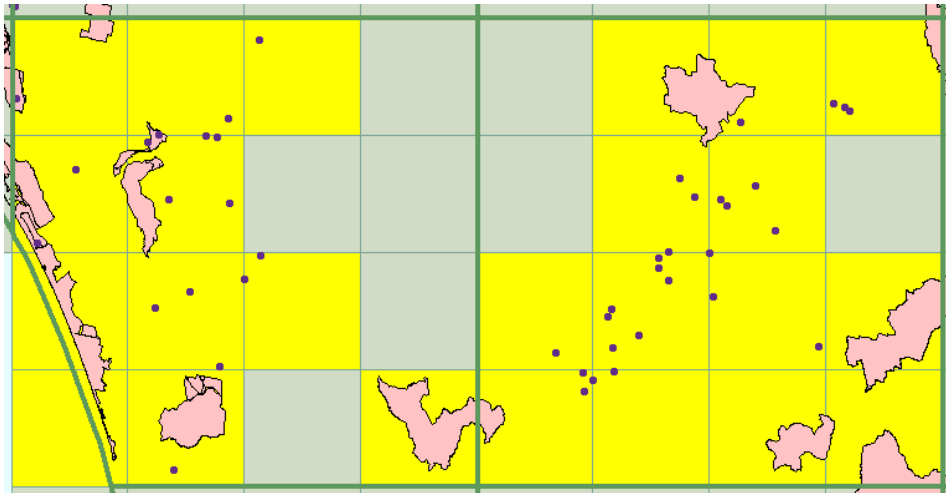
Note: The large green outer margin in the image below represents the original 1/2 degree reporting unit (approximately 50km x50km), and the finer light green light represents the refined 1/8th degree grid reporting unit (approximately 12.5km x 12.5km) adopted in the project. This provides finer scale reporting outputs throughout this project.



3.5 Compilation of point and polygon datasets for pest animals

The project method allows a number of formalised datasets to be accessed and centralised in a data single format for assessment and reporting. Data are characteristically available in point and polygon format. This project utilised data in point format from existing spatial databases reporting precise locations for pest or pest data, as well as polygon data reporting the pest status, such as occurrence on known reserves or national parks. Figure 3 depicts fictional data on the occurrence of foxes in 1/8th reporting units derived from point and polygon datasets.

Figure 3: A graphic representation of point and polygon data used to report the occurrence of foxes in 1/8th reporting units.



3.6 Target outputs and delivery of information to end-users

Pest animal data in this project have been collated and reported to provide a number of outputs including:

- Improved information and maps reporting the status of pest animals throughout each NRM region, state/territory and nationally.
- Centralised datasets and mapping outputs for 23 priority pest animal species.
- Improved national baseline data on 23 species of nationally significant pest animals to improve on-ground management activities and assess the effectiveness of investment.
- An Australia-wide wide inventory of pest animals for all 56 regional NRM groups, state and territory governments, and the Australian Government.

Final project outcomes will be reported to APARP, the Australian Government (DAFF and SEWPaC), state and territory government agencies, and all 56 NRM regional groups as per Table 4.

Online reporting and delivery tools, such as FeralScan, the FERAL.ORG information portal and PESTMAPS website (located at www.feral.org.au) the web-portal, Invasive Animal CRC, will be used to communicate mapping outputs from this project.

National information will be made available via relevant web-portals (such as Australian Natural Resources Data Library, and national initiatives such as the Atlas of Living Australia (under the National Collaborative Research Infrastructure Program)).

Table 4: Outputs from this project

| Outputs | Description | Expected end-user |
|-----------------------------------|--|--|
| Maps, data and national inventory | Inventory of pest animals, data and maps per NRM management jurisdiction, for distribution to all 56 groups via CD-Rom | NRM regional groups, local government and pest control groups |
| Maps and inventory | Maps and inventory at regional and state/territory and national scales | State and Territory governments, and state-level pest management authorities. |
| Maps and data sets | Maps and datasets at regional and state/territory and national scales | Australian Government, CFOC, DAFF (ABARES), SEWPaC, Atlas of Living Australia, ABIN and Invasive Animals CRC |

3.7 Engagement of relevant parties

This project was discussed in detail with the APAMP coordinators at project commencement (now referred to as APARP), to establish a suitable reporting and communication path, as follows:

National

- This project worked closely with members of the Invasive Animals CRC
- DAFF and SEWPaC were engaged in discussions centred on delivering data to support revisions to Threat Abatement Plans and format out output national datasets to align with existing pest animal data at national scale
- Joint AWC/VPC National Indicators Working Group were engaged in discussion on development of data for this project
- The Vertebrate Pests Committee was consulted initially via an out-of-session paper at commencement of the project and provided in-principle support of the project. All reporting outputs will be made available to VPC representatives via existing communication channels.
- Atlas of Living Australia were consulted regarding outputs from this project and adoption of any relevant maps and data at project completion.

State and Territory

- A series of face-to-face meetings in each state/territory were held regarding available spatial data and method for access and reporting
- Follow up discussion were held with 6 of 8 states regarding precision access arrangements for data and reporting, including acknowledgement of source data.

Regional/local

- Regional workshops with NRM regional groups were not held due to the absence of any suitable pest animal data within regional groups that was not obtained through other means.
- Data from this project will be distributed to NRM groups at project end - a series of output products (digital data and customised maps) will be supplied to each NRM regional body to support on-ground NRM programs

4. RESULTS

4.1 Pest animal data – centralising datasets

A total of 23 nationally significant pest animal species were the target of this project. Datasets were gathered from databases and datasets managed by all states and territory jurisdictions and centralised within a single project for simultaneous comparison and evaluation. Data were collated from a total of 11 independent datasets across each state/territory jurisdiction including nationally scaled data managed by the Invasive Animals CRC. All data were imported to a GIS project and centralised in a single dataset.

A total of 28 individual datasets were accessed and imported into a GIS application for this project (see table 5). Data were obtained for all species of this project and all jurisdictions. Some datasets contained as few as 1 record, while others contained up to 5500 records.

Reporting in this project follows the agreed method of reporting against:

- Pest occurrence – confirmed and no confirmed evidence
 - Known occurrence records (data present)
 - No known occurrence records (no recorded data)
- Pest distribution – Total distribution of the species in a given area.

Individual species information were managed in separate GIS layers to provide a measure of the number of records in a given area, and a measure of spatial pattern of data across management jurisdictions. These data are included in individual species data layers.

4.2 Accessing and importing data from available databases

Pest animal data for this project were obtained through 11 formalised state-government databases including: the Tasmania Natural Values Atlas courtesy of the Tasmanian Department of Primary Industries, Parks, Water and Environment; Victorian Biodiversity Atlas courtesy of the Victorian Department of Sustainability and Environment; Queensland Annual Pest Distribution Survey, courtesy of Biosecurity Queensland; Atlas of NSW Wildlife, courtesy of the NSW Office of Environment and Heritage; data from the NSW Pest animals survey courtesy of NSW Department of Primary Industries; data from the NSW Department of Environment and Heritage on cane toads, pest animal occurrence data from the Department of Agriculture and Food WA, feral camel data from the Australian Feral Camel Management Project, feral deer data from Biosecurity South Australia, as well as records from several databases (including FeralScan) managed by the Invasive Animals Cooperative Research Centre.

Table 5 reports the sources of data used in each state and territory from existing sources to prepare data in this project.

Data access agreements were signed for access to spatial datasets under the management of:

- Victorian Government – Victorian Biodiversity Atlas (VBA)
- NSW Office of Environment and Heritage (OEH) – Atlas of NSW Wildlife
- Biosecurity Queensland – Annual Pest Distribution data
- Tasmanian Department of Primary Industries, Parks, Water and Environment – Natural Values Atlas (NVA)

Data access agreements were not required for other datasets.

All data were imported to a GIS project in a single dataset for examination and assessment. Species datasets were prepared from combined records and data for each species, and centralised in a single database for comparison.

Table 5: Databases accessed during project containing pest animal data

| | Database accessed for this project |
|------------------------|---|
| New South Wales | • Office of Environment and Heritage - Atlas of NSW Wildlife |
| | • NSW Pest Animals Survey 2006 and 2009 outputs from NSW Department of Primary Industries |
| | • Invasive Animals CRC - Feralscan data outputs at September 2011 for rabbit, fox, feral pig, feral camel and cane toad sightings. |
| | • Office of Environment and Heritage - cane toads records. |
| | • Records compiled through Invasive Animals CRC pest animal mapping project 2005-2011, including records from former NLWRA project 2007-08. |
| Tasmania | • Natural Values Atlas 2011 – Department of Primary Industries, Parks, Water and Environment. – NVA data licence. |
| | • Incidental data compiled by Invasive Animals CRC |
| | • Invasive Animals CRC - Feralscan data outputs at September 2011 for rabbits, and feral pig records. |
| | • Records compiled through Invasive Animals CRC pest animal mapping project 2005-2011, including records from former NLWRA project 2007-08. |
| Queensland | • Annual pest distribution survey outcomes 2008/09 |
| | • Invasive Animals CRC - Feralscan data outputs at September 2011 for rabbit, fox, feral pig, feral camel and cane toad sightings. |
| | • Incidental data compiled by Invasive Animals CRC |
| | • Records compiled through Invasive Animals CRC pest animal mapping project 2005-2011, including records from former NLWRA project 2007-08. |
| Victoria | • Victorian Biodiversity Atlas (VBA) Atlas of Wildlife 25 and 100. Department of Sustainability and Environment (DSE) licensed data. |
| | • Invasive Animals CRC - Feralscan data outputs at September 2011 for rabbit, fox, and feral pig sightings. |
| | • Incidental data compiled by Invasive Animals CRC |
| | • Records compiled through Invasive Animals CRC pest animal mapping |

| | |
|-------------------------------------|---|
| | project 2005-2011, including records from former NLWRA project 2007-08. |
| Northern Territory | <ul style="list-style-type: none"> • Invasive Animals CRC - Feralscan data outputs at September 2011 for rabbit, fox, feral pig, feral camel and cane toad sightings. |
| | <ul style="list-style-type: none"> • Records compiled through Invasive Animals CRC pest animal mapping project 2005-2011, including records from former NLWRA project 2007-08. |
| Western Australia | <ul style="list-style-type: none"> • Invasive Animals CRC - Feralscan data outputs at September 2011 for rabbit, fox, feral pig, feral camel and cane toad sightings. |
| | <ul style="list-style-type: none"> • WA museum data – no data extracted due to limitations of Western Australia Museum. |
| | <ul style="list-style-type: none"> • Records compiled through Invasive Animals CRC pest animal mapping project 2005-2011, including records from former NLWRA project 2007-08. |
| South Australia | <ul style="list-style-type: none"> • Records compiled through Invasive Animals CRC pest animal mapping project 2005-2011, including records from former NLWRA project 2007-08. |
| | <ul style="list-style-type: none"> • Invasive Animals CRC - Feralscan data outputs at September 2011 for rabbit, fox, feral pig, feral camel and cane toad sightings. |
| | <ul style="list-style-type: none"> • Data from Biosecurity SA on feral deer species |
| Australian Capital Territory | <ul style="list-style-type: none"> • NSW Pest Animals Survey 2006 and 2009 outputs from NSW Department of Primary Industries |
| | <ul style="list-style-type: none"> • Invasive Animals CRC - Feralscan data outputs at September 2011 for rabbit, fox, feral pig, feral camel and cane toad sightings. |
| | <ul style="list-style-type: none"> • Records compiled through Invasive Animals CRC pest animal mapping project 2005-2011, including records from former NLWRA project 2007-08. |

4.3 Number and trends in pest animal occurrence data

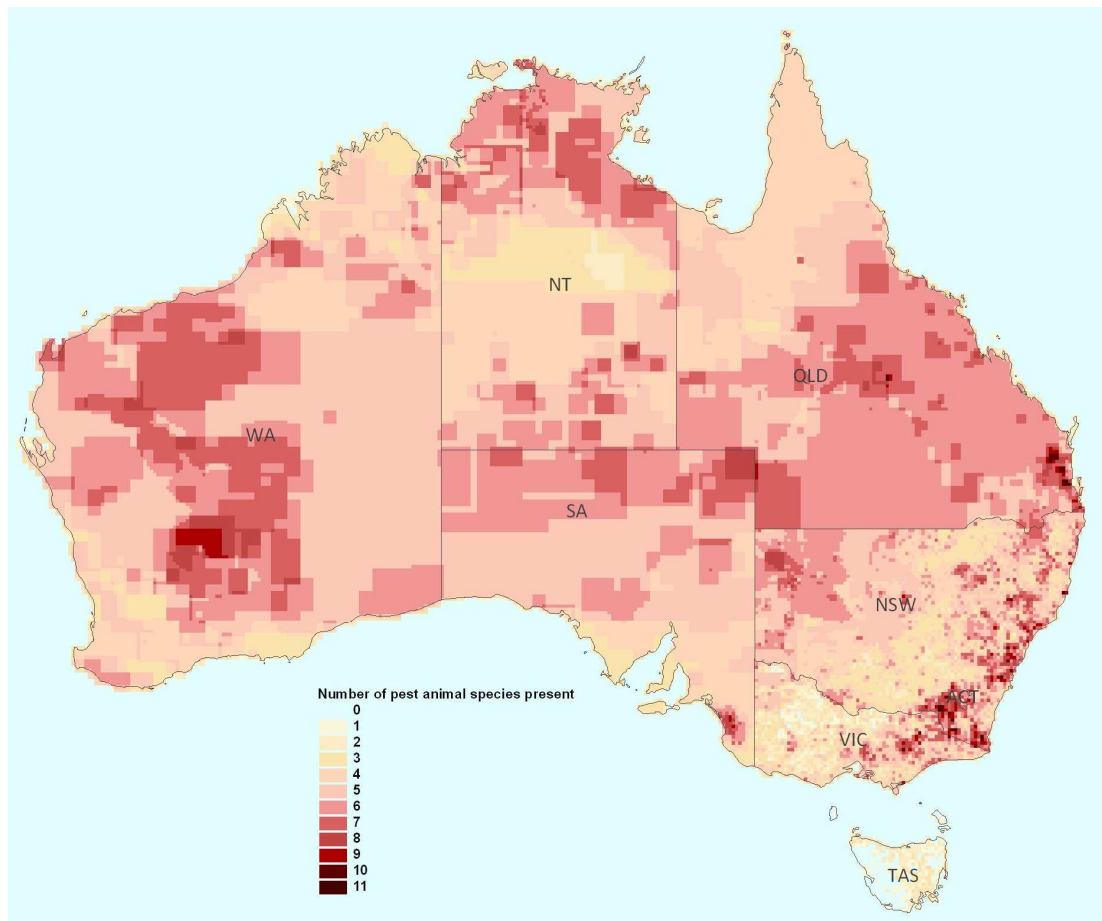
Data were obtained for all 23 species in this project. When the occurrence of each species was combined (ie, the sum of all species known to occur in each 1/8th degree reporting unit – equivalent to 12.5km x 12.5km) trends in the number of species across Australia was revealed. Figure 4 shows that there are a high number of species in many areas across the country, and in each state and territory. The maximum number of species in any was reported to be 11 species. A high number of species were recorded in northern South Australia, the northern regions of the Northern Territory, central region and Pilbara region of Western Australia, central and south-eastern Queensland, south-eastern NSW and the far north-west of NSW.

Other trends identified from the data include:

- Observed low numbers of species in northern Queensland
- Observed low numbers of species in the north of WA throughout the Kimberley region
- Moderate number of species in the far south-east of South Australia
- Many areas across food production zones in Queensland, Northern Territory and NSW contain a large number of pest animal species.

- Areas of Tasmania contained low numbers of pest animal species.
- Many remote areas contain widespread populations of many pest animal species.

Figure 4. Number of pest animal species occurring through Australia (includes feral camels, water buffalo, feral horses, feral donkeys, banteng cattle, six feral deer species, feral pigs, feral goats, rabbits, wild dogs, foxes, feral cats, cane toads, feral livestock, brown hare, Indian palm squirrels, red-eared slider turtles, and ferrets)



When all deer species (fallow, red, rusa, sambar, chital and hog) occurrence data were compared, trends were revealed to show that feral deer species in Australia are widespread and occupy all states and territories (Figure 5). Sighting records for feral deer were obtained through this project for Tasmania, Victoria, NSW, and the ACT. Other data represent occurrence data in polygon format.

The highest number of feral deer species was recorded in south-eastern Queensland, south-eastern NSW, and the south-east of South Australia (Figure 6). The central plateau of Tasmania contained many feral fallow deer records. Significant populations of feral deer also occur in eastern Victoria and NSW, however some data used in this project did not contain species name, and therefore the number of species reported in figure 6 is weighted towards areas where species type had been identified. This does not necessarily reflect areas where feral deer are most abundant.

Figure 5: Occurrence of feral deer species and sighting locations (red, rusa, fallow, chital, sambar, hog). Sighting records are depicted in blue, occurrence data are shaded brown.

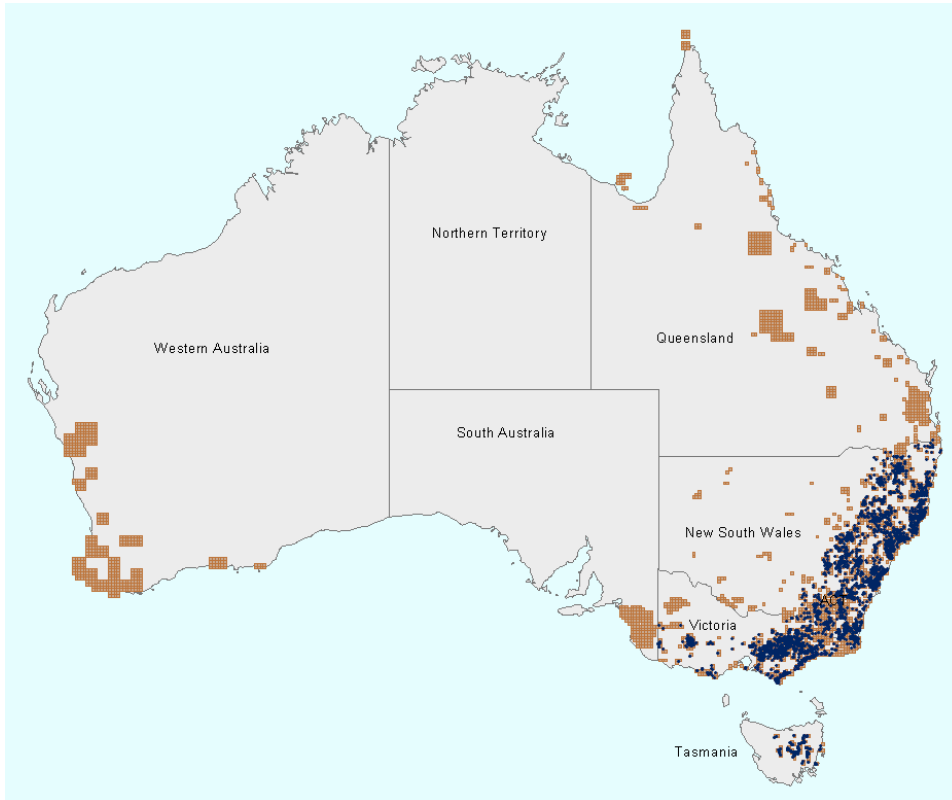
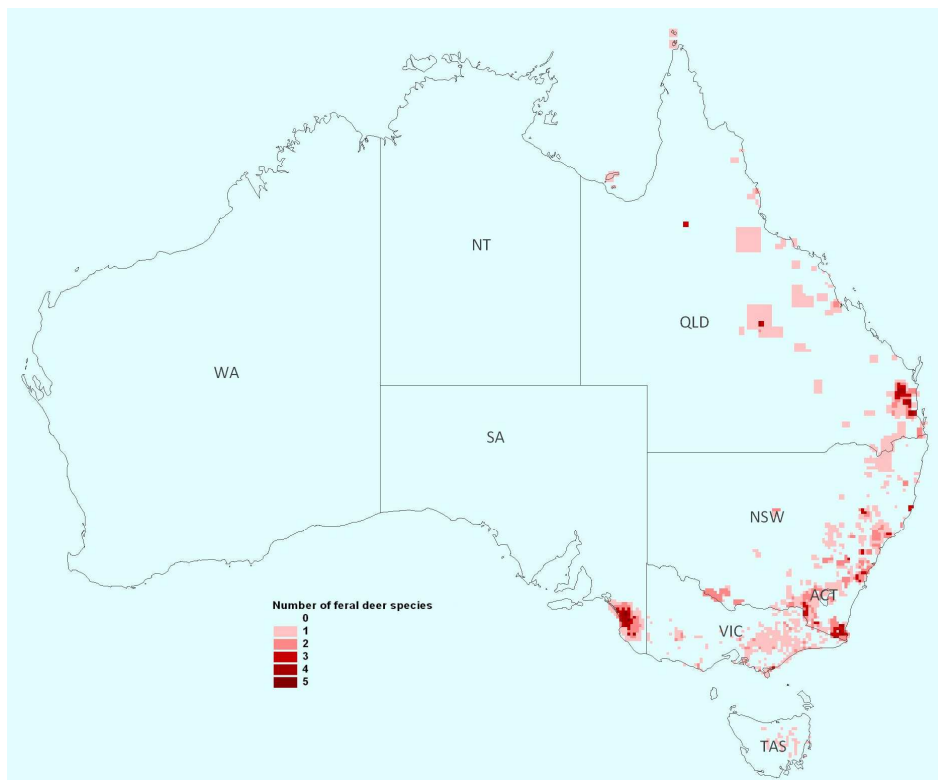


Figure 6. Number of species of feral deer occurring in Australia (includes fallow, chital, sambar, rusa, red, hog). Dark red areas represent the highest number of species.



When the occurrence of new and emerging pest animal species (including feral deer species) in Australia were examined together, very similar trends are revealed. The east of Australia, ranging from Adelaide to south-central Queensland contained the highest number of new and emerging species. Small areas also reported to contain banteng cattle, red-eared slider turtles, Indian palm squirrels, and ferrets. Feral deer are by far the most widespread of the new and emerging pest species.

More detailed species data are contained in Appendix 1.

Figure 7. Occurrence and location of new and emerging species [includes feral deer species (red, rusa, fallow, chital, sambar, hog), bali banteng cattle, Indian palm squirrels, ferrets, and red-eared slider turtles].

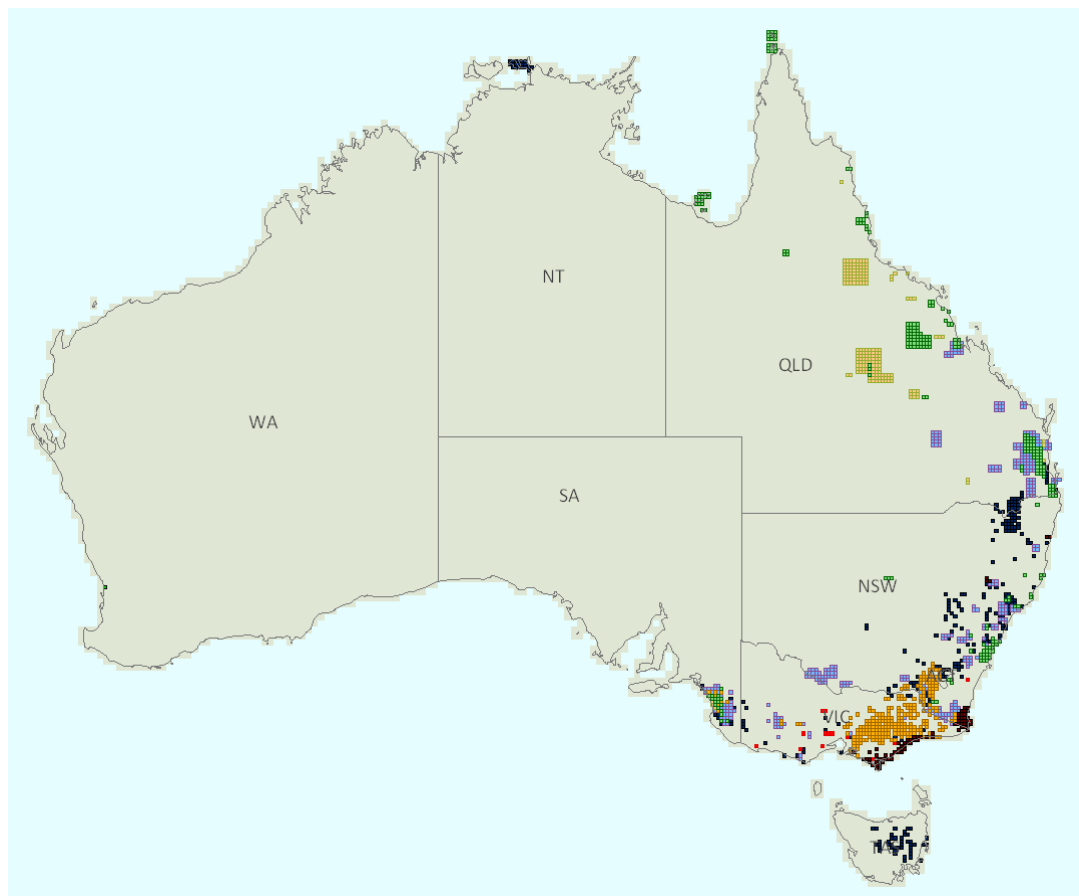


Figure 8 depicts the readily available data on feral camels. Data available for feral camels consists of generalised reporting from 2006/07, modelled distribution and density from 2008, sighting and damage records from the FeralScan (via CamelScan) website mapping application, incidental records for western NSW from NSW Department of Primary Industries databases, and a small sub-set of aerial survey records kindly provided from the Australian Feral Camel Management Project. Other information on feral camels should be sourced from the Australian Feral Camel Management Project.

Figure 8. Example of input layers: Data consolidated on feral camels consisting of incidental sighting locations, aerial survey data, and predicted density data.

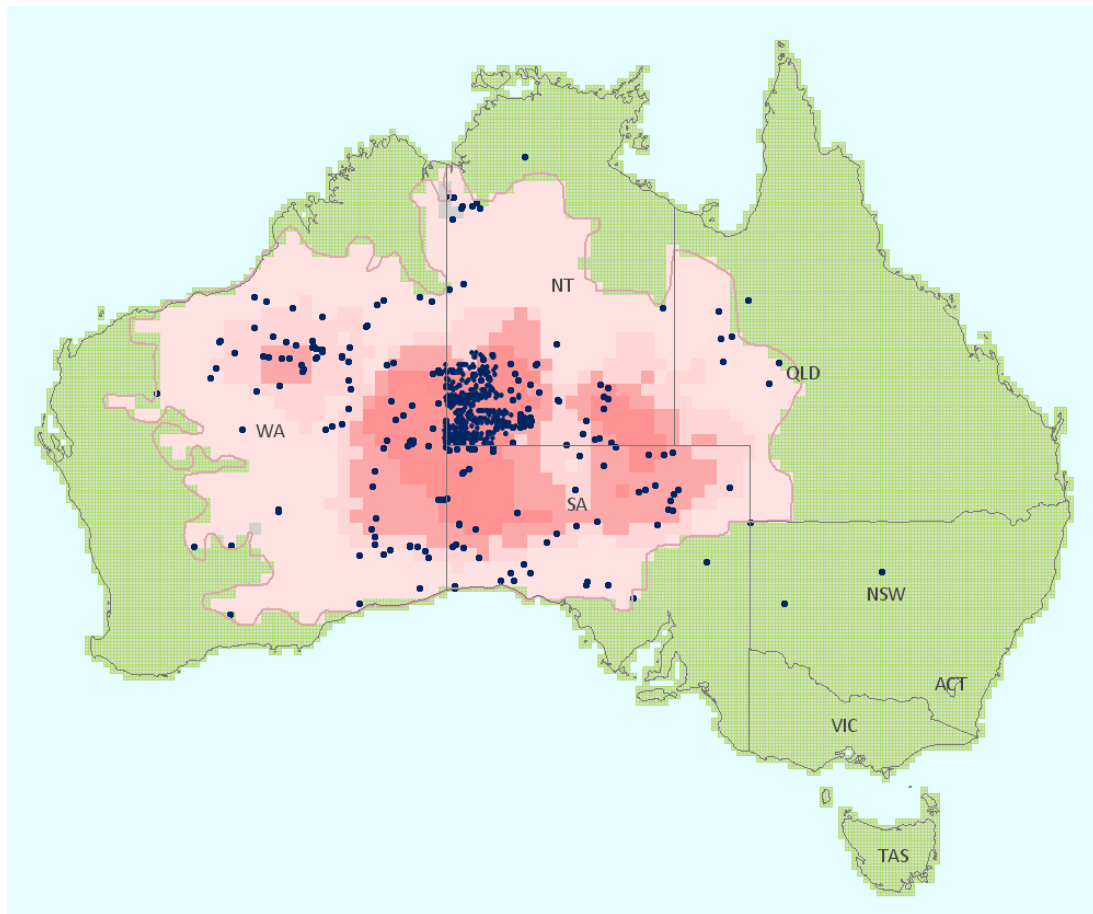


Figure 9 represents the total number of grazing animals (including rabbits, feral pigs, feral goats, six deer species, feral horses, feral donkeys, feral buffalo, feral livestock, banteng cattle, and feral camels) occurring throughout regions of Australia. A high number of grazing species occur in central and Pilbara regions of Western Australia, northern NT, central Australia, central Queensland, south-east and western NSW, south-east of South Australia and eastern Victoria (Figure 9). Relatively low numbers of grazing species occur in Tasmania in comparison, as well as northern Queensland, and the central region of Northern Territory (figure 9).

In contrast, figure 10 represents the number of large herbivores occurring throughout regions of Australia. Large herbivores are concentrated in the central and Pilbara region of WA, northern NT, the far north-east of South Australia, south-eastern NSW, SE South Australia, and south-east Queensland. Areas with no large herbivores can be found in western and southern Victoria, Yorke and Eyre Peninsulas of South Australia, central NSW, western and southern Tasmania, some areas in the south-west of WA, and a single area in central NT associated with the Barkley Tablelands.

This figure represents large herbivores only, and shows that without the occurrence of rabbits, grazing animals in Australia remain widespread, but occur in defined management areas. Note that this figure reports the occurrence of species and not the density of animals in these areas.

Figure 9. Number of grazing species present (rabbits, pigs, goats, deer species, horses, donkeys, feral buffalo, feral livestock, banteng cattle, feral camels)

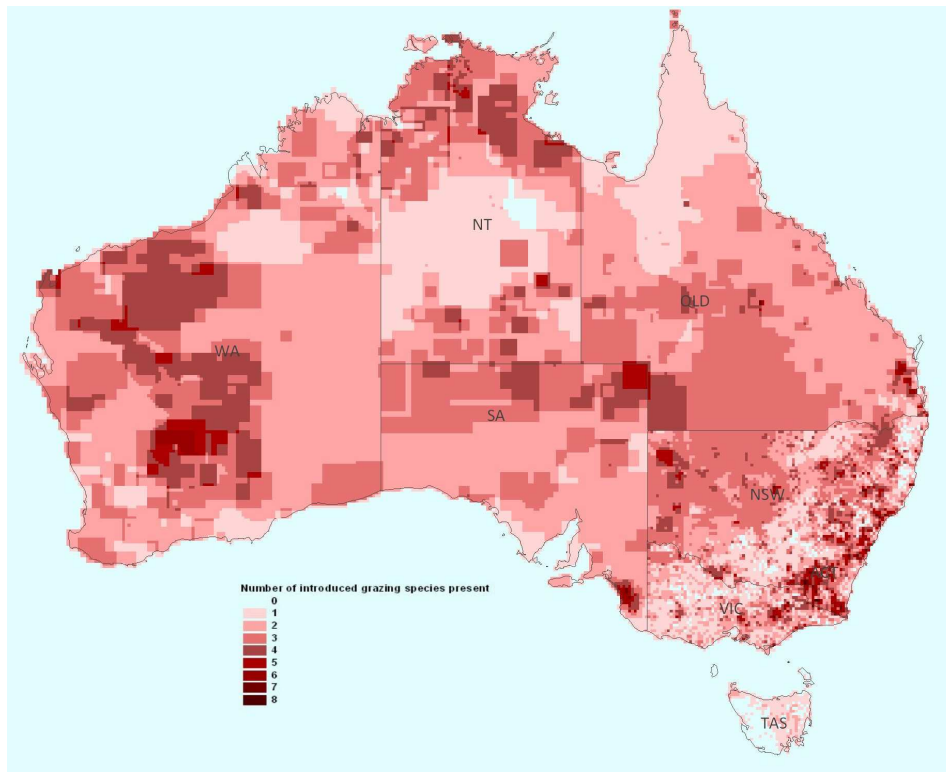
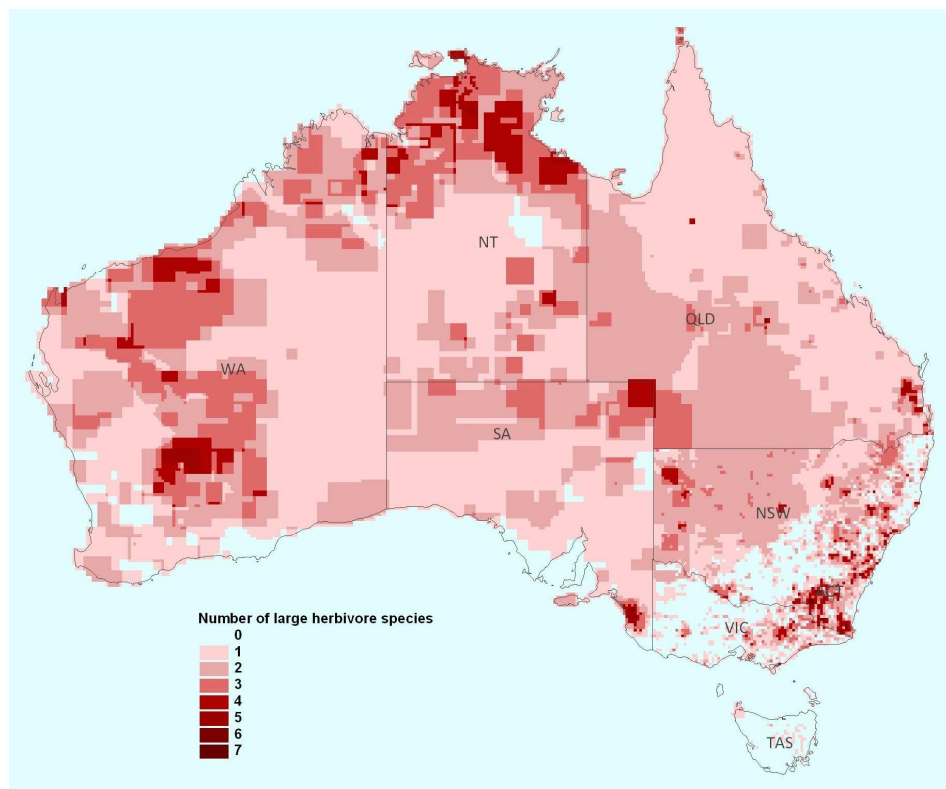
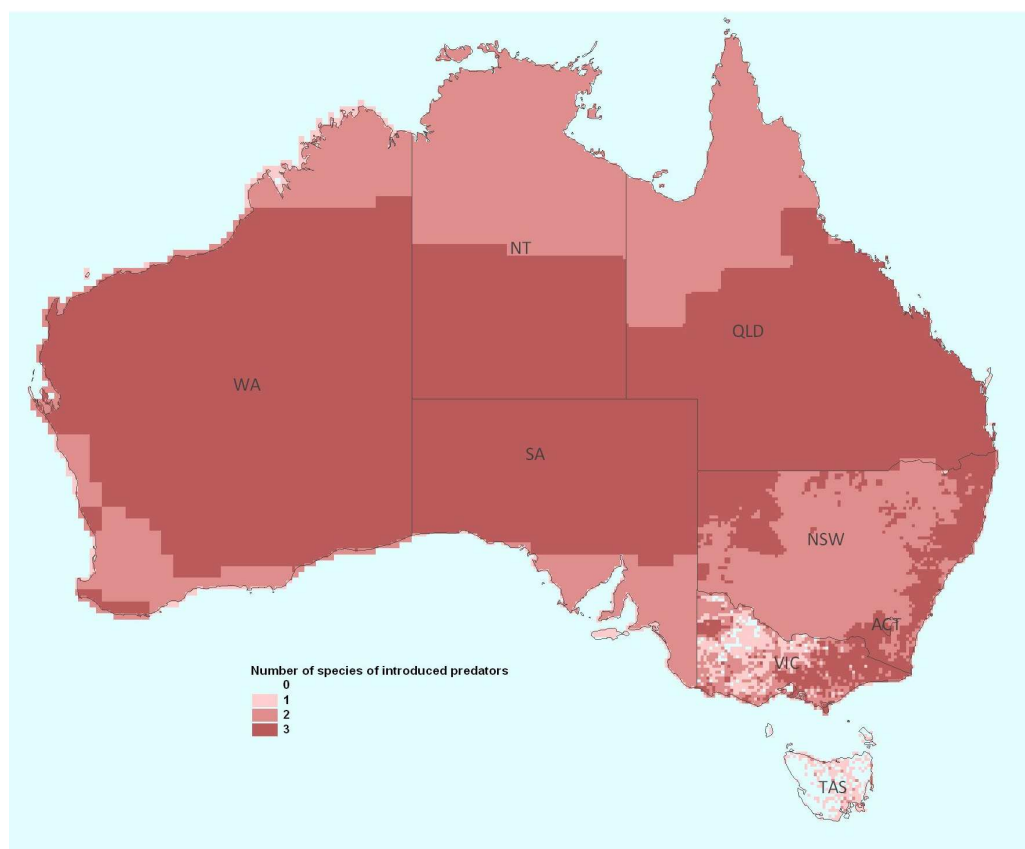


Figure 10. Number of species of large herbivores present (including feral pigs, goats, six deer species, horses, donkeys, feral buffalo, feral livestock, banteng cattle, feral camels).



The occurrence of introduced predators (wild dogs, foxes and feral cats) is depicted in Figure 11. Areas where all 3 species occur includes central WA, northern SA, southern NT, central and eastern Queensland, western and eastern NSW, and eastern Victoria (figure 11). All states and territories contain all 3 introduced predators. Areas reported to contain 1 or less species were restricted to small pockets in western Victoria and the large proportion of Tasmania. Foxes have only recently been introduced to Tasmania, feral cats are quite widespread, and wild dogs are only known to a few isolated cases. Appendix 1 contains maps for these species. While a few small areas of western Victoria where reported to contain no predators, this may reflect lack of feral cat data, rather than lack of feral cats, as anecdotal evidence reports that feral cats occur across the entire state.

Figure 11. Number of species of introduced predators present (wild dogs, foxes and feral cats)



4.4 Occurrence of pest animals in each state/territory jurisdiction

This project presents data consolidated from known databases and known occurrence records in all state and territory jurisdictions. Comparison of the data across each state and territory revealed that most of the species assessed in this project are widespread and occur in several jurisdictions. Table 6 shows a breakdown of species occurrences in each state/territory jurisdiction.

Table 6 presents the number of species identified to occur in each state/ territory region. Of the 23 species assessed in this project, a maximum of 20 species were reported to occur in NSW, followed by 17 in Queensland, and 15 in Victoria and South Australia (see table 6). The ACT contained 12 pest animals species assessed in this project. The least number of species reported to occur was 7 in the Tasmania.

Six species were recorded to occur in all state and territory jurisdictions, namely feral pigs, feral goats, rabbits, foxes, wild dogs, and feral cats (table 6). Banteng cattle and Indian palm squirrels were the only species to occur in one state/territory region. Feral livestock were reported to occur in 5, feral horses in 7, and feral donkeys in 5 state and territory regions respectively.

With the exception of hog deer, feral deer species occur in 3 or more state/territory jurisdictions. Feral fallow deer were the most widespread, occurring in 6 jurisdictions. Evidence from NSW suggests each feral deer species is increasing its range and new populations are becoming established. Evidence presented herein on the extent of species alone suggests feral deer are rapidly becoming a nationally significant pest problem.

A full inventory of pest animal data are contained in maps for each species in this project is displayed in Appendix 1.

Table 6: Data identified for pest animals in each State/Territory

| State / Territory | Feral camels | Water buffalo | Feral horses | Feral donkeys | Banteng cattle | Fallow deer | Sambar deer | Red deer | Rusa deer | Chital deer | Hog deer | Indian palm squirrels | Red-eared slider turtles | Feral pigs | Feral goats | Rabbits | Wild dogs (incl. dingoes) | Foxes | Feral cats | Cane toads | Feral livestock (cattle and sheep) | Brown hare / European hare | Polecat / Ferret | Total |
|------------------------------|--------------|---------------|--------------|---------------|----------------|-------------|-------------|----------|-----------|-------------|----------|-----------------------|--------------------------|------------|-------------|---------|---------------------------|-------|------------|------------|------------------------------------|----------------------------|------------------|-------|
| New South Wales | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 20 |
| Victoria | ✗ | ✗ | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 15 |
| Queensland | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ | 17 |
| South Australia | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✗ | ✓ | ✗ | 15 |
| Western Australia | ✓ | ✗ | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✗ | 12 |
| Tasmania | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ | 7 |
| Northern Territory | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✗ | 13 |
| Australian Capital Territory | ✗ | ✗ | ✓ | ✗ | ✗ | ✓ | ✓ | ✗ | ✓ | ✗ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✗ | 12 |
| Number of jurisdictions | 5 | 2 | 7 | 5 | 1 | 6 | 4 | 4 | 4 | 3 | 2 | 1 | 2 | 8 | 8 | 8 | 8 | 8 | 8 | 5 | 5 | 5 | 2 | |

4.5 Up-to-date inventory of pest animals in each NRM region of Australia

Information compiled and reported in this project also provides the opportunity to examine data across the NRM regions of Australia. Table 7 reports an inventory of pest animal species known to occur in each of the 56 NRM regions of Australia.

The greatest number of species in an NRM region were location in the NSW Southern rivers (16 species), followed by NSW Hunter-Central Rivers NRM (16 species), Hawkesbury-Nepean NRM (15 species), Namoi NRM (14 species) Central West NRM (14 species), Murrumbidgee (14 species) and West Gippsland (14 species).

The least number of species detected in this project in an NRM region was the Kangaroo Island NRM region (3 species) followed by Adelaide and Mount Lofty ranges NRM (5 species). There was no NRM regions reported to contain no nationally significant pest animal species.

The species that occur the most frequently across the NRM regions include feral cats (56 NRM regions), feral pigs and wild dogs (54 NRM regions), foxes and rabbits (53 NRM regions), and feral goats (51 NRM regions). The species that occur in the least number of NRM regions include Indian Palm Squirrels (1 NRM region – Swan NRM), and Banteng cattle (1 region – Northern Territory). Red-eared slider turtles, water buffalo, and hog deer were also reported to occur in only a few NRM regions.

Alarmingly, feral populations of Ferrets were reported from 7 NRM regions spanning NSW and Victoria.

This national inventory of pest animals in NRM regions will be compiled and supplied to each NRM region as an output of this project.

4.6 Data types accessed during this project

Of the data consolidated for this project, the large proportion of data obtained and centralised for pest animals was point style data representing precise locations with latitude and longitude coordinates. Other datasets are equally valuable providing regional reporting units (such as 5km x 5km reporting of data in NSW and reporting on management units e.g. national parks). These data were combined in this project.

Table 8 shows that the point and polygon data sets obtained for each species in this project and the state/territory jurisdiction that those data relate to. More commonly than not, data was obtained from both point and polygon data origins for species in this project (see Table 8).

Table 7: NRM DATA INVENTORY - Data identified for pest animals in each NRM region. Note: Occurrence data represents the presence of one or more observations of the species in each region, or data reported in polygon format.

| State / Territory | | NRM region / catchment | Feral camels | Water buffalo | Feral horses | Feral donkeys | Banteng cattle | Fallow deer | Sambar deer | Red deer | Rusa deer | Chital deer | Hog deer | Indian palm squirrels | Red-eared slider turtles | Feral pigs | Feral goats | Rabbits | Wild dogs (incl. dingoes) | Foxes | Feral cats | Cane toads | Feral livestock (feral cattle and feral sheep) | Brown hare / European hare | Polecat / Ferret | Total | |
|-------------------|-----------------------|------------------------|--------------|---------------|--------------|---------------|----------------|-------------|-------------|----------|-----------|-------------|----------|-----------------------|--------------------------|------------|-------------|---------|---------------------------|-------|------------|------------|--|----------------------------|------------------|-------|----|
| NSW | Border Rivers-Gwydir | | x | x | x | x | x | ✓ | x | x | x | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | 10 |
| NSW | Central West | | x | x | ✓ | x | x | ✓ | x | ✓ | ✓ | ✓ | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | 14 |
| NSW | Hawkesbury-Nepean | | x | x | ✓ | x | x | ✓ | x | ✓ | ✓ | ✓ | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | 15 |
| NSW | Hunter-Central Rivers | | x | x | ✓ | x | x | ✓ | x | ✓ | ✓ | ✓ | ✓ | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | 16 |
| NSW | Lachlan | | x | x | x | x | x | ✓ | x | ✓ | x | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | ✓ | ✓ | x | 10 | |
| NSW | Lower Murray Darling | | ✓ | x | ✓ | ✓ | x | x | x | x | x | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | ✓ | ✓ | x | 11 | |
| NSW | Murray | | x | x | ✓ | x | x | ✓ | ✓ | ✓ | x | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | 13 |

| State / Territory | | NRM region / catchment | Feral camels | Water buffalo | Feral horses | Feral donkeys | Banteng cattle | Fallow deer | Sambar deer | Red deer | Rusa deer | Chital deer | Hog deer | Indian palm squirrels | Red-eared slider turtles | Feral pigs | Feral goats | Rabbits | Wild dogs (incl. dingoes) | Foxes | Feral cats | Cane toads | Feral livestock | Brown hare / European hare | Polecat / Ferret | Total | |
|-------------------|------------------------------|------------------------|--------------|---------------|--------------|---------------|----------------|-------------|-------------|----------|-----------|-------------|----------|-----------------------|--------------------------|------------|-------------|---------|---------------------------|-------|------------|------------|-----------------|----------------------------|------------------|-------|----|
| NSW | Murrumbidgee | | x | x | ✓ | x | x | ✓ | ✓ | ✓ | ✓ | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | 14 | |
| NSW | Namoi | | x | x | ✓ | x | x | ✓ | x | ✓ | x | ✓ | ✓ | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | 14 |
| NSW | Northern Rivers | | x | x | x | x | x | ✓ | x | x | x | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | 10 |
| NSW | Southern Rivers | | x | x | ✓ | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | ✓ | ✓ | ✓ | 16 | |
| NSW | Sydney Metro | | x | x | x | x | x | ✓ | x | ✓ | ✓ | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | 13 |
| NSW | Western | | ✓ | x | ✓ | ✓ | x | x | x | x | x | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | ✓ | ✓ | x | 11 | |
| VIC | Corangamite | | x | x | x | x | x | ✓ | x | ✓ | x | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | ✓ | ✓ | ✓ | 11 | |
| VIC | East Gippsland | | x | x | ✓ | x | x | ✓ | ✓ | ✓ | x | x | ✓ | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | ✓ | ✓ | x | 13 | |
| VIC | Glenelg Hopkins | | x | x | x | x | x | ✓ | ✓ | ✓ | x | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | ✓ | ✓ | ✓ | 12 | |
| VIC | Goulburn Broken | | x | x | ✓ | x | x | ✓ | ✓ | ✓ | x | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | ✓ | ✓ | ✓ | 13 | |
| VIC | Mallee | | x | x | x | x | x | ✓ | ✓ | x | x | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | ✓ | ✓ | x | 10 | |
| VIC | North Central | | x | x | x | x | x | ✓ | ✓ | ✓ | x | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | ✓ | ✓ | ✓ | 12 | |
| VIC | North East (VIC) | | x | x | ✓ | x | x | ✓ | ✓ | ✓ | x | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | 13 | |
| VIC | Port Phillip and Westernport | | x | x | x | x | x | ✓ | ✓ | ✓ | x | x | ✓ | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | ✓ | ✓ | ✓ | 13 | |

| State / Territory | NRM region / catchment | Feral camels | Water buffalo | Feral horses | Feral donkeys | Banteng cattle | Fallow deer | Sambar deer | Red deer | Rusa deer | Chital deer | Hog deer | Indian palm squirrels | Red-eared slider turtles | Feral pigs | Feral goats | Rabbits | Wild dogs (incl. dingoes) | Foxes | Feral cats | Cane toads | Feral livestock | Brown hare / European hare | Polecat / Ferret | Total | |
|-------------------|------------------------|--------------|----------------|--------------|---------------|----------------|-------------|-------------|----------|-----------|-------------|----------|-----------------------|--------------------------|------------|-------------|---------|---------------------------|-------|------------|------------|-----------------|----------------------------|------------------|-------|---|
| | | VIC | West Gippsland | x | x | ✓ | x | x | ✓ | ✓ | ✓ | x | x | ✓ | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | ✓ | ✓ | ✓ |
| VIC | Wimmera | x | x | x | x | x | ✓ | ✓ | ✓ | x | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | ✓ | ✓ | x | 11 | |
| QLD | Burdekin | x | ✓ | x | x | x | ✓ | x | ✓ | ✓ | ✓ | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | x | x | 12 | |
| QLD | Burnett Mary | x | x | x | x | x | ✓ | x | ✓ | ✓ | ✓ | x | x | x | ✓ | x | ✓ | ✓ | ✓ | ✓ | ✓ | x | x | x | 10 | |
| QLD | Cape York | x | ✓ | x | x | x | x | x | ✓ | ✓ | ✓ | x | x | x | ✓ | x | x | ✓ | x | ✓ | ✓ | x | x | x | 7 | |
| QLD | Condamine | x | x | x | x | x | ✓ | x | ✓ | ✓ | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | x | x | 10 | |
| QLD | Desert Channels | ✓ | x | ✓ | ✓ | x | ✓ | x | ✓ | ✓ | ✓ | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | x | x | 14 | |
| QLD | Fitzroy | x | x | x | x | x | x | x | ✓ | ✓ | ✓ | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | x | x | 10 | |
| QLD | Mackay Whitsunday | x | x | x | x | x | x | x | x | ✓ | x | x | x | x | ✓ | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | x | x | 7 |
| QLD | South East (QLD) | x | x | x | x | x | ✓ | x | ✓ | ✓ | ✓ | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | ✓ | x | 13 | |
| QLD | South West (QLD) | ✓ | x | x | x | x | x | x | x | x | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | x | x | 8 | |
| QLD | Southern Gulf | ✓ | ✓ | ✓ | x | x | x | x | x | ✓ | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | x | x | 11 | |
| QLD | Torres Strait | x | x | x | x | x | x | x | x | ✓ | x | x | x | x | ✓ | ✓ | x | ✓ | x | ✓ | ✓ | x | x | x | 6 | |
| QLD | Wet Tropics | x | x | x | x | x | x | x | x | ✓ | ✓ | x | x | x | ✓ | x | ✓ | ✓ | ✓ | ✓ | ✓ | x | x | x | 8 | |

| State / Territory | NRM region / catchment | Feral camels | Water buffalo | Feral horses | Feral donkeys | Banteng cattle | Fallow deer | Sambar deer | Red deer | Rusa deer | Chital deer | Hog deer | Indian palm squirrels | Red-eared slider turtles | Feral pigs | Feral goats | Rabbits | Wild dogs (incl. dingoes) | Foxes | Feral cats | Cane toads | Feral livestock | Brown hare / European hare | Polecat / Ferret | Total |
|-------------------|-------------------------------|--------------|-------------------------------|--------------|---------------|----------------|-------------|-------------|----------|-----------|-------------|----------|-----------------------|--------------------------|------------|-------------|---------|---------------------------|-------|------------|------------|-----------------|----------------------------|------------------|-------|
| | | QLD | Border Rivers Maranoa-Balonne | x | x | x | x | x | ✓ | x | ✓ | x | ✓ | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | ✓ |
| QLD | Northern Gulf | x | ✓ | x | x | x | x | x | ✓ | ✓ | ✓ | x | x | x | ✓ | x | ✓ | ✓ | ✓ | ✓ | ✓ | x | x | x | 10 |
| SA | Alinytjara Wilurara | ✓ | x | ✓ | ✓ | x | x | x | x | x | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | x | x | x | 9 |
| SA | Eyre Peninsula | ✓ | x | x | x | x | x | x | x | x | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | x | x | x | 7 |
| SA | Kangaroo Isl. | x | x | x | x | x | x | x | x | x | x | x | x | x | ✓ | ✓ | x | x | x | ✓ | x | x | x | x | 3 |
| SA | Adelaide & Mount Lofty Ranges | x | x | x | x | x | x | x | x | x | x | x | x | x | ✓ | ✓ | ✓ | x | ✓ | ✓ | x | x | x | x | 5 |
| SA | Northern and Yorke | x | x | x | x | x | x | x | x | x | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | x | x | x | 6 |
| SA | SA Arid Lands | ✓ | x | ✓ | ✓ | x | x | x | x | x | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | x | x | x | 9 |
| SA | SA Murray Darling Basin | x | x | x | x | x | ✓ | x | x | x | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | x | x | x | 7 |
| SA | South East (SA) | x | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | x | x | ✓ | x | 11 |
| WA | Avon | ✓ | x | ✓ | ✓ | x | x | x | x | x | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | x | x | x | 9 |
| WA | Northern Agricultural | x | x | ✓ | ✓ | x | x | x | x | x | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | x | x | x | 8 |
| WA | Rangelands (WA) | ✓ | x | ✓ | ✓ | x | x | x | x | x | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | x | 11 |

| State / Territory | NRM region / catchment | Feral camels | Water buffalo | Feral horses | Feral donkeys | Banteng cattle | Fallow deer | Sambar deer | Red deer | Rusa deer | Chital deer | Hog deer | Indian palm squirrels | Red-eared slider turtles | Feral pigs | Feral goats | Rabbits | Wild dogs (incl. dingoes) | Foxes | Feral cats | Cane toads | Feral livestock | Brown hare / European hare | Polecat / Ferret | Total |
|-------------------|------------------------|--------------|---------------|--------------|---------------|----------------|-------------|-------------|----------|-----------|-------------|----------|-----------------------|--------------------------|------------|-------------|---------|---------------------------|-------|------------|------------|-----------------|----------------------------|------------------|-------|
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| WA | South Coast | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ | 7 |
| WA | South West | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ | 6 |
| WA | Swan | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ | 7 |
| TAS | North (TAS) | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ | 7 |
| TAS | North West (TAS) | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ | 6 |
| TAS | South (TAS) | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ | 7 |
| NT | Northern Territory | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✗ | 13 |
| ACT | ACT | ✗ | ✗ | ✓ | ✗ | ✗ | ✓ | ✓ | ✗ | ✓ | ✗ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✗ | 12 |
| | Totals | 12 | 5 | 22 | 9 | 1 | 33 | 14 | 27 | 20 | 15 | 6 | 1 | 4 | 54 | 51 | 53 | 54 | 53 | 56 | 26 | 26 | 27 | 7 | |

Note: Occurrence data represents the presence of one or more observations of the species in each region, or data reported in polygon format. As a result of polygon reporting where a single latitude and longitude coordinate was not available, some reported tally data herein may differ slightly at the local scale.

Table 8: Types of data centralised as part of this project from state and territory regions.

| PEST ANIMALS – data types | | | | | | | | |
|----------------------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| SPECIES | NSW | QLD | SA | WA | ACT | NT | TAS | VIC |
| Feral camels | Point | Point Polygon | Point Polygon | Point Polygon | | Point Polygon | | |
| Water buffalo | | Point | | | | | | |
| Feral horses | Point Polygon | | Point | Point | Point Polygon | Point Polygon | | Point |
| Feral donkeys | Point Polygon | | Point | Point | | Point Polygon | | |
| Banteng cattle | | | | | | Point | | |
| Fallow deer | Point Polygon | Point | Point | | Point | | Point | Point |
| Sambar deer | Point | | Point | | | | | Point |
| Red deer | Point Polygon | Point | Point | | | | | Point |
| Rusa deer | Point Polygon | Point | Point | | | | | |
| Chital deer | Point | Point | Point | | | | | |
| Hog deer | Point | | | | | | | Point |
| Indian palm squirrels | | | | Point | | | | |
| Red-eared slider turtles | Point Polygon | Point Polygon | | | | | | |
| Feral pigs | Point Polygon | Point Polygon | Point | Point Polygon | Point Polygon | Point Polygon | | Point Polygon |
| Feral goats | Point Polygon | Point | Point | Point | Point Polygon | Point | Point Polygon | Point Polygon |
| Rabbits | Point Polygon | Point Polygon | Point Polygon | Point Polygon | Point Polygon | Point Polygon | Point Polygon | Point Polygon |
| Wild dogs (incl. dingoes) | Point Polygon | Point | Point | Point | Point | Point | Point | Point Polygon |
| Foxes | Point Polygon | Point Polygon | Point Polygon | Point Polygon | Point Polygon | Point Polygon | Point | Point Polygon |
| Feral cats | Point Polygon | Point | Point | Point | Point Polygon | Point | Point | Point Polygon |
| Cane toads | Point | Point Polygon | | Point Polygon | | Point Polygon | | |
| Feral livestock | Point Polygon | | | Point | Point Polygon | Point | | Point |
| Brown hare | Point | | | | | | | Point |
| Polecat / Ferret | Point | | | | | | | Point |

4.7 Outputs at NRM regional, state/territory and Australia-wide scales

This project has developed and provided a centralised dataset for nationally significant pest animals across Australia and an inventory of pest animals in each NRM region and each state/territory for use by respective management authorities and pest control groups. The data have been centralised for the purposes of a single reporting process and examination of data across all state/territory management areas. A series of informative maps based on data developed in this project will be uploaded to specialised pest animal websites including web portals such as www.feral.org.au (PESTMAPS), data libraries and websites.

This project produces outputs at national, state/territory and regional/local scales as follows:

- Reporting of a single national database of known occurrence data from existing information systems and databases. [*Data is classified for 'known occurrence data' and 'no known occurrence data', allowing future re-classification under agreed data standards and protocols currently being independently developed by the Joint AWC/VPC National Indicators Working Group.*]
- A national inventory of pest animals occurring in each for the 56 NRM regions of Australia, and in each state/territory, for use by management agencies and on-ground land managers.
- Reporting of a series of national, state/territory and regional pest animal maps reporting occurrence data at 1/8 degree reporting units (equivalent to approximately 12.5 x 12.5 km) combining information from many sources for comparison with existing state/administered datasets.
- State/territory data on known occurrence data from existing information systems and databases.
- Regional/local reporting (across all 56 NRM regions) of a database of known occurrence data from existing information systems and databases at the 1/8 scale.

5. DISCUSSION OF RESULTS AND IMPLICATIONS FOR FUTURE MANAGEMENT OF PEST ANIMALS

5.1 Trends in pest animals

Data were collected and collated in this project for 23 nationally relevant pest animal species throughout Australia, many of which occupy several state and territory jurisdictions and represent a significant threat to agricultural productivity, food security, biodiversity, environmental and cultural values, social amenity, human health and exotic disease management.

Data and maps reported provide an Australia-wide inventory of pest animals in each NRM region, and each state and territory. This information provides an up-to-date snapshot of the status of the extent of pest animals in Australia, and builds on previous initiatives of the Invasive Animals CRC, Australian Pest Animal Research Program, and the National Land & Water Resources Audit, to capture and report information on a broad cross-section of pest animals at a national scale with consistency and meaningfulness.

Data from this project clearly show that many nationally significant pest animals are widespread throughout Australia – and some are further expanding their range. Data for some species can be further developed to provide increased value for on-ground management and evaluation of problems across landscape and jurisdictions. Feral horses, feral donkeys, feral water buffalo and feral livestock are all reportedly increasing throughout their range and data herein show an increase in the range of these species in several jurisdictions from previous assessments. Feral camels remain a widespread and abundant, and are being addressed through the Australia Feral Camel Management Project.

This project identified that feral deer species are now very widespread and connected throughout large areas on eastern Australia. Feral deer are also common throughout some areas of South Australia, Western Australia and Tasmania. Trends identified suggest several species of feral deer are expanding their range rapidly, as supported by evidence gathered throughout NSW. While providing specific management recommendation is beyond the scope of this project, the expansion of feral deer populations reported in this project raises concerns about current management practices/policies. This project also demonstrates that data gathering tasks (as implemented in this project) can significantly help to identify trends in deer populations, and should be undertaken periodically to assist with feral deer management.

This project also shows that there is a clear need for improved reporting procedures and mechanisms for targeted surveillance of new and emerging species, such as feral deer species, ferrets, red-eared slider turtles, and Indian palm squirrels, as well as species reported to be expanding their range such as feral livestock, or water buffalo in northern Australia. Without targeted surveillance and monitoring, populations may remain undetected and be overlooked in future management planning.

For some species there appeared limited data available through existing databases, despite credible reports of wild populations. To ensure data on wild populations is gathered and centralised relies on an institutionalised reporting framework for pest animal data. This could take the shape of a Monitoring and Reporting framework within Caring-For-our-Country, or concurrent Biosecurity initiatives. This would provide a mandate for collecting and reporting of pest animal data to a single authority and largely overcome the need for lengthy data gathering, allowing investment in examination and analysis of pest animal data nationally. This would constitute a value-adding process to the initiatives already in place within state/territory jurisdictions with current databases and data management systems.

5.2 Method adopted during the project

Previously applied reporting for Australia-wide pest animal data was at a scale of 0.5 degree (equivalent to approximately 50km x 50km) and across the 1:100 000 map-sheet series. Reporting in this project was performed at an improved scale of 1/8th (0.125) of a degree (approximately 12.5km x 12.5km) providing increased spatial accuracy of data for pest animals nationally. This improved reporting scale translates to a 16-fold increase in the size of the dataset for each pest species, and an equivalent increase in the value of the dataset in reporting on-ground variation in population distribution and abundance.

The refined reporting units are also based on the 1:100 000 map-sheet tiles, and as a result, the data are directly comparable to previous datasets and can be used in combination with other data gathered or reported at the 1:100 000 scale, such as land-use data. A range of existing databases and information systems were queried during this project for pest animal data, and outputs reported in the above reporting format.

At the time of this project, nationally endorsed data standards and an agreed protocol for gathering and reporting pest animal data had not been fully developed. This is currently being developed through the Joint AWC/VPC National Indicators Working Group. As a consequence, this project was not able to apply an endorsed reporting protocol throughout the states/territories and NRM regions of Australia, and we were reliant on using previously agreed data reporting procedures, which are now considered unsuitable or of limited value for some pest animals species. These former protocols were used as a guide and data were developed wherever possible for the pest species in this project.

Data gathered in this project provide a new series of outputs that build on previous knowledge and data at local/regional, state/territory and national scales, which will assist with assessing pest problems and support management planning on many levels.

5.3 End-user utilisation of project information

This project builds on the achievements of previous work to provide improved pest animal data on established, new and emerging species at the regional, state/territory and national scales. It provides seamless national datasets at a significantly finer scale than previously adopted to report on the extent of pest animal populations,

and draws on the latest data from a wide range of independently managed spatial databases in each state/territory jurisdiction.

The project also provides for the first time a national inventory of pest animal data across the 56 NRM regions that will provide improved data directly on NRM program on the extent of pest animals and across jurisdictions. This will in turn help to better target pest animals, and increase capacity to address pest animal problems across management jurisdictions. This project also provides data that can be used as a benchmark to assess the effectiveness of various investment programs in reducing the extent of pest populations through on-ground control activities.

This project delivers datasets for nationally significant pest animals at regional, state/territory and national scales, as well as map information products via a range of online and digital formats. Increasing the accessibility of this data to land management agencies and pest managers is essential if problems such as spreading species are to be contained, isolated incursions controlled, and damage levels reduced. Real-time reporting models can provide an improved method for capturing and delivering data direct to end-users with reliability and in a timely manner. This will in turn increase early detection of changes in species range and damage levels, increase response time and improve the efficiency of control by targeting sites and species.

5.4 Recommendations from this project

This project undertook a series of activities to gather and centralise data on the extent and abundance of nationally relevant pest animal species. A series of face-to-face meetings were held in each state/territory jurisdiction, followed by a phase of data collation to source all available relevant spatial datasets for each species in the project. This project demonstrates that data gathering tasks can significantly help to identify trends in pest animal populations, and should be undertaken periodically to assist with pest management. However, this project also shows that there is a clear need for improved reporting procedures and mechanisms for targeted surveillance of new, emerging and established pest animals. Real-time reporting models can significantly value-add to current processes and increase early detection of species, increase response time and improve the control efficiency.

This project delivers improved national-scale information and maps on the extent of pest animals – which can be used to assess the effectiveness of current policy, pest management programs, investment, and on-ground control activities.

Recommendations from this project include the following:

- This project relied on collection and collation of data from independent data sources across all jurisdictions of Australia. We strongly support the concept of a nationally institutionalised process and clear mandate for gathering and reporting of established, new and emerging pest animal species data from across the state/territory and NRM regions of Australia to allow assessment of pest animal problems at the national scale. This will provide a means for accurately assessing the continued threat that pest animals pose to biosecurity, food production systems, natural resources, social values, cultural assets, infrastructure and human health. This will also identify opportunities

for research and development, targeted investment, assessment of program efficiencies and sharing of responsibility for pest management across government, industry, community and business sectors.

- This project has developed an updated set of pest animal data and mapping outputs reporting information on 23 nationally significant pest animal species. We recommend the outputs of this project be disseminated directly to state and national authorities for biosecurity, pest management and animal health programs. This can be undertaken through existing networks, collaborations, pest animal information websites and web-portals. We also recommend the outputs of this project be disseminated directly to NRM regional groups and local government, to increase capacity of local authorities to integrate pest animal data in existing and future NRM management programs. Many pest animals occur in urban, peri-urban and rural interface area where pest control is imperative to reduce pest damage in adjoining agricultural, food production and urban landscapes.
- This project builds on previous initiatives and gathers data at a vastly improved reporting scale. Despite some datasets being well developed in most regions, others contain information gaps. We recommend building on datasets developed as part of this project for all species, and especially feral livestock, feral deer species, new and emerging species such as ferrets, water buffalo in northern Australia as well as feral horses and feral donkeys that are reportedly increasing in numbers throughout many regions. Feral camel data is being concurrently developed by the Australian Feral Camel Management Project. Integration of feral camel data with other large herbivore data will help to assess the landscape pressure from large herbivores in Australia and their impacts on the productivity of land, environmental values and social/cultural assets.
- Methods for data reporting can be streamlined and expanded. We recommend improving facilities and procedures for gathering of data from field-based land managers on the occurrence and abundance of pest animals. This could be in the form of further web-portals for online reporting on pest data, mobile technology for pest animal reporting by landholders and pest controllers (especially for new and emerging species), or improved channels for reporting to local pest authorities and upwards to state-administered real-time databases. This would provide a means of surveillance and early detection of new pest animals in high priority areas, increase response time to incursions, improve control efficiencies by reducing wasted control effort, and reduce potential for pest populations to continue to expand.
- Data from this project reports the occurrence of six feral deer species and the number of deer species known to occur in problem areas throughout Australia. Further data on the abundance, movement and population trends of feral deer populations in each area will provide improved information for responding to future incursions of feral deer, expansions in the range of deer, and help to address the problems they cause. As feral deer pose an exotic

disease risk, this information will also serve to inform management agencies responsible for biosecurity and animal health.

- Similarly, on-ground monitoring of feral deer and other new and emerging pest animals identified in this project will provide an improved capacity to respond to changes in populations, such as new incursions, as well as coordinating on-ground control for damage prevention. This data will also help to prevent populations from expanding further.
- Large herbivores (including feral livestock) are widespread and abundant across Australia. They present a livestock disease problem in grazing country, contribute to land degradation, and may present a biosecurity risk if exotic diseases such as foot-and-mouth were introduced to Australia. We recommend gathering of further data on the species of feral livestock known to occur across regions of Australia, and gather data on the abundance and movement of these species to accurately assess the likely threat they pose to production systems, natural resources and biosecurity.
- As concurrent work to develop an data standards and an improved reporting procedure for pest animals is underway via the Joint AWC/VPC National Indicators Working Group (see Terms of Reference Appendix 2), we recommend consideration of National Data Standards for Reporting of Pest Animals once developed. This could permit consistent reporting of data across all management areas in alignment with other pest animal reporting, and translate to equitable apportionment of value control resources, and targeted control and investment to high priority areas regardless of jurisdiction and management responsibility.

5.5 Explanatory note: Outcomes not fully reached during the project

This project engaged with each state/territory jurisdictions through a series of face-to-face meetings followed by a series of discussions with expertise regarding available data and accessibility. One project outcome was not reached during this project.

| Project objective | Project outcome not achieved |
|---|---|
| <p>To collect, collate and report information for established, new and emerging pest animal species throughout Australia (at a fine-scale) and review of the data in consultation with NRM regional groups in key areas through a series of regionally</p> | <p>This project engaged with each state/territory jurisdiction and prepared work plans for collating pest animal data in each state/territory for further review within workshops involving focus groups across the NRM regions.</p> <p>During consultation with regional NRM groups following the collation of interim datasets obtained from the respective state/territory agencies, it was determined that the NRM regions would have little further data to contribute to the process of centralising pest animal data. NRM groups are largely reliant on their respective state-government organisations for data on pest animals, and access data through established state government</p> |

| | |
|--|--|
| focused workshops. | databases. These datasets were already obtained in this project. As a consequence, scheduled workshops in the NRM regions were not undertaken. |
| Strategy to engage NRM regions with pest animal data developed as part of this project. | It was agreed that a more suitable strategy for engaging the NRM groups is to provide output data and information products from this project directly to each NRM to complement data they may receive from other sources. In doing so, expanding the up-to-date information set they may access for NRM activities and programs. |

The above strategy will be implemented through the Invasive Animals CRC NRM engagement officer.

6. REFERENCES

Mitchell, B and Balogh, S (2007). *Monitoring techniques for vertebrate pests*. Bureau of Rural Sciences and NSW Department of Primary Industries, Orange.

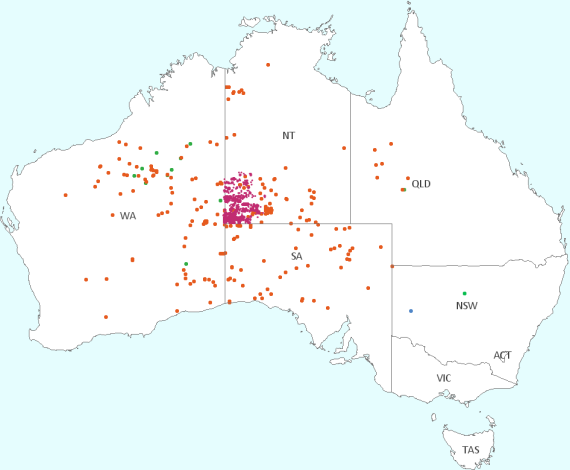
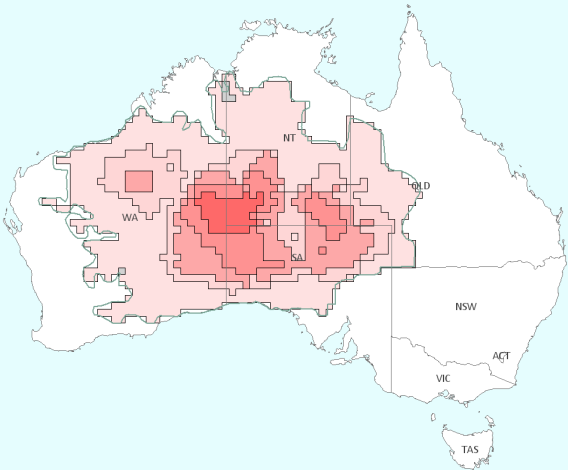
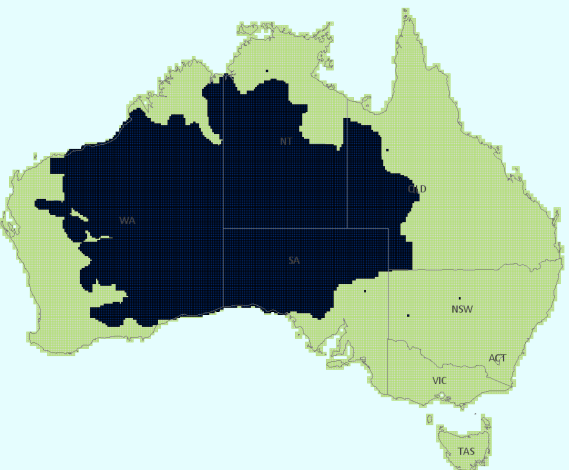
NLWRA (2007) Nationally endorsed monitoring protocol for the occurrence, distribution, abundance of vertebrate pests. National Land and Water Resources Audit, Land and Water Australia. 2007.

West, P (2008). *Assessing invasive animals in Australia 2008*, National Land & Water Resources Audit and Invasive Animals Cooperative Research Centre, Canberra.

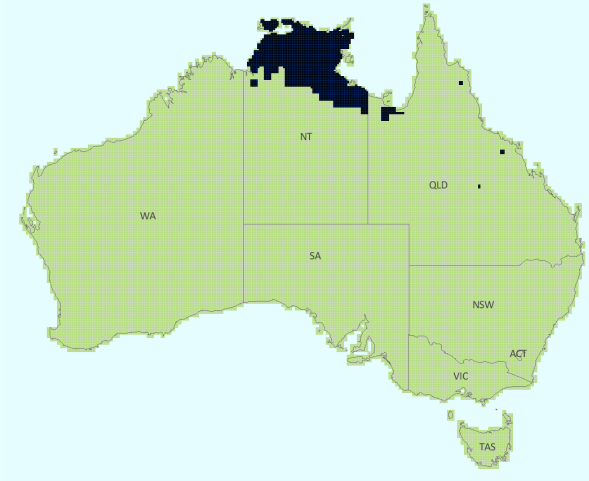
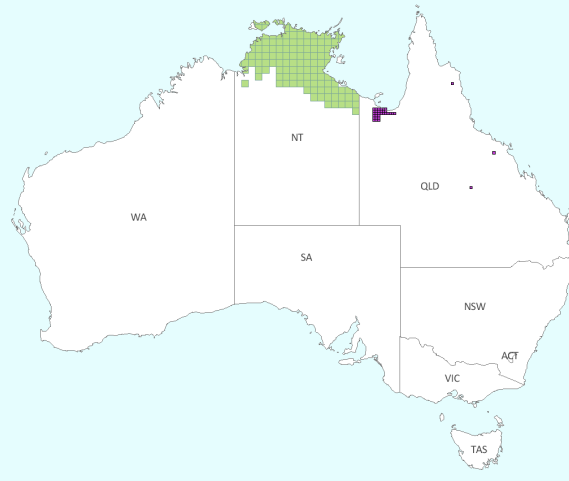
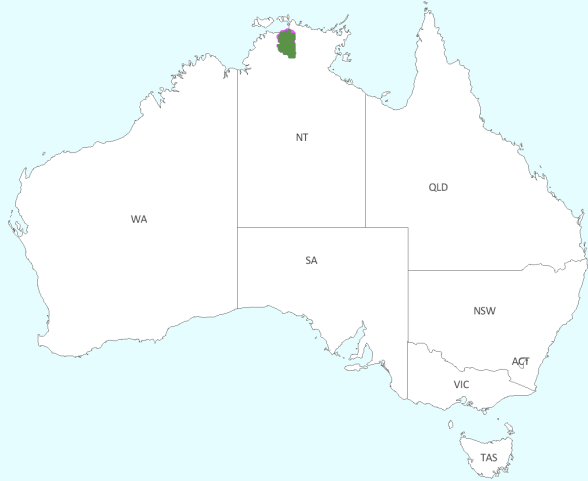
West, P (2010). National workshop for development of improved pest animal monitoring and reporting procedures for Australia-wide application. Final report to the Australian Pest Animal Research Program, Australia Bureau of Agricultural and Resource Economics and Sciences, 2010. Report by the Invasive Animals Cooperative Research Centre, Canberra.

APPENDIX

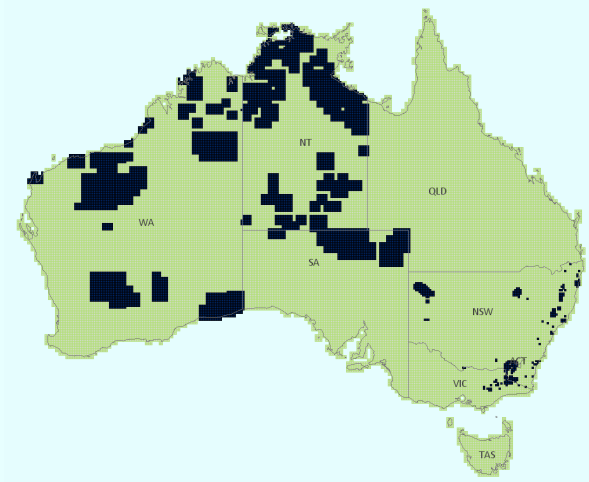
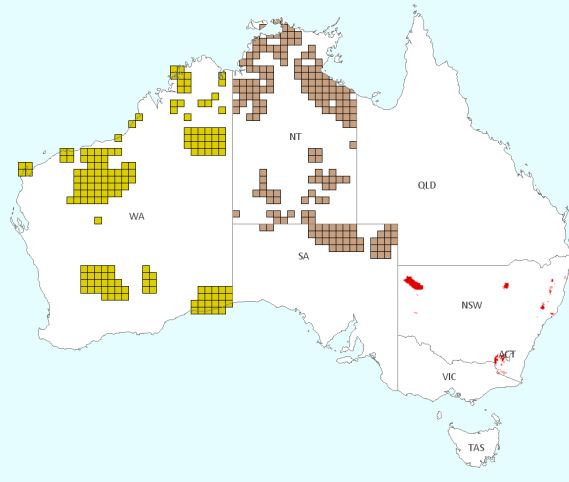
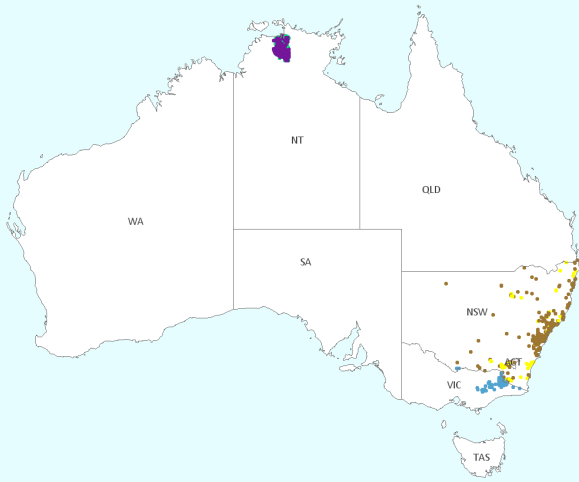
Appendix 1: Collated and centralised point and polygon data for each pest animal and reported occurrence or abundance against fine-scale seamless national 1/8th degree grid.

| Map 1 Collated and centralised occurrence records in point format from all identified database and Atlas systems for pest animals in this project. | Map 2 Collated and centralised occurrence data in polygon format from all identified database and Atlas systems for pest animals in this project. | Map 3 Reported occurrence of species using a seamless datasets at the scale of 1/8 th degree reporting unit. |
|--|---|---|
| Feral camels  |  |  |

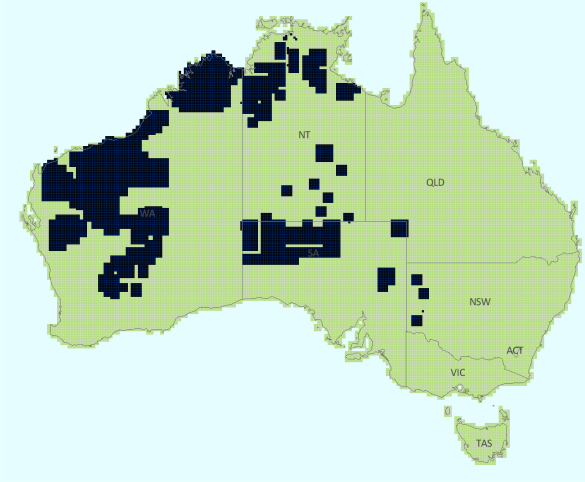
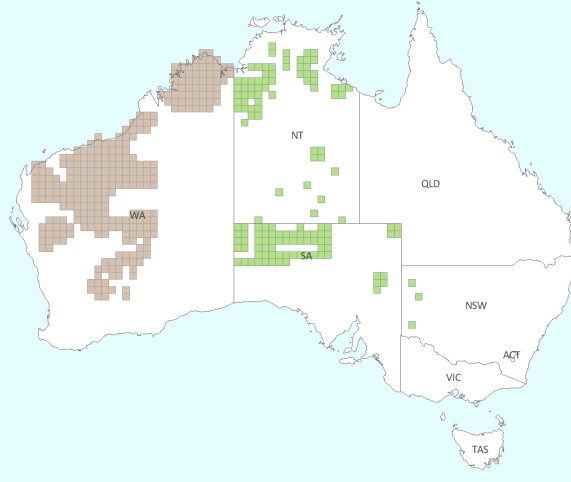
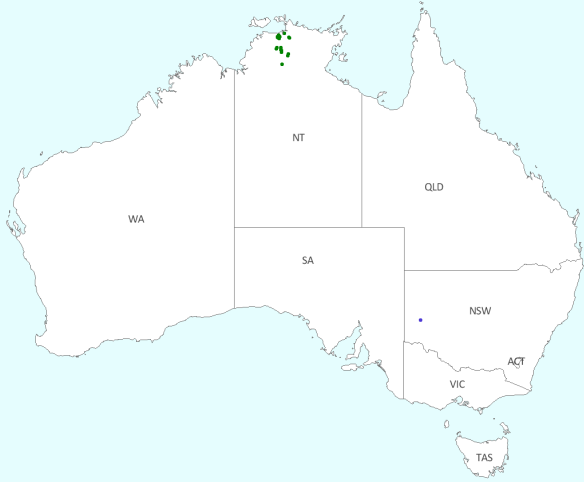
Water buffalo



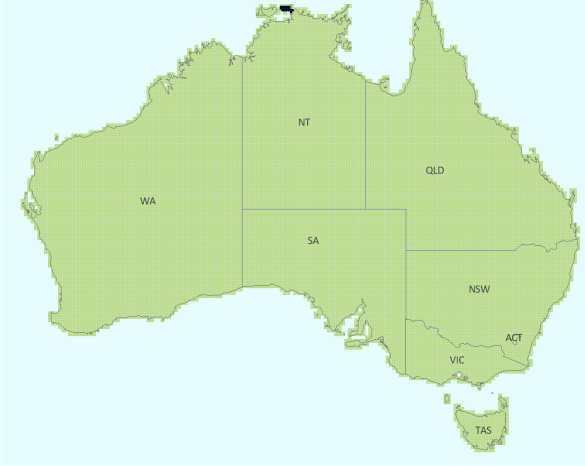
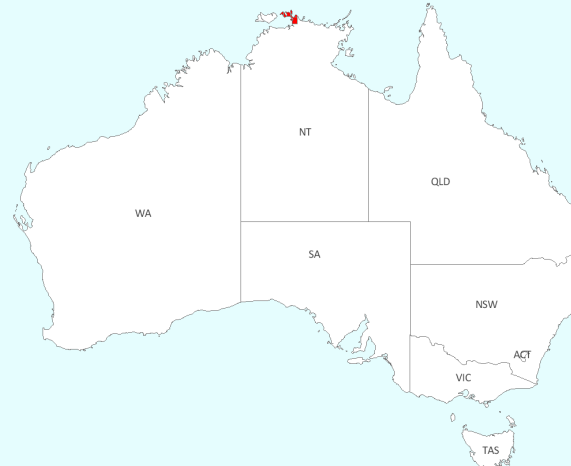
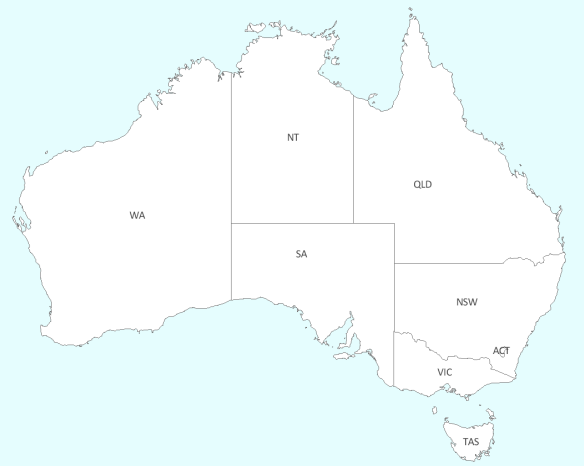
Feral horses



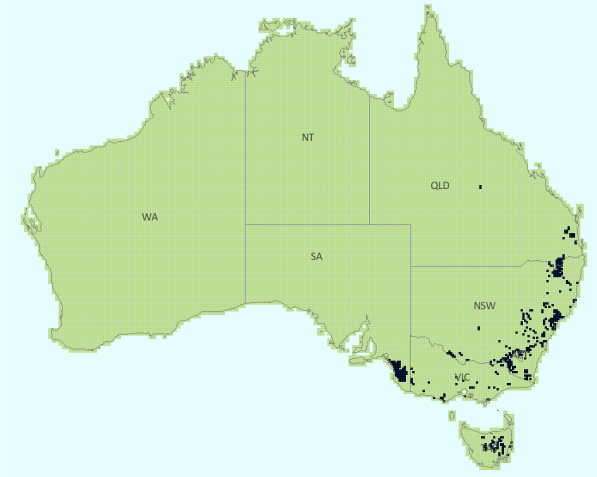
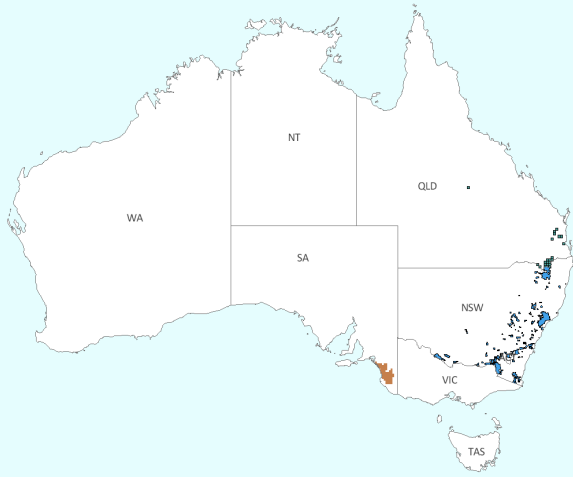
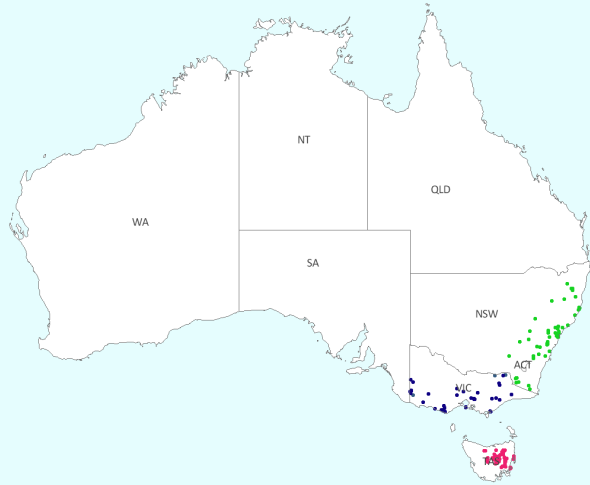
Feral donkeys



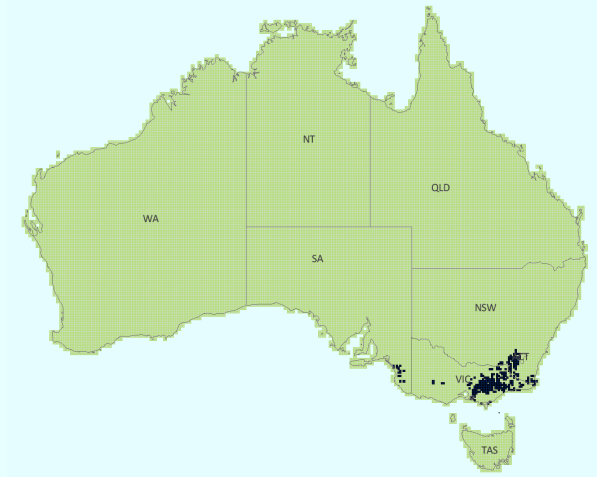
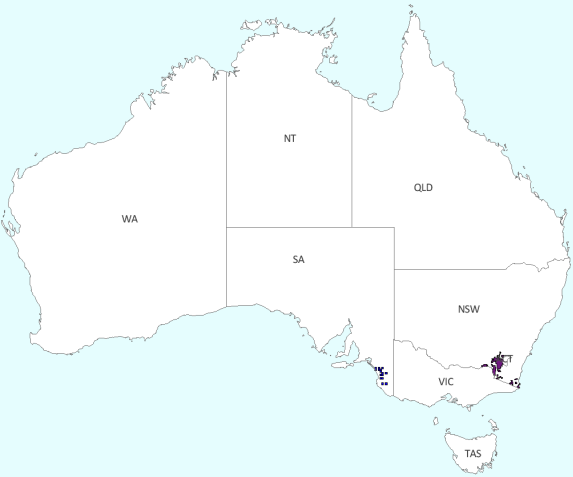
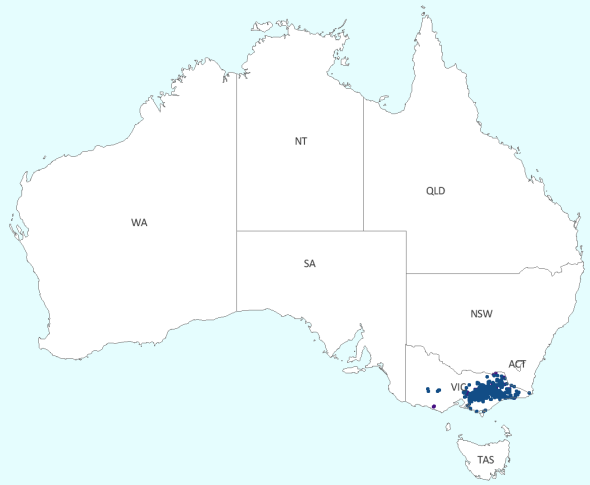
Banteng cattle



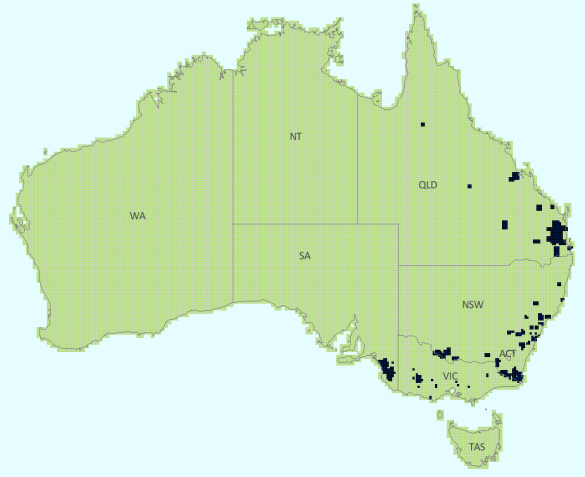
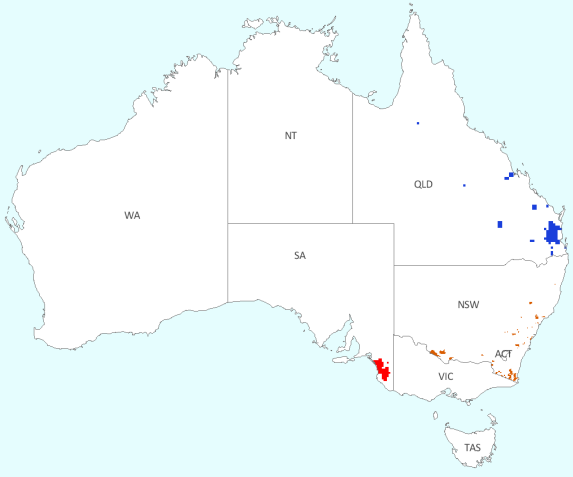
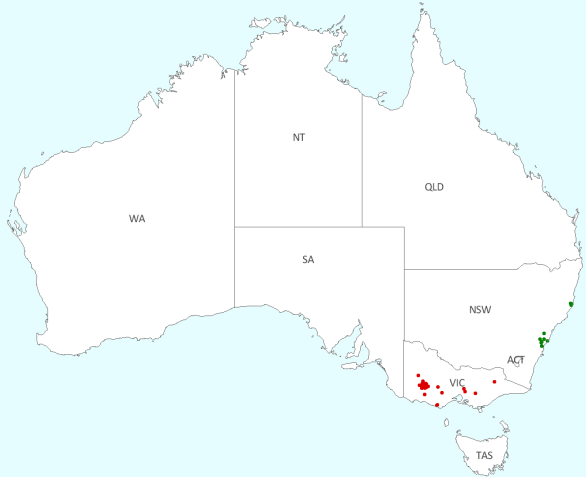
Fallow deer



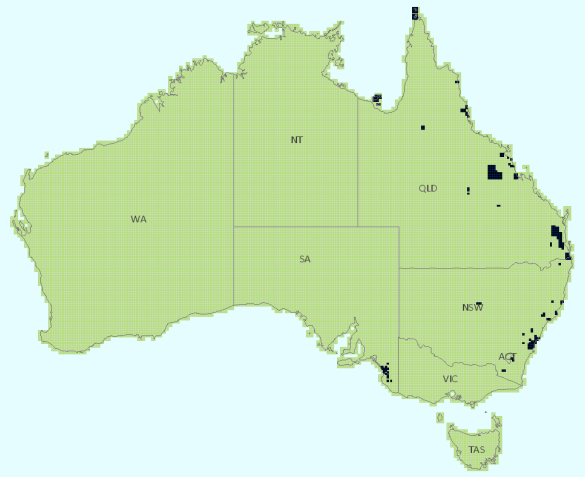
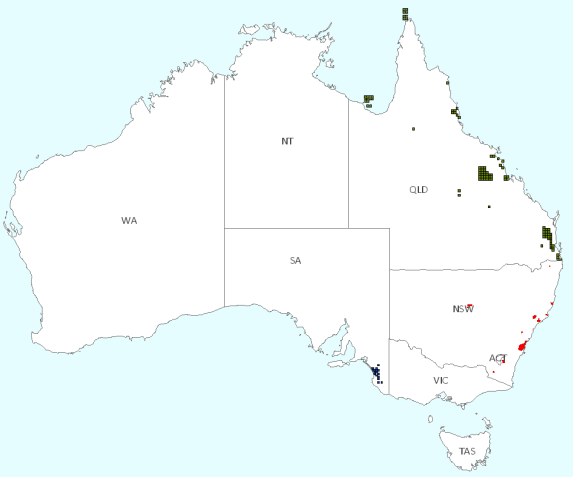
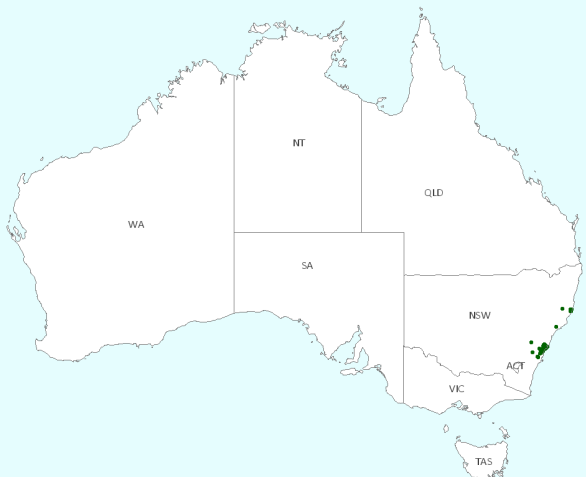
Sambar deer



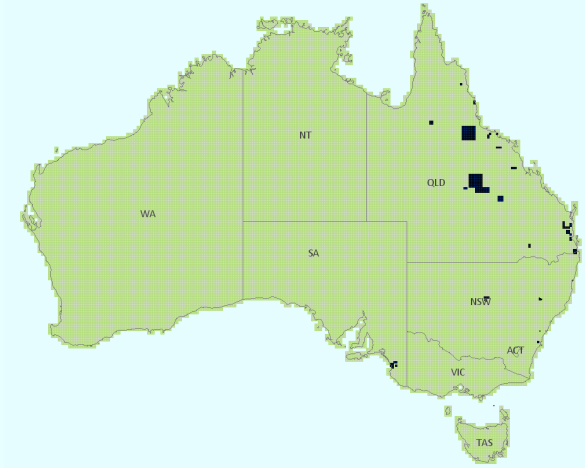
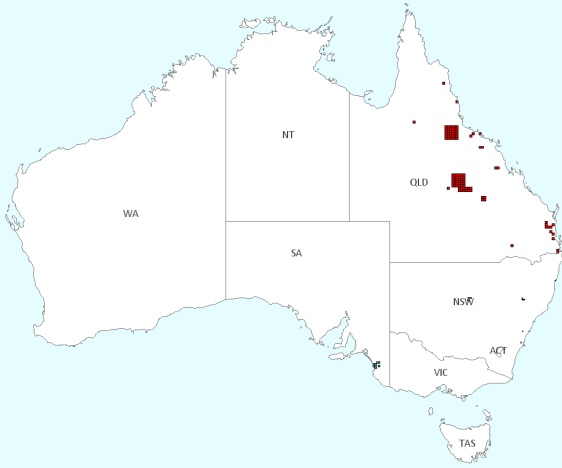
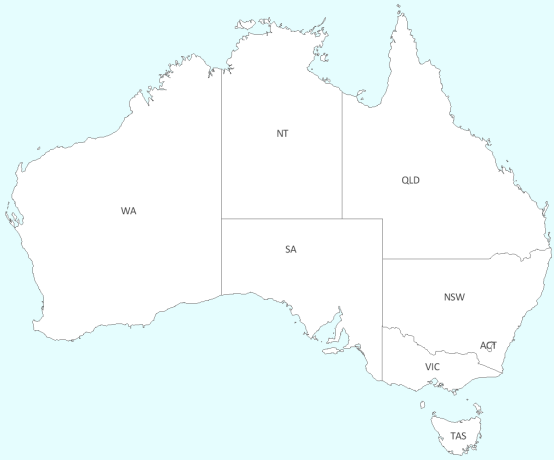
Red deer



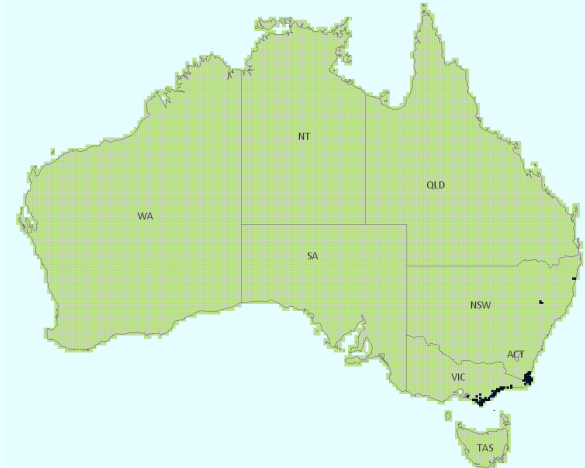
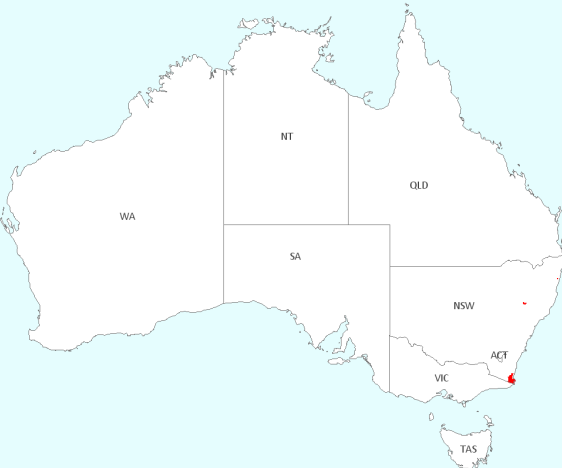
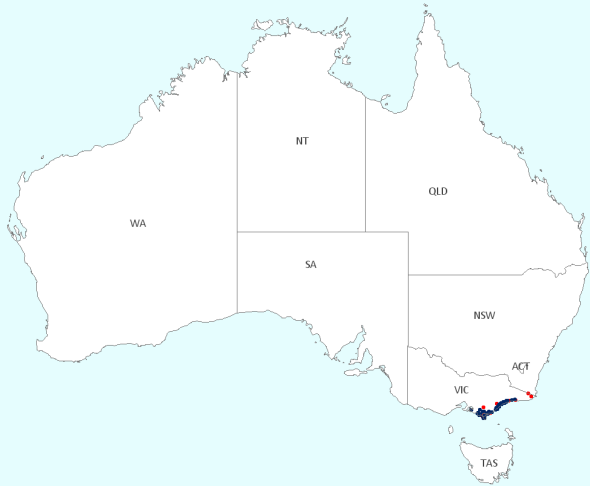
Rusa deer



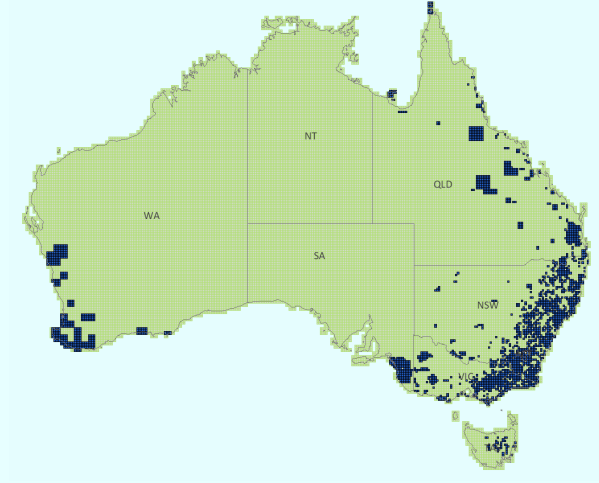
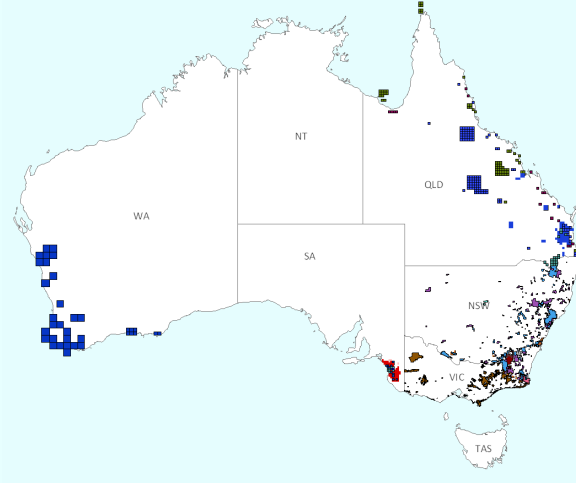
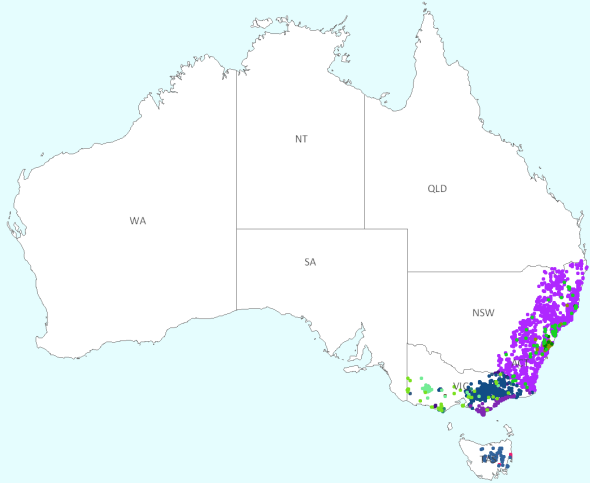
Chital deer



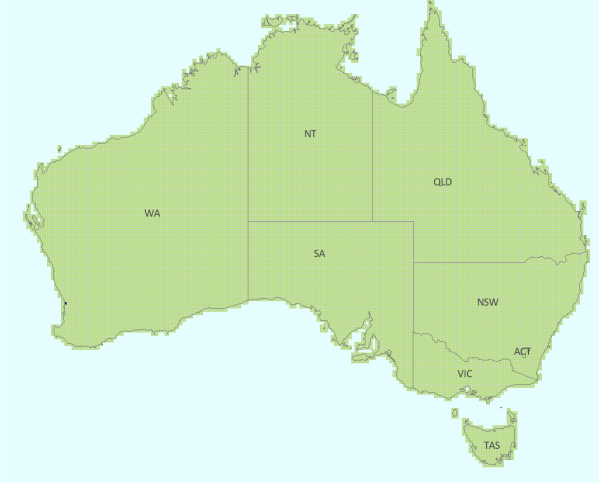
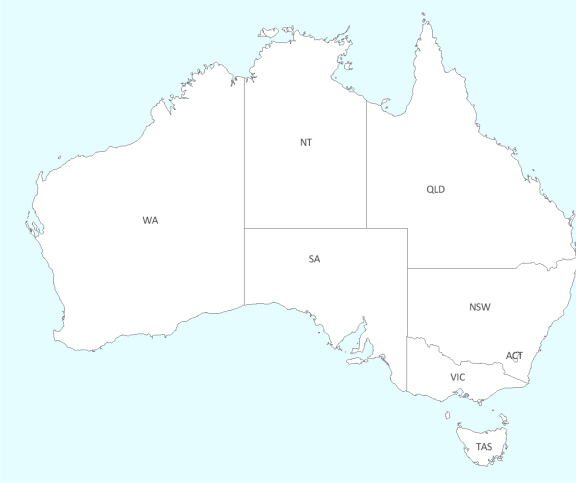
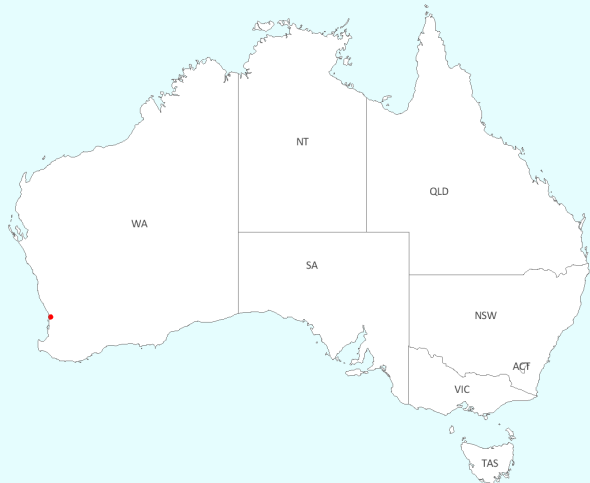
Hog deer



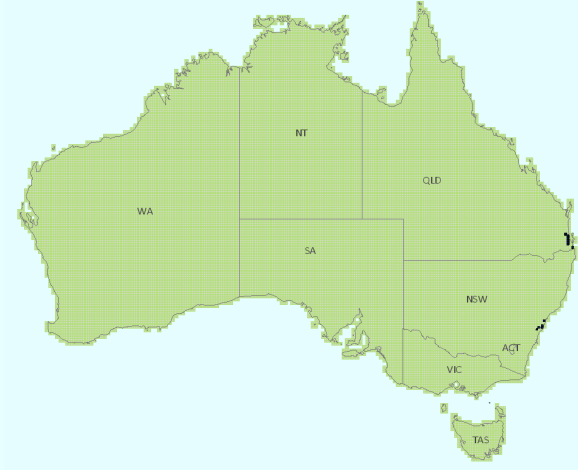
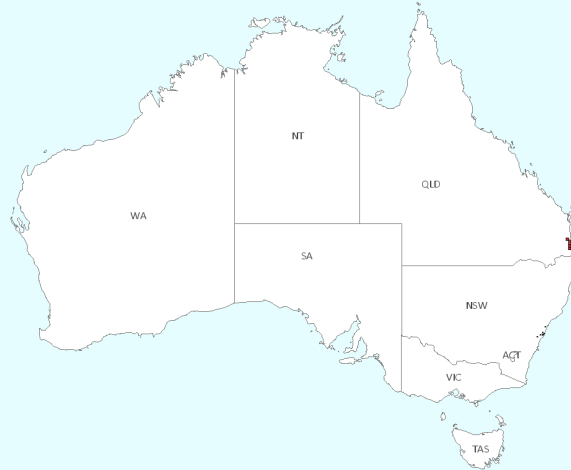
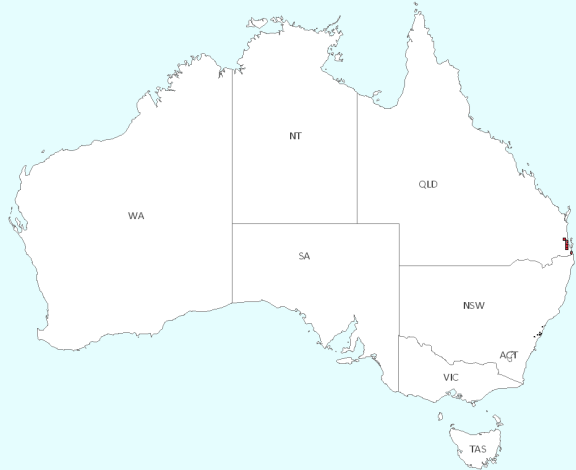
All deer species occurrence data



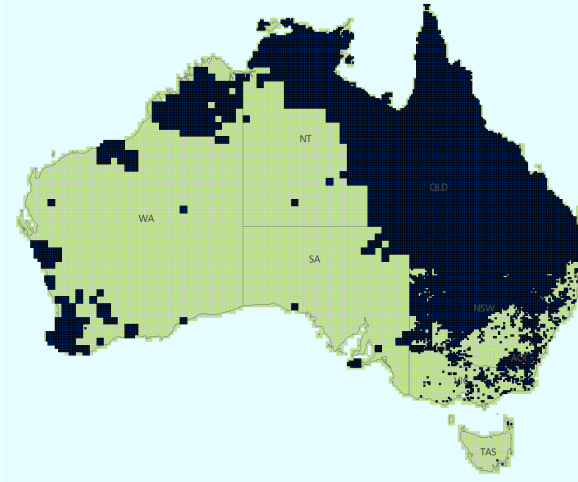
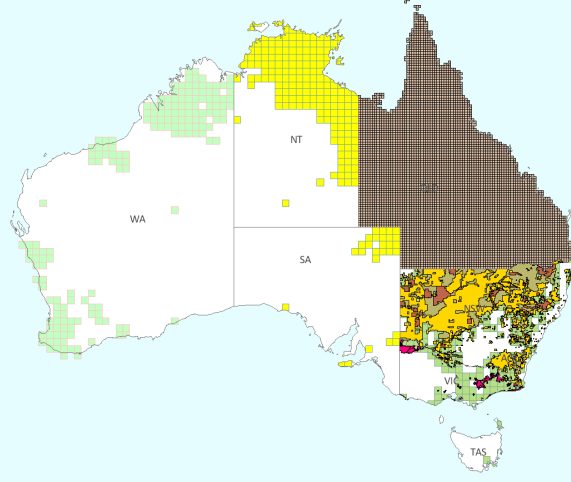
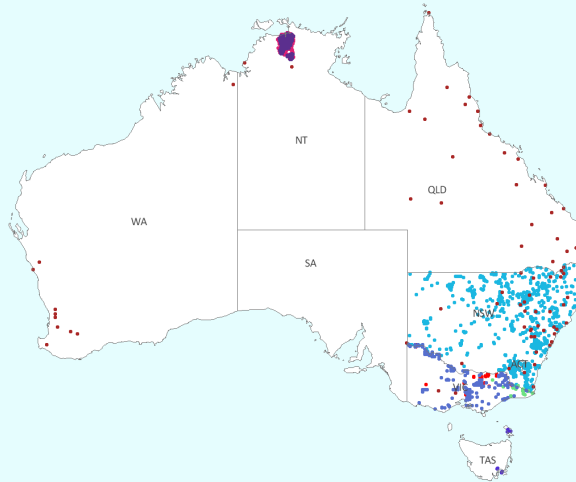
Indian palm squirrels



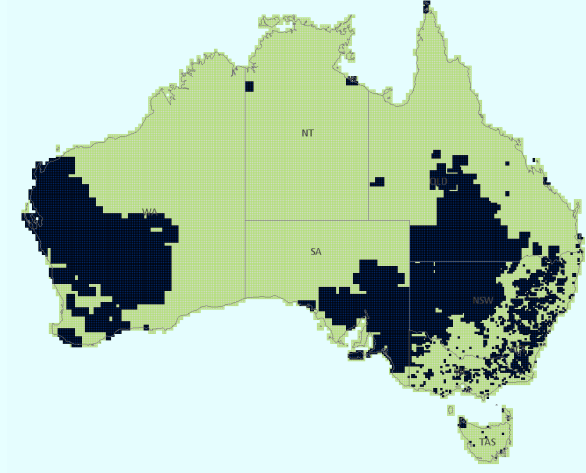
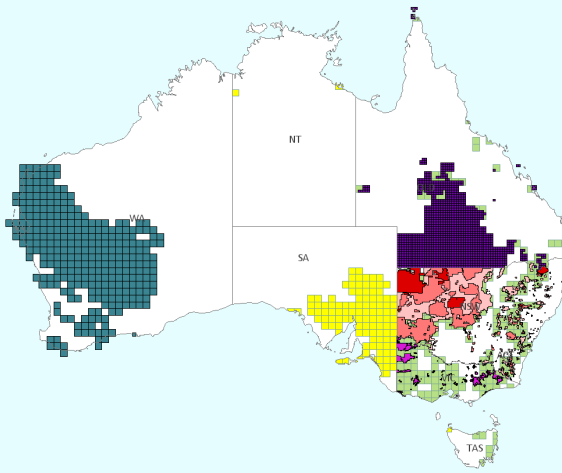
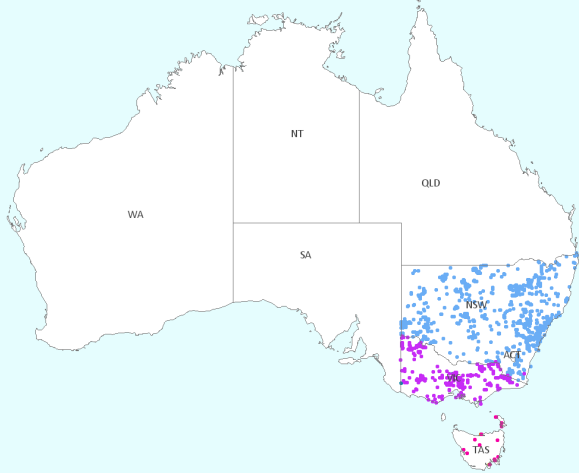
Red-eared slider turtles



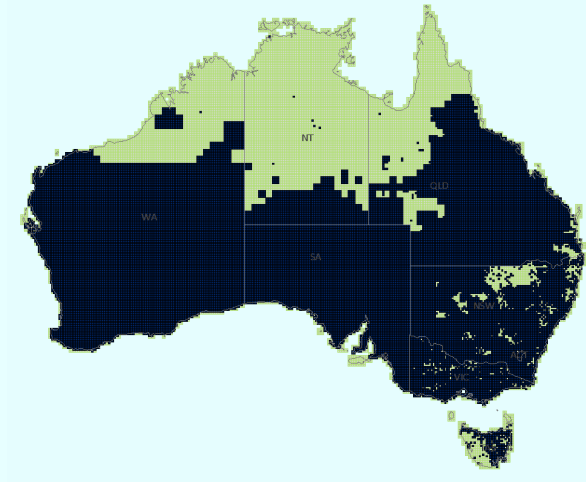
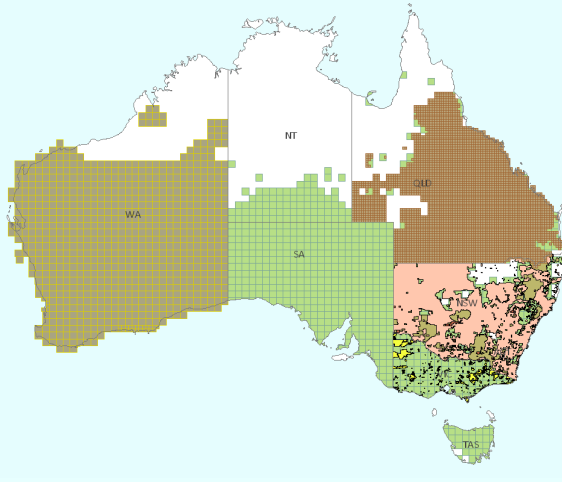
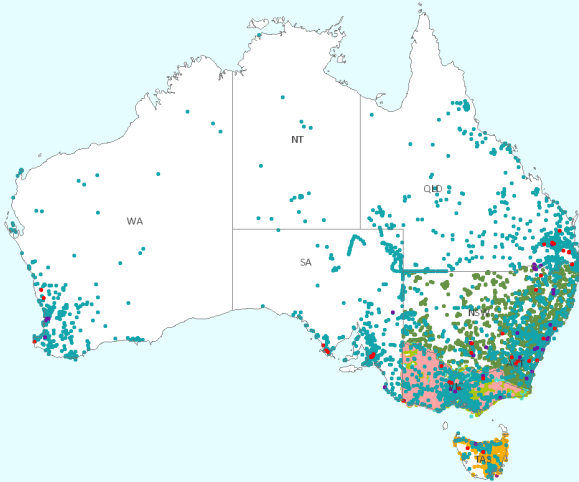
Feral pigs



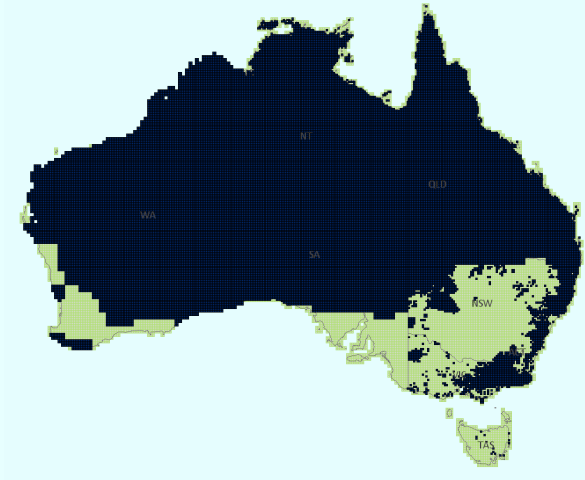
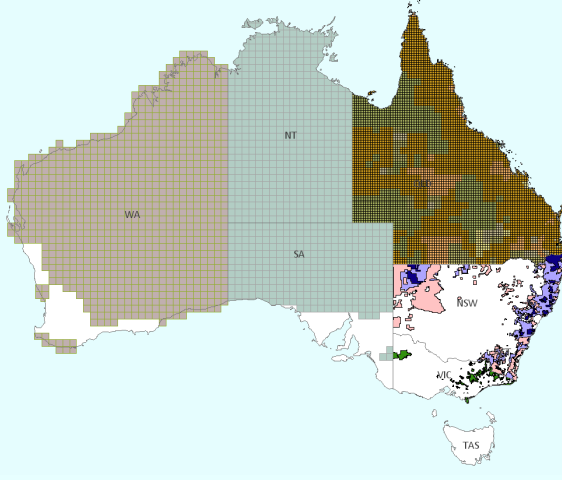
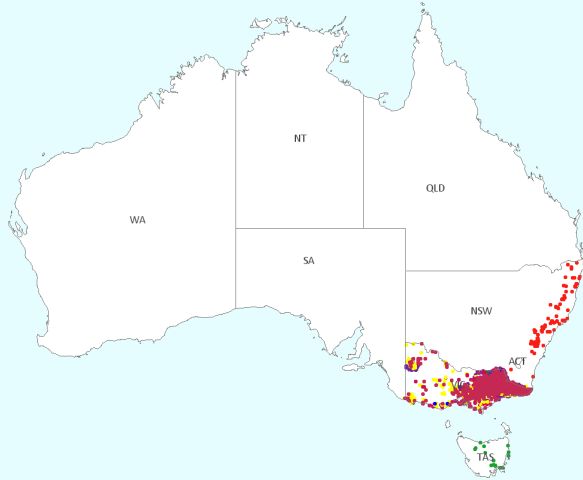
Feral goats



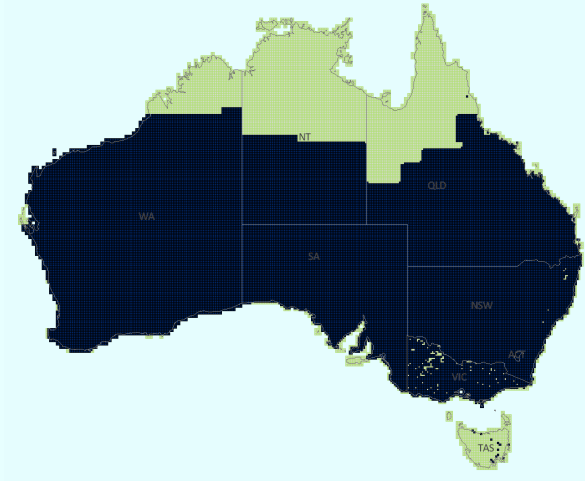
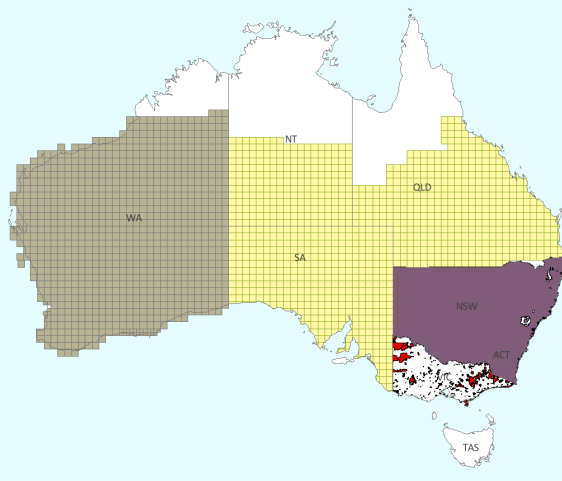
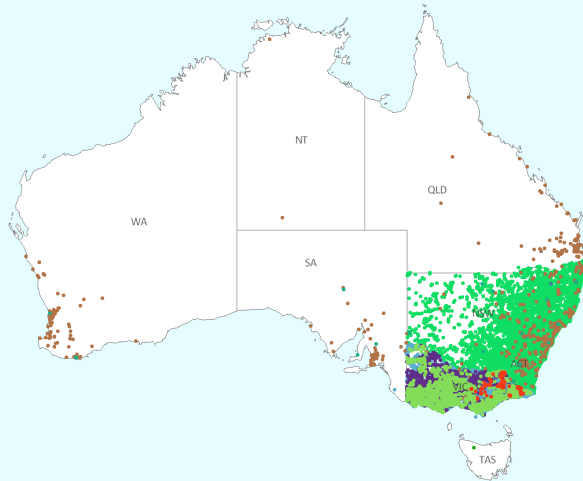
Rabbits



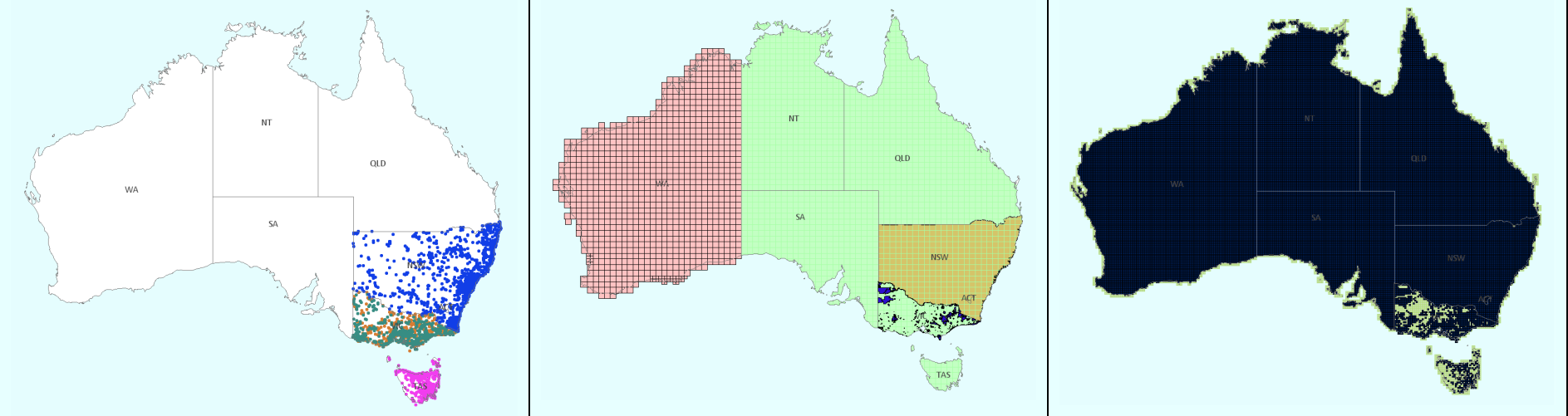
Wild dogs (including dingoes and hybrids)



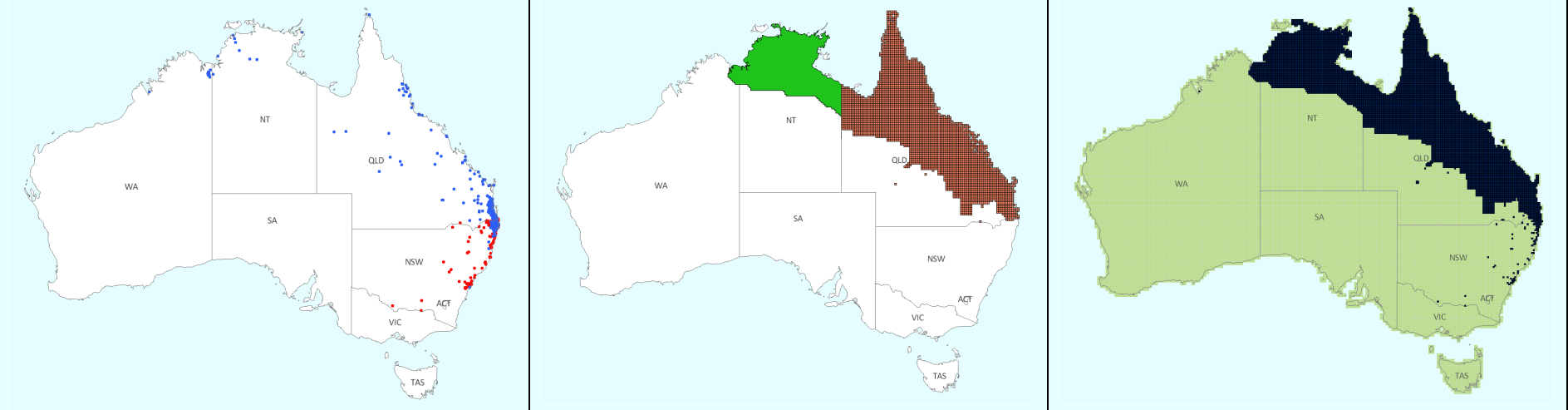
Foxes



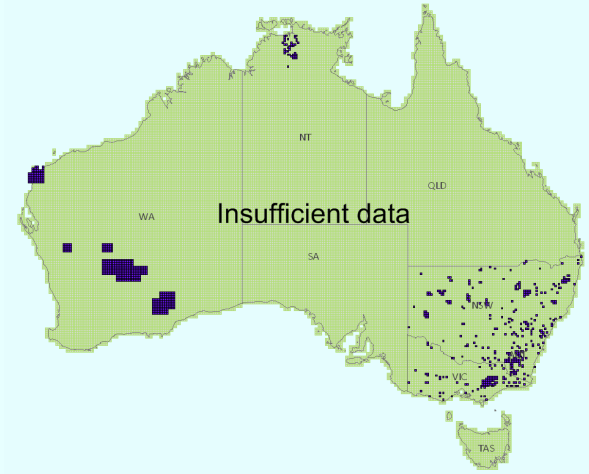
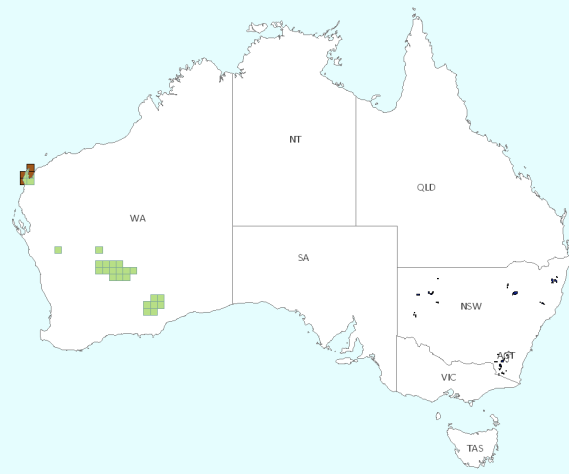
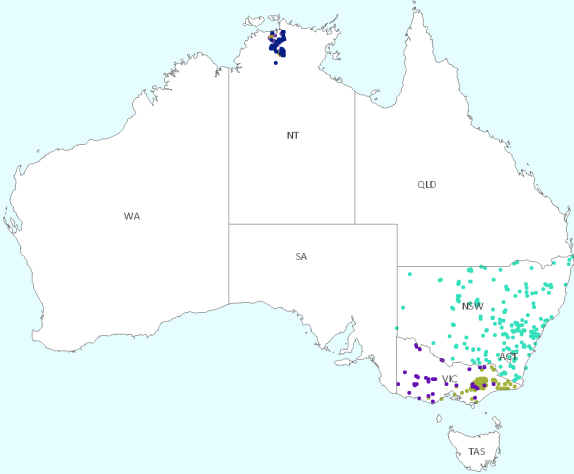
Feral cats



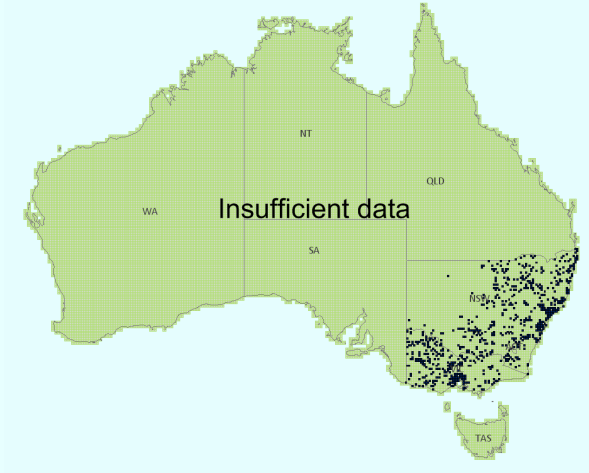
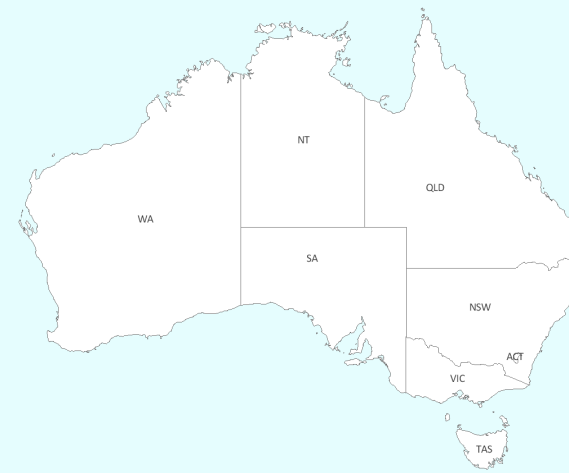
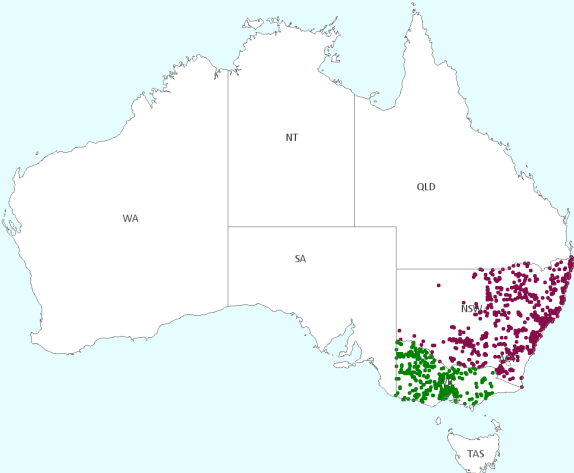
Cane toads



Feral livestock (feral cattle and feral sheep)



Brown hare / European hare



Ferret / Polecat

