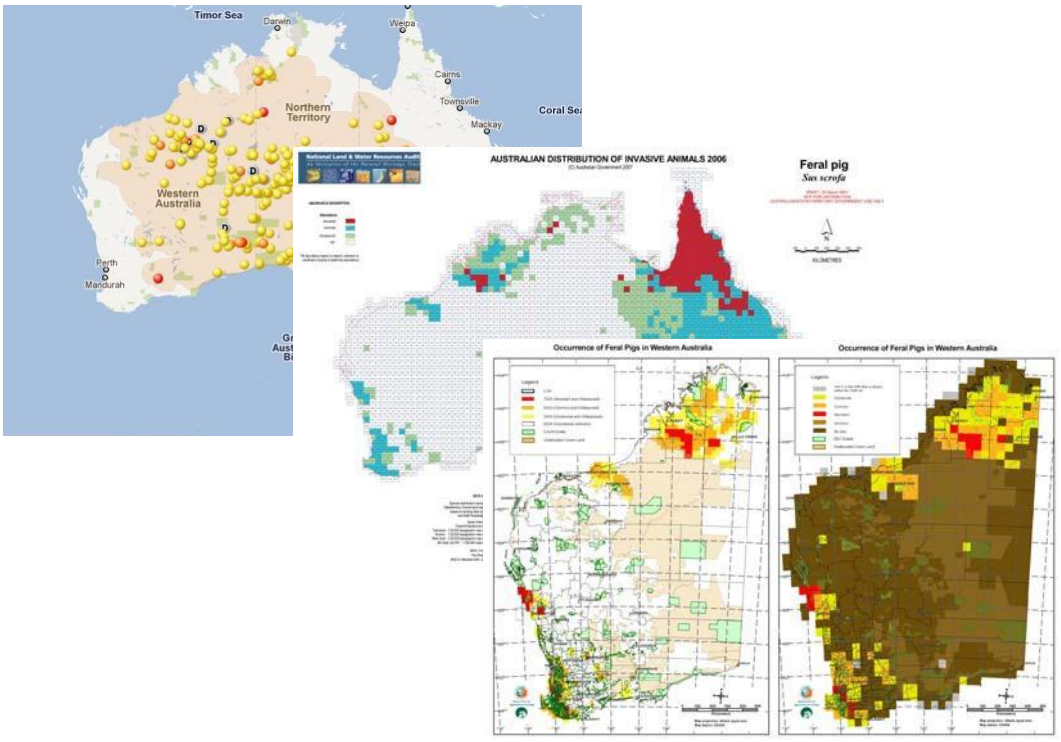
Evaluation of Spatial Data Capture and Information Systems for Invasive Species Management

Final report



Prepared by Mark Sander and Damian Shepherd

Department of Agriculture and Food WA

October 2011

This project was funded by the Australian Government through the Australian Pest Animal Research Program (APARP)

APARP is funded through the Department of Agriculture, Fisheries and Forestry and administered by the Australian Bureau of Agricultural and Resource Economics and Rural Sciences (ABARES, formerly Bureau of Rural Sciences).

Australian Government
Australian Bureau of Agricultural and Resource Economics and Sciences

Invasive Animals CRC

Department of Agriculture and Food

Document title:
Evaluation of Spatial Data Capture and Information Systems for Invasive Species Management - Final report.

Report prepared for the Australian Pest Animal Research Program (APARP).

Published by: Department of Agriculture and Food Western Australia
Postal address: Locked Bag Number 4, Bentley Delivery Centre Western Australia 6983
Office Location: 3 Baron-Hay Court, South Perth Western Australia 6151
Telephone: +61 8 9368 3333
Facsimile: +61 8 9368 3925
Email: gis@agric.wa.gov.au
Internet: http://www.agric.wa.gov.au

Cover images: Camel and feral pig distribution and density maps (2006 – 2011) produced for the National Land and Water Resources Audit, FeralScan project and Department of Agriculture and Food Western Australia.

This document should be cited as: Sander, M. and Shepherd, D. 2011. Evaluation of Spatial Data Capture and Information Systems for Invasive Species Management - Final report. Department of Agriculture and Food Western Australia.

Contents

Table of Figures

List of Tables

Acknowledgements

We would like to thank the following people for their attendance at the workshops and contributions to the stock take and assessment of databases and information systems in their jurisdiction:

Victoria
John Burley, Grace Grech, Andrew Hodges, Hamish.Hurley, Sean Kelleher, David Mifsud, Ruth Myers and Nigel Ainsworth (Department of Primary Industries Victoria), Kelly Raymond and Timothy Varcoe (Parks Victoria), Adrian Moorrees and Anne.Dennis (Department of Sustainability and Environment).

Queensland
Moya Calvert (Pest Information Systems, Invasive Plants and Animals, Biosecurity Queensland, Department of Employment, Economic Development and Innovation), Roxanne Blackley (Queensland Murray Darling Committee), Rob Hassett, John Mathews (Queensland Parks and Wildlife, DEEDI), Jason Reberger (Department of Environment and Resource Management), and Lee Blacklock (Queensland Regional NRM Groups Collective).

Northern Territory
Anne Walters (Department of Natural Resources, Environment, The Arts and Sport - Parks and Wildlife Division), Keith Saalfeld (NRETAS - Biodiversity Conservation), Alaric Fisher (NRETAS - Biodiversity Conservation), Yusuke Fukuda (NRETAS - Biodiversity Conservation), Gay Crowley (NRETAS - Natural Resources Management Board), Chantal Bramley (NRETAS - Natural Resources Management Board), Chris Dale (Australian Quarantine and Inspection Service) and Robyn Maurer (Department of Defence, Darwin)

South Australia
John Virtue, Mark Biosecurity and Tim Reynolds, Mark Ramsey, Peter Buxton, Mike Fleming, Mark Williams and Shauna Potter (Primary Industries South Australia), Chris Auricht (consultant).

New South Wales
Robyn Henderson and John Tracey (Department of Industry and Investment NSW), Peter West (DII NSW and CRC for Invasive Species).

Tasmania
Rhys Stickler and Andrew Bishop (Department of Primary Industries, Parks, Water and Environment, Tasmania).

Western Australia
Andrew Woolnough (formerly with Department of Agriculture and Food), Andrew Reeves (DAFWA), Tony Leeming (DAFWA), Jason Batory (DAFWA), John Bruce (DAFWA), Mitchell Davies and John Asher (Department of Environment and Conservation).

Commonwealth
Jeanine Baker and Michael Cole and (Department of Agriculture, Fisheries and Forestry), Joanne Banyer and David Miron (ABIN).

Executive Summary

The primary objective of this project was to document and compare information systems currently available, or with the potential, to collect and share of data on the distribution, abundance and management of invasive animal species in Australia. This project addresses the goals and objectives of the Australian Pest Animal Strategy (APAS) by: Supporting national consistency in information collection and reporting; and providing effective tools for managing data and information on national significant invasive species.

A comparative assessment of some fifty information systems and databases from across every Australian State and Territory was conducted with reference to a triple bottom-line framework – meaning the assessment took into account:

i) the role of people (the public, Regional NRM groups, and agencies) in collecting and sharing data;

ii) effectiveness of information systems in understanding pest animal distribution, abundance and impacts; and

iii) opportunities for improving the efficiency and cost effectiveness of data collection and management through the use of these information systems.

This results of this project clearly demonstrate that a wide variety of information systems continue to be used to collected, manage and share data and information on invasive species across Australia; and that a significant number of new systems are currently being planned and/or developed using a wide range of technology.

However, it is clear that the technology that is underpinning the development of many of the new or upgraded systems also provides means through which long-standing issues impacting the ability to share this information, such varying standards and formats, may be overcome.

A series of recommendations are made to address both the ongoing issues in collecting and managing data highlighted by this project, and the opportunities that rapidly evolving technology provides in addressing these issues.

These are that:

1) Projects funded or otherwise supported through Commonwealth programs should clearly identify a mechanism through which any new data on invasive species distribution, abundance and impacts collected or managed in these systems will be made accessible to other systems. This may be via web services in the case of new or re-developed information systems funded by the Commonwealth, or through transfer to an information system that can make these data available e.g. via web services.

2) Projects funded or otherwise supported through Commonwealth programs that involve the collection and/or management of data on the distribution, abundance and impacts of invasive species should record data in a form consistent with a recognised attribution standard (see Table 6 and Recommendation 3), or (where this is not possible) provide a means through which the data collected can be translated to a common standard.

3) Further work be undertaken by sectoral commissions (particularly the VPC and AWC), or associated working groups, to identify a common set of core attribution standards between the standards identified in Table 6 to support Recommendation 2.

4) A set of guidelines consistent with recommendations 1, 2 and 3 be developed at the national level for the collection of data on the distribution, abundance and impacts via crowd sourcing. These guidelines should address the management of personal information, the use of collection standards to facilitate the use of these data by other systems, and the protection of the rights and interests of individuals to the use and enjoyment of land.

1. Introduction

1.1 Background

A number of information systems for the collection and management of invasive species data and information are currently being used, or are in various stages of development, across Australia. Information systems have been used since the 1980's to record, analyse and share data and information on invasive species at a range of scales – from local or regional scales, through State and Territory, to the national continental scale.

Although there has been significant work in recent years to promote the need for consistent collection of data on invasive species distribution abundance, impact and management through initiatives such as the National Land and Water Resources Audit (NLWRA) – the proliferation of new information systems, particularly at regional scales, presents a growing challenge in ensuring the data collected can be used consistently at a range of scales to effectively to monitor existing and emerging pest animal threats, and develop effective management responses to these threats.

The NLWRA represented the first attempt in Australia to develop a nationally consistent approach to managing these data and information, through development of a National monitoring protocol for monitoring and reporting on the extent, distribution and abundance of significant vertebrate pests. This was developed under the National Heritage Trust monitoring and evaluation framework.

The Beaten Track Group (2004) reviewed potential sources of information to support reporting on the national indicators. At that stage only two national-scale datasets for each of vertebrate pests and weeds were identified (based on feral animal and weed density), augmented by 16 other datasets that provided context e.g. mean annual and monthly rainfall.

In 2006, the Vertebrate Pests Committee, which operates in accordance with terms of reference defined by the Natural Resources Management Standing Committee and reports through the Natural Resource Policies and Programs Committee, endorsed two national indicators for invasive vertebrate pest animals to guide monitoring and reporting activities. They were:

1. Distribution and abundance of significant invasive vertebrate pests, and

2. Impacts of significant invasive vertebrate pests - measured in terms of environmental, economic and social impacts.

At this time, Land and Water Australia (through the NLWRA) and the Cooperative Research Centre for Invasive Animals coordinated a national project to address fundamental information needs and collect, collate and centralise information on invasive animals throughout Australia. This project informed the National Natural Resource Management Monitoring and Evaluation Framework (NM&EF). Under the NM&EF it was recommended that information be collected on the 'extent and impact of selected ecologically significant invasive vertebrate species'

Paping (2006) conducted a review of invasive species information systems, identifying the key information sources in each jurisdiction and summarising the technical approaches used to capture and manage data through these systems.

A national workshop was also conducted in 2006 by the NLWRA and Cooperative Research Centre for Invasive Species (West, Auricht, Franco and Alexandra 2006) to consolidate advice in relation to Invasive Species (Weeds and Invasive Animals) Indicators under the NM&EF. An important issue raised at this workshop was the need to resolve cross State/ data-access and exchange arrangements and the issues surrounding reporting of information to the NLWRA with their respective data managers.

In 2006 the first consistent national seamless national datasets for 10 nationally significant vertebrate invasive species were generated on a 0.5 degree grid. These information products were built-up through a series of information products collated at the State / Territory, and regional NRM scales – based on a data from a number of the information systems identified earlier.

In 2008 the NLWRA published a report on the status of information for reporting against invasive species indicators under the National Natural Resource Management Monitoring and Evaluation Framework (National Land and Water Resources Audit 2008). It was noted at this time that there was need to address gaps in knowledge of the occurrence and impacts of new and emerging invasive species. This report included a list of information systems, based on the previous work of Paping (2006), which has been expanded through this project.

“A collaborative approach to collecting, collating, analysing, storing and sharing biosecurity information to improve decision making and enhance operational efficiency” has been recognised in the Intergovernmental Agreement on Biosecurity (IGAB). In late 2009 the National Biosecurity Committee (NBC) endorsed the National Biosecurity Information Management Conceptual Framework developed by the Jurisdictional Information Needs Working Group. The NBC also requested that sectoral committees, such as the Vertebrate Pests Committee (VPC) and Australian Weeds Committee (AWC) refine the Framework for their respective sectors to guide information or data collection and management in each sector.

With the closure of the NLWRA and subsequent implementation of the Caring for our Country - Monitoring, Evaluation, Reporting and Improvement (MERI) Strategy, a number of new priorities for investment have been identified, including Biodiversity and natural icons – and specifically ‘tackling weeds and pest animals that threaten biodiversity’.

The Caring for our Country Business Plan 2011-12 includes support for projects consistent with the Australian Pest Animal Strategy (APAS). This project has been funded under the APAS to address the ongoing challenge of consistently managing data on the distribution, abundance and management of invasive animal species in Australia.

1.2 Project objectives

The primary objective of this project was to document and compare information systems currently available, or with the potential, to collect and share of data on the distribution, abundance and management of invasive animal species in Australia.

This comparative assessment was conducted with reference to a triple bottom-line framework – meaning the assessment took into account:

i) the role of people (the public, Regional NRM groups, and agencies) in collecting and sharing data;

ii) effectiveness of information systems in understanding pest animal distribution, abundance and impacts; and

iii) opportunities for improving the efficiency and cost effectiveness of data collection and management through the use of these information systems.

A 'stocktake' was undertaken of currently used information systems, and assessment of these against these triple-bottom-line criteria. The driver of investment in Natural Resource Management through Caring for our Country program provides an imperative for such as assessment so future investment can be more effectively targeted.

This project addresses the goals and objectives of the Australian Pest Animal Strategy (APAS) by: *Supporting national consistency in information collection and reporting; and providing effective tools for managing data and information on national significant invasive species.* Specifically this project aims to address Objectives 1.3, 2.2, 3.1 and 3.3 of the Australian Pest Animal Strategy (APAS), see Table 1.

Outputs from this project described in this report are:

1. A summary and comparative assessment of currently available and developing information systems;

2. Stakeholder workshop outcomes reports; and

3. A report on outcomes of recent projects – including recommendations for the use of BioSIRT in invasive animal species surveillance.

4. Recommendations for better focussing resources across jurisdictions to provide information systems that help address the highest priority pest animal problems;

Outcomes expected from this project are:

- Improved understanding of currently available, and practical, potential information system that can be used to respond effectively to new exotic species incursions across Australia; and

- Information to support the development of guidelines for utilising existing and developing information systems to support reducing the impact of pest animals of national significance.

In delivering these outputs and outcomes this project aims to deliver the following benefits:

- Standardised methods for the collection, collation, storage and reporting of animal pest related information at different levels e.g. state and national based on a paradigm in which the states are the custodians of their own datasets;

- Improvement in the capacity for multiple users of invasive species - related information to use the same data for numerous purposes; and

- Guidance for policy and program development at scales that allow priorities to be set and outcomes measured against those priorities e.g. the MERI framework

In summary the project aims to inform future planning for the development and implementation of information systems used to manage animal invasive species and their impacts at the local, regional, State and National scales.

Table 1. How this project aligns with the Australian Pest Animal Strategy (APAS)

Goal	Objective	Actions	Outcomes	Current Project
1. Provide leadership and coordination for management of pest animals	1.2 To ensure nationally consistent pest animal management approaches are in place at all scales of management.	1.2.3 Develop nationally consistent codes of practice and standard operating procedures for pest animal management.	Nationally-consistent and regionally appropriate approaches to guide pest management.	Review current Regional, State and National information systems and highlight opportunities / barriers for sharing of data.
2. Prevent establishment of new pest animals	2.2 To ensure early detection of, and rapid response to, new incursions of exotic animals.	2.2.3 Establish and maintain nationally consistent processes for surveillance, reporting and identification of new invasive species incursions.	Australia has nationally coordinated procedures to respond effectively to new exotic species incursions.	Contribute towards the development of a more consistent approach to information sharing.
3. Manage the impacts of established pest animals	3.1 To identify established pest animals of national significance.	3.1.1. Identify established pest animals of national significance as the subjects of nationally coordinated action.	Resources are focused on addressing the highest priority pest animal problems.	Identify and document species for which data and information is collected in invasive species information systems across Australia.
	3.3 To coordinate management of established pest animals across Australia.	3.3.1 Develop national guidelines for managing pest animals of national significance.	The impacts of pest animals of national significance are reduced.	Make recommendations regarding ongoing efforts to improve the national coordination of data collection and sharing through information systems.

2. Methods

2.1 Reference Groups

In order to ensure the outputs from this project are as complete as possible, and that they represent a true picture of arrangements in each jurisdiction, early contact was made with key personnel in each jurisdiction. These personnel are variously involved in existing working groups established through the National Biosecurity Committee e.g. Vertebrate Pests Committee (VPC), Australian Weeds Committee (AWC), Jurisdictional Information Needs Working Group, AWC/VPC National Indicators Working Group and/or were identified as being responsible for the implementation of key information systems in each jurisdiction. These individuals are individually acknowledged in this report.

2.2 Rapid Assessment and Literature Review

A rapid assessment and literature review was conducted early in the project in order to scope the range of databases and information system that are deployed for managing invasive species; and to identify any significant trends in how these have been taken-up, and continue to evolve with regard to rapid changes in technology. This review considered:

1) The current state of invasive species databases and information systems across the various Australian jurisdictions; and

2) Current and emerging trends in the evolution of database and information systems technology as demonstrated through more recent projects.

The rapid assessment and literature review was carried-out principally by reviewing the previous research work funded and conducted by the National Land and Water Resources Audit, the Australian Pest Animal Research Program (APARP), and the Cooperative Research Centre for Invasive Animals, reviewing relevant conference proceedings; and through on-line searches for relevant research publications and media releases by the various biosecurity agencies and groups across the Australian jurisdictions.

Table 2. Main sources of information for the rapid assessment and literature review

Source of Information	Information referenced
Paul Paping (2006) Invasive Species Information Systems NLWRA	Starting list of information systems and comparison material for changes since 2006
Australian Pest Animal Research Program publications	Listing of information systems and vertebrate pest spatial analysis usage
Vertebrate Pest Research Publications	Vertebrate pest spatial analysis trends and usage
State and Territory government websites	Departmental information and publically accessible web interfaces

The findings of the rapid assessment and literature review are described in section 3.1, which highlights the variation in approaches to managing data on invasive species, and identifies the key trends in how these systems are evolving with changes in technology.

2.3 Jurisdictional Workshops

Following the review of the initial rapid assessment report by the Project Reference Group a series of jurisdictional workshops - involving representatives from State agencies and Regional natural resource management groups and other local organisations as appropriate – were held to validate and expand on the findings of the rapid assessment, and capture further information required for a more detailed comparative assessment of currently available and developing information systems. A summary of the findings of these workshops is provided in Section 3.2 of this report.

Through these workshops, and follow-up discussion with jurisdictional contacts, the potential of current, or planned, information systems to address the following requirements was assessed in consideration of the context in which these systems have been developed and are operated, and a range of capabilities including:

1) The scope of information recorded (**Records**): Geo-temporal (GT) species point observations for native and pest plant and animal species;

2) The specifications of the **Database** used to record this information;

3) The process through which these data are recorded, including who captures the information (**Recording of data**);

4) The **Reliability** of the information captured; and

5) The technical approach (**Interface**) used to capture and deliver data and information to users.

This information provided important context on each information system for the comparative assessment, discussed further in section 2.4.

2.4 Comparative Assessment

Information systems for managing data and information invasive species have been established for a very wide range of business applications and user groups e.g. park rangers, local government officers and community groups. The requirements for collecting, managing and sharing within and between these users are, then, often very different – resulting in a great diversity of information systems in terms of technical architecture and function. Those that design these information systems also have a wide range of software and development environments (technology) from which to choose in designing and implementing a system, and this technology is evolving rapidly over time.

For these reasons, it was important to apply a series of objective criteria and rating scales when comparing information systems for the purposes of this project. These criteria and scales to not attempt to rate the quality of the design or architecture of each system. Rather, the approach taken is designed to indicate the scope of each information system in terms of its ability to manage information for a variety of business applications in invasive species management, and to highlight the similarities and/or differences between each information system as an approach to understanding the opportunities and limitations of using information from each system.

The criteria and rating scales applied are described below:

1) **Reporting** – the capability of each information system to generate reports on the data managed, rated as follows: 1-No reporting; 2-Ad-hoc project reports only; 3-Ad-hoc regional or State-wide reporting; 4-Dynamic project reports; and 5-Dynamic regional or State-wide reports.

2) **Mapping** - the type and complexity of location-based information captured through each information systems, rated as follows: 1-No location information; 2- Captures coordinates/addresses only; 3-Captures points, lines, polygons; 4-Dynamic capture of cords; and 5-Dynamic capture of points, lines, polygons.

3) **Analysis** – the capability of each information system to carry-out analysis of the data captured and managed through each system, rated as follows: 1-No analysis applied; 2-Ad-hoc extraction of data for analysis; 3-Automated extraction of data for analysis; 4-Ad-hoc analysis embedded; and 5-Dynamic analysis embedded.

4) **Potential for biased observations** – the susceptibility of each system, or the data managed in each system, to bias through the source and/or methodology used to capture data, rated as follows; 1-Relatively small number of records, no formal sampling strategy; 2-Relatively large number of samples, but no formal sampling strategy applied; 3-Comprehensive survey, but no formal sampling strategy applied; 4-Sampling strategy applied; and 5-Sampling strategy carefully designed to avoid bias.

5) **Gap filling (Occurrence)** – the potential for the data and information managed in each system to address gaps at a local, regional or broader scale in terms of invasive species distribution and abundance, rated as follows: 1-Data limited to local area/s only; 2-Data has regional or State coverage, but limited sample; 3-Comprehensive data over local area/s only (could be used to fill local gaps); 4-Data has regional or State coverage, but limited to a single time period; and 5-Extensive coverage and recorded over multiple time intervals.

6) **Gap filling (Impacts)** – the potential for the data and information managed in each system to address gaps in terms of the impacts of invasive species at a local, regional or broader scale, rated as follows: 1-Data limited to local area/s only; 2-Data has regional or State coverage, but limited sample; 3-Comprehensive data over local area/s only (could be used to fill local gaps); 4-Data has regional or State coverage, but limited to a single time period; and 5-Extensive coverage and recorded over multiple time intervals.

7) **Modeling** – the potential for the data and information managed in each system to be used to model the future distribution, abundance and/or impacts of invasive species, rated as follows: 1-Data cannot be used to map occurrence; 2-Data can be used to map current occurrence only; 3-Data can be used to map occurrence and density; 4-Data can be used to map current occurrence and density over time; and 5-Data currently used to model and predict occurrence.

In summary, lower scores generally indicate that an information system has a relatively narrow business focus, limited functionality to support this function and/or has been used to capture a relatively small number of records, or data that has limited value for other applications. It is important to note that these scores are not a reflection of the quality of the design or implementation of each system, or the quality of the data recorded in each system.

Section 3.3 provides a detailed assessment of each system according to the criteria discussed above. The implications of these assessments, with regard to the potential to leverage the information systems and/or the data in each system for broader applications in invasive species management, are summarised for each system in this section as a basis for the review in section 4, and recommendations in section 5.

3. Results

3.1 Rapid assessment and overview

The rapid assessment highlighted two main themes in terms of the development and diversity of information systems used to manage invasive species in Australia:

1) the current state of database and interface technology as relevant to invasive species databases; and

2) the current state invasive species databases across the various Australian jurisdictions.

In the four years since the last review of Australian systems (Paping 2006), the technology available has advanced significantly, while many of the systems identified by Paping and used by the various Australian jurisdictions have remained in place, with some enhancement of functionality and the implementation of new user interfaces. Several State agencies have plans to build new systems or new interfaces for existing systems, but only some of these have been funded and/or are currently being implemented as of mid-2011. These are identified individually in section 3.

Since 2007 a significant effort across all States and Territories has been invested in the implementation of BioSIRT (Biosecurity Surveillance, Incident Response and Tracing). This program has moved from the a development and planning phase in the mid-2000's to testing and implementation through standardised templates for various biosecurity business application – including the management of invasive species. Victoria is not implementing BioSIRT; however this jurisdiction has invested significant resources in development of its own biosecurity information management framework through the development of BioWeb and allied applications such the Invasive Species Information System (ISIS), and is establishing mechanisms through which standardised data can be exchanged with BioSIRT when working with other jurisdictions.

Although this project is focussed on information systems used to record and manage information about pest animal species, it became evident through the initial rapid assessment and literature review that the systems used to manage both animal and plant invasive species are often integrated and/or closely associated. For this reason a number of systems that are primarily used to manage plant pest data (primarily for weed species) have been included in this review and assessment. Where these systems have been included, this is clearly indicated in the descriptions in sections 3.2 and 3.3.

Identifying and comparing the various databases and information systems used to manage pest animal species across the country has required working closely within each jurisdiction the relevant government departments and other organisations (such Catchment Management Authorities of Natural Resource Management groups) that are responsible for managing invasive species; and in particular people in a diversity of roles that are developing, managing and using these information systems. This work could not have been completed without the support and advice of the project reference group members, who were able to offer advice on which agencies and which people within these organisations to contact for the relevant information.

3.1.1 Databases & information systems

Currently the States and Territories of Australia operate numerous animal pest management databases, often developed independently to meet the legal and operational requirements of the Government agency responsible for pest management in that jurisdiction. Paping (2006) identified three main components in the structure of invasive species databases: Access, Storage and Interface. These are discussed in sections 3.1.1.1 through 3.1.1.3, below.

3.1.1.1 Information access

The three types of database access used in Australian invasive species databases are stand-alone, networked and web-based.

Stand-alone databases usually run both a computer application and database stored on the user's computer. The benefit of this approach lies primarily in portability; useful as a significant amount of invasive species management work is undertaken in remote and regional areas, and low operating costs, as constant access to the internet or an agency's internal network is not required (Paping 2006).

However, this approach also has a number of drawbacks, including:

- Version control, of both the application and the database structure. Especially when the database is still being developed, or new features are being added.
- Reference consistency, of historical records and reference data for a region.
- Collation, the more copies in use the more difficult it is to collect all the data reliably for use by the supporting agency. Data may be lost altogether if a staff member leaves, or a computer is corrupted or lost (Paping 2006).

Networked systems databases are usually stored centrally on a network server and users access the database across the government agency's internal network. Web accessible databases work in a similar way, except that the interface is accessed via the Internet using an internet browser (Paping 2006). Over the past several years, this approach has been extended further into the 'cloud' computing environment; through which both the database and the application itself is accessed by the user remotely from the internet (the 'cloud'). In this approach, the application and database/s may be hosted virtually anywhere in the world, providing an opportunity to leverage large scale server and computer storage infrastructures.

The main benefit of a networked system is that all users have access to the same data, without having responsibility for managing versions, collation, storage and updating reference datasets. The principal disadvantage is the cost and difficultly of accessing the database while away from office infrastructure, especially in regional and remote areas.

From an operations perspective, the major difference between a networked and a stand-alone database system is that adding more users to a networked database can result in significantly lower operational costs per user. Conversely, adding more users to a collection of stand-alone databases usually increases the operational cost per user of collating and managing the data and database structure. Setting up a networked database costs more than distributing copies of a stand alone database; however in the longer-term the coordination and collation of information is more sustainable where an organisation has large numbers of disparate users.

3.1.1.2 Storage

The two main types of database storage used in Australian pest management databases are relational databases and flat-structure databases.

A flat-structure database is a plain text or mixed text and binary file which usually contains one record per line, and has a single table structure. The most basic form is the spreadsheet. Flat databases are useful for small datasets because of their simplicity of creation and use; however they are inefficient for large datasets because they duplicate data (Paping 2006).

Inefficient storage becomes an issue once the database file size reaches the point that accessing, saving and transmitting the database becomes difficult. This problem presents itself most commonly when attempts are made to collate the flat databases for state or national reporting and research purposes. The flat database structure can make this process very complex and time consuming as large numbers of records need to be filtered and manually cross-referenced to avoid duplication of data,

A relational database is organized and around the common characteristics of the records making up the database. The records are divided up into relational tables, reducing the number of times a single piece of information is recorded. This is a very efficient method of storing data and, properly designed reduces or eliminates duplication of data (Paping 2006). Most networked multi-user databases are relational databases.

3.1.1.3 Interfaces

The two forms of user interface for Australian pest management databases are Textual or a mixture of Textual and Graphical, where text forms are accessed via the graphical interface.

Textual data entry and access via a series of customised data entry and query forms is the standard for older vertebrate databases in Australia (Paping 2006). Recording of Geographical information has in most cases been added through the addition of coordinate recording or linking to a spatial database through a Property Identifier or other geographical record identifier. These are then displayed in another GIS program or web interface as points or polygons.

Many existing and developing pest management databases include the ability to record multiple points, lines and polygons through a graphical interface that may either be a desktop based or web based mapping program (Paping 2006). Most new initiatives in the field of vertebrate spatial data recording are based around web delivered interfaces.

There are several classifications of web maps in use around Australia, and individual web maps may use different elements of each for different layers of information presented.

The most basic level of web maps are static maps. They may be generated from static reference datasets, a pre-produced image, or a scan of a historical published paper map. Static maps are the oldest form of maps on the internet. They may be interactive, by including links to other sites or more detailed local maps (Kraak 2001).

Dynamic maps are created on demand from dynamic databases each time the user reloads the webpage. These databases can be populated either by users or automated sensors i.e. traffic maps, satellite imagery (Kraak 2001).

User populated ‘Collaborative’ or ‘Crowd Sourced’ web maps allow the public to add to or even edit the information stored in the database and displayed. Depending on the sophistication of the map the edits may be checked before being shared with all users. They are used to recruit members of the general public or communities of interest to assist in populating and maintaining datasets.

There are several different Desktop Geographic Information Systems (GIS) software platforms in use around Australia to manage or populate vertebrate pest databases. These include Esri’s ArcView and ArcGIS, MapInfo, SmallWorld GIS, and Intergraph’s GeoMedia. The main advantage of desktop GIS is its power to manipulate spatial data to better present it or analyse it for scientific purposes. That is one of the major reasons desktop GIS is still the main method used to analyse vertebrate pest data and generate vertebrate pest maps in Australia. The major disadvantage of desktop GIS is the high staff training costs to produce even basic maps or analyses, and the relatively high cost per PC software licence.

Desktop GIS is most effective for advanced manipulation of vertebrate pest spatial data rather than widespread common usage, while Web maps come into their own in terms of cost effectiveness for fast, standardised and easy access to pre-prepared map products by users.

3.1.2 Emerging trends and issues

Existing databases and interfaces used to record invasive species information by government departments around Australia cover the full spectrum of types and configurations described above.

Some databases are stand-alone, flat table, textual access only, researcher only populated. While at the other end of the scale some databases are fully networked, web accessible, relational table, with graphic dynamic maps and embedded forms, and populated by interested members of the public as well as government staff.

There are static compilations of maps, manually collected from numerous data sources and extrapolated to fill in gaps (West and Saunders 2006). Dynamic maps that display a layer of regulatory inspection data, that while constantly growing is not interpreted or extrapolated (De Milliano, Woolnough, Reeves and Shepherd 2010), and there are collaborative maps that display volunteer collected data, but don't attempt to interpret or extrapolate the results (RabbitScan Challenge 2009).

From this disparate collection of different philosophies and ages of technology there are several emerging trends for new or re-developed databases and their associated interfaces.

3.1.2.1 Web interfaces

The field of web mapping has advanced rapidly over the past fifteen years. Evolving from static depictions not much more advanced than the printed maps of the past few centuries, to dynamic collaborative maps with temporal and analytical capabilities at the cutting edge of technology.

Most of the newer information systems, or systems under development, incorporate the use of web interfaces to either access or enter data. This trend is being driven by a number of factors, including the increasing availability of access to affordable high speed broadband internet, and the relative economies of scale of a centrally served database that doesn't require software to be installed locally.

3.1.2.2 Visualising change over time

Currently comparison of vertebrate pest spatial data collected over time is done manually using desktop GIS or comparing static images. Temporal web maps have built in capabilities to allow users to view, compare and contrast spatial data at specific dates or time slices or over data ranges. The interface may also have the ability to animate the display of information to show changes over time, for example in the context of vertebrate pests the spread of an invasive species like Cane toads across Northern Australia. This enables visual analysis of patterns and changes over time that can then be followed up. This approach has been adopted by Google through Google Earth, and by the recently established Australian company *nearmap.com*. These companies have added a simple slide-bar function that enables users to quickly compare changes in satellite and aerial imagery visually.

3.1.2.3 Extrapolation of distribution

There is increasing use of sophisticated analysis of known pest vertebrate sightings and densities to extrapolate a species likely range and population density across the landscape. This is usually currently undertaken through the use of desktop GIS tools to overlay known populations of a species with as environmental variables such as precipitation, altitude, soils and topography etc.; statistically assessing which of those variables influence or limit that particular species distribution and how strongly they influence it (West and Saunders 2006, Cowled, Aldenhoven, Odeh, Garrett, Moran and Lapidge 2007, Rebelo and Jones 2010). After the factors are mapped and the population range and density extrapolated, ground truthing of the results from different modelling methods can be used to prove the model most suitable for a particular species (Rebelo and Jones 2010).

Developments in the analytic capabilities of GIS webmap packages are allowing dynamic extrapolation of population datasets to become easier and more widespread. This involves the automation of extrapolation algorithms and queries developed for invasive species, and visualising the results of this analysis through a dynamic web map that automatically updates as new information is added. This approach allows users to work on modelling invasive pests without the need to access relatively expensive proprietary desktop GIS software.

3.1.2.4 Community-based monitoring

Community Monitoring is increasingly being relied upon by researchers. It involves encouraging members of the public to organise, plan and execute monitoring activities, giving them a sense of responsibility. It also allows institutions to more effectively use limited funds for support, materials and professional staff (Thomas 2004). Community involvement also helps to build awareness and support of NRM issues in the wider community (Government of South Australia 2010).

3.1.2.5 Crowd sourcing data

“Crowd sourcing” refers to the displacement of the usual internally employed labour by soliciting unpaid help from the general public, usually motivated by curiosity or serendipity while browsing the web (e.g. online product reviews), but sometimes part of a larger effort, as in the case of RabbitScan (Quinn and Bederson 2009) – see http://www.feralscan.org.au/rabbitscan/. Crowd sourcing is distinguished by its use of volunteers to do explicitly defined tasks that take a small amount of time to complete. Volunteers generally have no obligation to continue (Quinn and Bederson 2009).

Crowd sourcing has evolved out of an older model of Community Monitoring, and differs from this older approach in that instead of community groups compiling data from members of the local community, individuals enter their raw data directly into an interface over the internet. Many of the issues involved with Community Monitoring remain true of crowd sourcing.

To make best use of Community Monitoring / crowd sourcing the user interface must be simple to use and reliable to encourage rapid uptake by the community of interest. Careful design of the project and website is required to drive support and usage beyond an initial novelty stage. For example, and important component of the Rabbit Scan and subsequent FeralScan projects has been the engagement of a communications manager to ensure a broad community is encouraged to get involved through publicity in local media – supported by a number of sponsors (Peter West pers comm.).

Crowd sourcing applications can provide a sense of ownership or accomplishment to participants by enabling users to see the results of their work instantly reflected in a map or statistics, and to produce summary reports that combine their data with that contributed by other. It is important to make sure that the recognition of contributions is explicit and, as far as possible, takes the form which means most to the data those participating in data collection (Grove-White 2005).

3.1.2.6 Increased Public Access

Public access to data through a user friendly interface is becoming more widespread to support raising awareness of pest management issues and enlist support in understanding the impacts of invasive species from a community perspective (Thomas 2004). Examples of this approach include the Northern Territories *N.T. Infonet* (http://www.nt.gov.au/nreta/wildlife/infonet.html) which encourages land managers to download an overview of the biodiversity values and threats for the land they manage.

3.1.2.7 Privacy Issues

Where government-held data on pest populations and distribution gradually is made more freely available to the general public, the associated issues and potential implications for individual privacy need to be carefully balanced with the public right to access these data. These issues are especially contentious where there are potential economic impacts. For example, information that indicates quantities of commercially valuable pest animals on a property (such as goats or camels) can impact interests in right of entry to crown lands; and information that indicates numbers of an agriculturally destructive pests on a property may potentially impact land transactions and the real or perceived value of properties (Woolnough, Gray, Lowe, Kirkpatrick, Rose and Martin 2005).

Managing privacy concerns can become even more difficult when the information in question has been sourced from the general public. The success of the crowd sourcing approach (see section 3.1.2.5) relies on establishing and maintaining a level of trust within a potentially broad community collecting data, and with organisations that use these data. A significant challenge in designing these systems is capturing an objective measure of the reliability of each record, often dependent on a self-assessment by those capturing records. Care also needs to be taken to address the potential for incorrect data (e.g. misidentification of a series invasive species) to be innocently or maliciously captured and/or misinterpreted by users.

3.2 Workshop findings

3.2.1 Background

Workshops for each jurisdiction were organised by first identifying government departments, regional NRM groups, community based organisations, and then specific individuals working within those organisations involved in vertebrate pest management. Key contacts in each jurisdiction were sourced from previous workshops funded by APAMP and the Invasive Animals CRC, or provided by the project reference group members and personal contacts lists of the project officers.

Workshops were then organised in those jurisdictions where there were more than one or two individuals or organisations involved in vertebrate pest management. Phone interviews followed up by email exchanges were used for the remaining states.

The structure of the workshops involved each participant discussing a series of pre-prepared questions about the vertebrate pest related databases and interfaces their organisation operated. Where representatives of some smaller organisations were not able to be present on the day, details were obtained by asking other attendees about other agencies systems and following up those details with phone interviews. Many attendees derived a lot of value from the opportunity to learn about the work going on in other agencies, and the data available from those organisations.

3.2.2 Overview of current and planned information systems

A total of 47 information systems used to manage invasive species and/or associated land management issues were documented across the Australian States and Territories; these are outlined in Table 3, below. Of these systems, 39 are concerned primarily with invasive animals, 5 primarily deal with invasive plant species, 20 systems are used to manage data on both invasive animals and plants, and 2 systems (South Australia's Primary Industries Information Management System and Victoria's Viridans Biological Databases) do not include information on invasive species; however these do include information related to the management of these species and have been included in the survey.

Four of the information systems were not assessed against the criteria described in section 2.4. The Victorian Biodiversity Atlas was in the early planning stages of development when this work was undertaken and requirements had not been specified sufficiently to enable an assessment to be made. RabbitScan has been integrated with FeralScan (which was assessed separately). As noted previously, the South Australian Primary Industries Information Management System and Viridans Biological Databases in Victoria do not currently include information on invasive species.

A number of the information systems included are not used to actively capture information on invasive species. Rather, systems like the Atlas of Living Australia, NT Fauna Atlas and Victorian Biodiversity Atlas provide, or plan to provide access to existing taxonomic-based records from a range of separate databases.

Specific information on the background, scope and architecture of each of these systems is provided in section 3.2.2.

Table 3. Summary of information systems reviewed through this project.

Jurisdiction	System name	Invasive Animals	Invasive Plants	Other data
National	**BioSIRT**	■	■	■
National	**FeralScan**	■		
National	**RabbitScan**	■		
National	**Atlas of Living Australia**	■	■	■
National	**CyberTracker**		■	■
New South Wales	**Insect and mite collection in Australia**	■		■
New South Wales	**New and Emerging Pest Reporting**	■	■	■
New South Wales	**New Aquatic Pests**	■		
New South Wales	**New Invasive Species / Emerging Invasive Species / Widespread Invasive Species**	■	■	■
New South Wales	**Non-Indigenous Animals**	■		■
New South Wales	**Pest Animal Survey 2002/03, Pest Animal Survey 2004-2005 and Pest Animal Survey 2009-2010** (unpublished)	■		
New South Wales	**Reporting Notifiable Weeds**		■	■
New South Wales	**Riverine Eco-Systems**	■		
New South Wales	**Summary of Wild Dog Predation**	■		■
Northern Territory	**Northern Australia Quarantine Strategy (NAQS) survey database**	■	■	■
Northern Territory	**NT Fauna Atlas**	■		■
Queensland	**1080 database**	■		■
Queensland	**Annual Pest Distribution Survey (APDS) database**	■		
Queensland	**Island Survey**	■	■	■
Queensland	**LARIE** (Land and Resource Information Environment, DERM Qld) - Delbessie database	■	■	■
Queensland	**ParkInfo**	■	■	■
Queensland	**Pest Central**	■	■	
Queensland	**PestInfo 4.3**	■		
Queensland	**Queensland Murray-Darling Committee (QMDC) File Geodatabase**	■	■	■
Queensland	**The Herbert Resource Information Centre (HRIC)**	■	■	■
Queensland	**Tropical Weeds database**		■	
South Australia	**Arid Lands Information System (ALIS)**	■	■	■
South Australia	**Pest2000+**	■		
South Australia	**Primary Industries Information Management System (PIMS)**			■
Tasmania	**GT-Spot**	■	■	■
Tasmania	**Natural Values Atlas**	■	■	■
Victoria	**DSE - Biodiversity Interactive Mapper**	■	■	■
Victoria	**Environmental Information System** (Parks Victoria) - ParkView NVM	■	■	■
Victoria	**e-Weed**		■	
Victoria	**Integrated Pest Management System (IPMS)**	■	■	
Victoria	**Invasive Species Information System (ISIS)**	■	■	
Victoria	**Pest Animal Information System (PAIS)**	■		
Victoria	**Victorian Biodiversity Atlas**	■	■	■
Victoria	**Viridans Biological Databases**			■
Western Australia	**AgLine**	■	■	■
Western Australia	**Inspection, Quarantine and Compliance (IQC) database**	■	■	
Western Australia	**Rainbow Lorikeet Database**	■		
Western Australia	**Starlings Database**	■		
Western Australia	**State Barrier Fence / Wild Dogs Interface**	■		
Western Australia	**Vertebrate Pests Survey (2005)**	■		
Western Australia	**Vertebrates Contacts Database**	■		
Western Australia	**WeedWatcher**		■	

3.2.2.1 National systems

Information System: BioSIRT
Background: BioSIRT (Biosecurity Surveillance Incident Response and Tracing) is a National spatial and textual, web based software application that is intended to provide a single, consistent biosecurity information management system across Australia. A common system enables biosecurity personnel from across Australia to work more easily with counterparts in other jurisdictions and allows information to be exchanged in a common format. It aims to enable better management of information and resources in emergency responses and routine activities (De Milliano et.al. 2010).

The operation of BioSIRT is based on the development of standardised 'templates' (system configurations) customised for particular events or biosecurity business applications, including the management of invasive species. A common system potentially enables jurisdictions to share the effort of developing and testing templates; and to build an archive or library of these templates for rapid deployment in emergency management events (BIOSIRT 2010).

Although focussed initially on animal and plant health emergency incident response, BioSIRT has been extended in some cases to include the management of invasive plant and vertebrate animal species. Western Australia, South Australia and New South Wales intend to adopt BioSIRT for routine surveillance activities. This approach is based the potential for users to become more familiar with BioSIRT through day-to-day use of the system, rather than using the system only occasionally for emergency response incidents and training (NLWRA 2008).

Victoria is the only State not implementing BioSIRT for emergency response or surveillance activities. Victoria has developed the BioWeb system (see section 3.2.2.6) as an alternative, and plans to establish an import/export mechanism to enable data to be exchanged in a standardised format with the other jurisdictions.

Records: BioSIRT is being deployed for a wide range of biosecurity emergency response and surveillance business applications across Australia. Templates for recording data can be customised for most biosecurity applications by trained administrators.
Database: Data is recorded in an ORACLE database. BioSIRT is a web-based J2EE application which makes use of open standards GIS protocols to maximise interoperability with Jurisdictional GIS systems. BioSIRT uses a number of open source GIS servers including MapServer and GeoServer to deliver mapping functionality.
Recording of data: Data is captured through customised forms (templates) delivered through the J2EE application, integrated with a mapping capability delivered by the MoxiMedia component.
Reliability: Dependent on the expertise and experience of staff involved in each biosecurity business application.
Interface: On-line forms (J2EE application) and web map interface (MoxiMedia).

Information System: Pest Maps
Background: Pest Maps is a collection of PDF maps on the occurrence, distribution and abundance of significant invasive animal species throughout Australia. The maps are from existing published maps and information researched by Invasive Animal Cooperative Research Centre (IACRC) supported projects, and are accessed via the PestMaps website (http://www.feral.org.au/pestmaps/) (Lapidge et. al 2004).
Records: Not Applicable. Pest Maps in not a data capture application.
Database: Not applicable. See notes on Records.
Recording of data: Not applicable. See notes on Records.
Reliability: The information presented in the maps available from the Pest Maps web site are based on surveys of expert knowledge in each jurisdiction.
Interface: Not applicable. See notes on Records.

Information System: FeralScan
Background: FeralScan is an initiative of the Invasive Animal Cooperative Research Centre (IACRC), and is an Australia-wide project attempting to recruit individuals in the community and schools to help map the occurrence and impact of feral animals – rabbits, camels, foxes, pigs, mynas and toads. Participants are asked to 'scan' their landscape (school, farm, parkland, roadside reserves, ovals etc) for signs of rabbits and their damage, and to record their results online through a Google Maps interface.
Records: Public reports on locations, density and impacts of rabbits, camels, foxes, pigs, mynas and toads around Australia. There are plans to expand the range of pest animals included in the database in the future.
Database: Google Webmap
Recording of data: Entirely crowd-sourced from members of the public, landholders, landcare and community groups, local councils and schools.
Reliability: Coordinates can be captured through the web map interface. Participants must register to record sightings. The name, school or community group affiliation and contact details of participants is recorded, and users must agree to terms and conditions relating to responsibilities of participants and the rights of the Industry & Investment NSW (I&INSW) under partnership with the FeralScan Steering Committee (FSC) to re-use the data collected.
Interface: A public Google Map data capture webmap customised with embedded forms (http://www.feralscan.org.au/rabbitscan/)

Information System: RabbitScan
Background: RabbitScan is an initiative of the Invasive Animal Cooperative Research Centre (IACRC), and is an Australia-wide project attempting to recruit individuals in the community and schools to help map rabbit activity, by asking people to 'scan' their landscape (school, farm, parkland, roadside reserves, ovals etc) for signs of rabbits and their damage, and to record their results online (RabbitScan Challenge 2009). The project has now been relaunched after analysis of the results of the first 12 months of recorded sightings (May 2009-10), and user feedback. The RabbitScan database and interface is built on the Google Map data capture tool, and accessed via the internet (RabbitScan Challenge 2009).
Records: Public reports on Rabbit locations and density around Australia
Database: Google Webmap
Recording of data: Entirely crowd-sourced from members of the public, although landholders, Landcare and community groups, local councils and schools were targeted.
Reliability: Coordinates usually captured from web map, recorder login profile details recorded.
Interface: A public Google Map data capture web map customised with embedded forms (http://www.feralscan.org.au/rabbitscan/)

Information System: Atlas of Living Australia
Background: The Atlas of Living Australia (ALA) is an initiative launched in 2007 as a partnership between Australia's natural history collections and other agencies that collect and manage information on living organisms in Australia. More recently a range of data related to the recorded distribution of introduced species in Australia has been made available through this system, and this is being expanded through work with the WeedWatcher project (see section 3.2.2.7 Western Australia) through exchange of data via web or data services.
Records: The ALA is not used to record data on invasive species. However the Volunteer Portal (volunteer.ala.org.au/) has been created to test crowd‐sourcing as a mechanism for transcribing specimen details.
Database: Various (depending on data source) exchanged via web services.
Recording of data: See notes under records.
Reliability: Dependent on the source of data. Most records available through the ALA are vouchered specimens.
Interface: A number of on-line portals for ALA are being established. A web map – based spatial portal is now accessible at www.spatial.ala.org.au.

Information System: CyberTracker
Background: CyberTracker (www.cybertracker.org) is a mobile (PDA) – based data capture system that is being used by the Department of Sustainability, Environment, Water, Population and Communities to training indigenous rangers to collect basic environmental data, including data on the distribution and impacts of weeds. The CyberTracker software has been customised for a number of projects in northern Australia.
Records: Data on the presence of weed species and local site-based impacts.
Database: Various (depending on the local project).
Recording of data: See notes under records.
Reliability: Dependent on the experience and expertise of the officer collecting the data for each project.
Interface: PDA-based. Includes a mapping interface and basic forms for recording data on a PDA, and downloading to a personal computer.

3.2.2.2 Australian Capital Territory

See NSW listings (3.2.1.3).

3.2.2.3 New South Wales

Information on six information systems, or datasets related to pest animals in New South Wales was captured through the rapid assessment and follow-up discussions with contacts in New South Wales. Information on other systems related to weed management was also recorded through this project. These are discussed, where relevant, in the summaries below. A workshop was not held in this jurisdiction due to existing linkages between project and jurisdictional personnel, particularly through the BioSIRT program.

In New South Wales pest animal information is captured and maintained by the Department of Primary Industries – Industry and Investment, Department of Environment Climate Change (DECCW) and Water and Catchment Management Authorities. This information is stored in a mix of MS Access databases and ArcGIS datasets.

New South Wales is also engaged in the development and implementation of BioSIRT and plans to use this system to capture routine surveillance data, including for pest animal species. The information systems and data sources for pest animal species are:

Information System: Pest Animal Survey 2002/03, Pest Animal Survey 2004-2005 and Pest Animal Survey 2009-2010 (unpublished)
Records: The 2002/3 survey captured information on the invasive species extent, abundance, damage and control of 6 species; expanded to 10 species in 2004/5 and 12 in 2009/10. The NSW Local Government Weeds Survey also records similar information for weed species.
Database: Arc DBF
Recording of data: These state-wide consultation surveys involve staff from multiple agencies and also cover the ACT.
Reliability: Not recorded, but explicit in methodology.
Interface: Information is captured directly in ArcGIS desktop software.

Information System: New and Emerging Pest Reporting
Records: This system replaces the previous Unidentifiable Animal form. A similar system has also been developed to record data on Reporting Notifiable Weeds.
Database: SQL database
Recording of data: Records observations in a diary form.
Reliability: Dependent on data entered manually by Livestock Health and Pest Authorities.
Interface: On-line form-based application used by Livestock Health and Pest Authorities.

Information System: New Aquatic Pests
Records: Ad hoc reporting of new freshwater and marine species
Database: Excel spreadsheets
Recording of data: Records observations in a diary form.
Reliability: Dependant on contact information and geographic coordinates recorded by the public (includes capacity to up-load a photo of the suspected invasive species).
Interface: On-line form @ http://www.dpi.nsw.gov.au/fisheries/pests-diseases/aquatic-pest-sighting

Information System: New Invasive Species / Emerging Invasive Species / Widespread Invasive Species
Records: DPI – Industry and Investment collects information on aquatic invasive plants and animals (including marine algae but not freshwater plants). The Invasives Team also collects data on terrestrial invasive species from other agencies and groups and reports information is available from local government, LHPA, DPI – Industry and Investment Fisheries, DECCW and others.
Database: Excel spreadsheets
Recording of data: Records observations in a diary form.
Reliability: Dependent on a variety of sources including LHPA, DPI – Industry and Investment and Fisheries officers.
Interface: None.

Information System: Riverine Eco-Systems
Records: Sampling is based on a standardised electro-fishing and bait-trap sampling protocol undertaken at a combination of fixed and randomly generated sites dispersed throughout NSW. The methods used are consistent with those developed and implemented under the NSW Rivers Survey and the MDBA SRA. A total of 132 long-term sites have been established DPI – Industry and Investment and DECCW, augmented with 410 new randomly generated sites.
Database: Excel spreadsheets
Recording of data: Data is recorded on sampling forms and then transcribed to Excel files.
Reliability: Controlled through the standardised electro-fishing and bait-trap sampling protocol.
Interface: None.

Information System: Insect and mite collection in Australia
Records: The Agricultural Scientific Collections Unit (ASCU) maintains this site based at Orange Agricultural Institute - any suspected new incursion of insects or mites, specimens are forwarded to the Agricultural Scientific Collections Unit.
Database: Stand-alone database.
Recording of data: Records details of specimens forwarded to ASCU.
Reliability: Identification of specimens is validated by the ASCU.
Interface: None. However, records are now available through the Atlas of Living Australia.

Information System: Summary of Wild Dog Predation
Records: Reports on wild dog predation of livestock.
Database: MS Excel spreadsheet
Recording of data: Recorded through annual surveys (including Land and Stock Return) of ratepayers conducted by Rural Lands Protection Boards regarding wild dog activity on properties. The surveys ascertain the level of vertebrate pest activity for a range of invasive species and the types of control measures employed by land holders and groups. Survey data are entered into the RLPB ratepayer database.
Reliability: Dependent on data recorded by landholders (ratepayers)
Interface: None.

Information System: Non-Indigenous Animals
Background: Database used to manage the “controlled category” of non-indigenous animals in NSW regulated through the Non-Indigenous Animals Act 1987. These animals are listed in Schedule 1 of the Non-Indigenous Animals Regulation 2006 (currently being replaced by new Regulation, the Non-Indigenous Animals Regulation 2011).
Records: Movement and keeping (addresses and contacts) of controlled of non-indigenous animals in NSW.
Database: MS Excel spreadsheet
Recording of data: Maintained by DPI – Industry and Investment officers.
Reliability: Dependent on data captured by DPI – Industry and Investment officers.
Interface: None.

Information System: Reporting Notifiable Weeds
Records: Records species, location (latitude and longitude), land-use at the site, and status (number of plant and area affected).
Database: ORACLE database.
Recording of data: Recorded through a single page on-line form. This was originally a download form and has only recently (late 2010) be changed over to an on-line form.
Reliability: The form is used by Local Control Authorities (LCA) only. The name of the recorder and specimen voucher identifier is recorded. The public is directed to report issues to the relevant LCA.
Interface: On-line form @ http://extranet.dpi.nsw.gov.au/weeds/permit-report/report/notifiable-reports.

3.2.2.3 Northern Territory

In Northern Territory a number of State and Commonwealth agencies and environmental organisations collect data on invasive species. Most operational information is recorded in single project databases or spreadsheets that are rarely collated. The two exceptions are the NT Fauna Atlas and the Australian Quarantine and Inspection Service (AQIS) Northern Australia Quarantine Strategy survey (NAQS). The Northern Territory government has recently made it a condition that all government funded animal research projects provide a copy of their geospatial data to NT Fauna Atlas to receive their funding. However, this does not extend to operational pest animal management data.

Information System: NT Fauna Atlas
Records: Fauna sightings (including Pest vertebrates) in the Northern Territory. It does not record density or damage.
Database: Microsoft Access relational database.
In the future it is planned to move entirely over to Oracle, but currently there is no timeframe or funding to do this.
Recording of data: The NT Fauna Atlas database is populated mainly by formal survey data collected for projects operated or funded by NRETAS (Department of Natural Resources, Environment, The Arts and Sport) and its sub-departments (Parks, Wildlife Management and Biodiversity Conservation) and Charles Darwin University. It is now a requirement of most NT government grants for relevant research work that they supply a copy of their data to the NT Fauna database. **Reliability:** All uploaded data has details of who captured the data and the spatial reliability of the coordinate technique used recorded in the main NT Fauna database. **Interface:** The NT NRM Infonet web portal (http://www.ntinfonet.org.au/reports/).
A sub-set of the NT Fauna database is uploaded from the relational Access database to an Oracle database daily, with which the web portal combines information (such as fire history) from other sources to allow generation of reports.

Information System: Northern Australia Quarantine Strategy (NAQS) survey database (AQIS)
Records: Pest vertebrate carcass samplings (among others). It does not record density or damage.
Database: BioSIRT lab module (Mapping module not yet set up, in the future it is planned to use that component as well)
Recording of data: The NAQS project works with local Aboriginal communities from Broome to Cairns across Northern Australia to conduct exotic disease surveys. The frequency of surveys is determined by the 'risk zone' of the region. Samples are collected from one or two individuals per group of large vertebrate feral animals encountered, with a focus on known transmitters of exotic disease such as pigs. A GPS point of the sample site is recorded using iTracker or Cybertracker handheld GPS units.
Reliability: All coordinate data is captured using iTracker or Cybertracker handheld GPS units. No data, no payment.
Interface: The NAQS project uses the BioSIRT lab module interface. The interface is not publically available.

3.2.2.4 Queensland

In Queensland several different environmental organisations and governmental bodies were identified that collect vertebrate pest information in structured databases for different parts of the landscape for various operational and research reasons. Currently there is a significant amount if vertebrate pest related interface and database development going on. Several different organisations are in the process of building, upgrading or rolling out new products that their organisations believe will significantly improve their collection and use of data.

Information System: Queensland Murray-Darling Committee (QMDC) File Geodatabase system
Records: Used to record a large number of natural resource management details about the catchments and properties making up the Queensland Murray-Darling basin. This includes tables for recording animal pest sightings, treatment and density.
Database: Data is manually collated from three recording sites in File Geodatabase (ArcGIS), with master copies then manually redistributed. This system was migrated to ArcGIS 9.3 in 2011.
Recording of data: Vertebrate pest information is collated from QMDC projects that have a pest control aspect, including community - run activities to monitor or control pest animals.
Reliability: The process through which coordinates for each recorded are captured and provide an indication of the accuracy of each record.
Interface: Public access to the raw data is restricted due to privacy requirements for landowners. Summary information and reports is loaded into the enQuire (http://www.enquire.net.au/) website, for access by the Queensland government and regional groups via login.

Information System: Pest Central (operated by XY Mapping)
Records: Pest Plants and Animals
Database: Oracle Spatial (storage), GBM (capture)
Recording of data: Data is captured using a form based PDA Field capture system expressly designed to populate PestCentral databases. Each subscriber can set up an independent copy of the database on the cloud server via the internet. The Department of Employment, Economic Development and Innovation (DEEDI) plans to negotiate data sharing agreements to enable these 'silos' of data to be shared so as to create a pest animal 'point of truth' database for Queensland.
Reliability: All data is collected using a standardised PDA system, and the details of collector and host organisation is recorded.
Interface: Subscribers of the desktop application access their copy of the Pest Central database via the internet. The interface is designed to manage team activities e.g. design and send-out work program, which is then posted back.

Information System: Annual Pest Distribution Survey (APDS) databases
Records: Pest Plants and Animals
Database: Microsoft Access
Recording of data: The APDS database is compiled from pest plant and animal survey workshops held throughout Queensland on an annual basis. Information is stored on a ½ degree (approx. 50km x 50km) grid cell basis recording Year, Species, Grid Cell and species Frequency/Density. The survey was not undertaken in 2010. It is expected that in future the data will be collected through Pest Central.
Reliability: Not recorded as explicit in methodology.
Interface: There is no web interface for the APDS database. Static PDF maps are generated from the data and hosted by Primary Industries and Fisheries, see http://www.dpi.qld.gov.au/4790_9824.htm.

Information System: ParkInfo (Queensland Parks and Wildlife Service – QPWS, sub-department of DERM)
Records: Fire and Pest history and management, soon adding Strategic Asset Management (SAM) module
Database: ArcGIS
Recording of data: The ParkInfo database is populated via a separate instance for each local management unit, some 422 in 2005. The Ranger in Charge (RIC) of each office is responsible for the entry of pest and fire data. Custom built interface modules guide staff through the process of recording data, easing and standardising data capture and including such information as the reliability and method of capture. Twice a year copies of each instance are collated back to a state master copy for a state-wide summary.
Reliability: Recorder captured, along with a text comment on spatial reliability.
Interface: Each stand alone instance has a customised copy of ArcView 3.3. The next version planned will be an open source solution with a web-based interface.

Information System: LARIE (Land and Resource Information Environment, DERM Qld) Delbessie database
Records: Lease Land Conditions as per the Delbessie Agreement Dec 2007.
Database: Oracle spatial database
Recording of data: Data is recorded each time a Lease comes up for renewal (20-30 years), and in future at set review dates for all leases. Initially, a desktop review of the property is conducted using PestInfo database and other sources. Based on that review, a minimum of five assessment sites per land type per lease are selected. On each property these sites are evaluated with up to 23 indicators of land condition including pest animal presence or absence. Over time, assessors will return to the same sites recorded changes and minimise bias in observations. Additional information is also recorded regarding evidence of invasive species impacts while travelling between leases and assessment sites within leases. Around 50% of Queensland consists of Leases over 100ha, so it is expected that over time the database will cover a significant amount of the state.
Reliability: Recorder captured, and standardised GPS systems used for coordinates.
Interface: Dekho ArcGIS (Esri) is used to assess information and plan assessments in office. In the field, ArcEditor is used on a laptop, linked to a GPS and PDA to capture data. Information is synchronised back to a central database on return to the office.

Information System: The Herbert Resource Information Centre (HRIC)
Background: The Herbert Resource Information Centre (HRIC) is a joint venture comprised of the Council of the Shire of Hinchinbrook (Hinchinbrook Shire Council); CSR Sugar (Herbert) Pty Ltd (CSR); Herbert Cane Productivity Services Ltd (Productivity Services); Herbert River District Canegrowers Organisation Limited (Canegrowers); BSES Ltd (BSES); and FNQ NRM Ltd (Terrain NRM), established by a collaborative agreement between those parties last executed on 25th July 2007.
Records: Occurrence of pest plant and animal species.
Database: ArcSDE (on ArcServer).
Recording of data: The Spatial Pest Attribute Standard (SPAS) schema, with a cut-down species lists for North Queensland, is used to record pest plant and animals. Currently only two local government Herbert River partners use this system.
Reliability: The SPAS standard includes information on the level of expertise and experience of the observer.
Interface: Dekho web application on ArcServer. The interface was originally designed by the Cane industry to monitor its production chain. A customised instance for pest plant and animal recording was set up for the Herbert Resource Information Centre, and hosted by the Shire of Johnston. Users can capture information using web or desktop data capture tools and forms.

Information System: 1080 database
Background: Required to report to Health on application of 1080 poison. It is intended that these data be migrated to BioSIRT.
Records: Reports on baits used per Lot/Plan. Records type of bait used, dosage, and date made.
Database: Textual database.
Recording of data: The Invasive Plants and Animals team record and manage this information
Reliability: Dependent on the experience and expertise of DEEDI staff capturing the data.
Interface: Desktop-based form.

Information System: PestInfo 4.3
Background: Previously used by State and Local Government to record invasive species distribution and abundance on a grid-based survey basis. Users imported a template and then exported completed dataset and sent back to Brisbane, where data was collated in an central database. Still being used by some Local Governments, but no longer supported by DEEDI (de-commissioned).
Records: Invasive species presence/absence and trend information.
Database: Built on Intergraph Geomedia Objects version 5. Data stored in a Geomedia data warehouse (Microsoft Access).
Recording of data: The presence/absence and abundance of invasive species was recorded on a grid-cell basis in a desktop mapping interface.
Reliability: Dependent on the knowledge and expertise of local government and biosecurity staff.
Interface: Desktop mapping interface based Geomedia Objects version 5.

Information System: Island Survey
Background: Limited survey of land management issues on off-shore islands.
Records: Observations (presence/absence) of invasive species.
Database: Microsoft Access.
Recording of data: Recorded by specialist, trained survey staff.
Reliability: Dependent on the experience and expertise of survey staff.
Interface: Simple ArcView form designed for use on a laptop.

Information System: Tropical Weeds database - Siam weed 'four tropical weeds program' (national cost sharing program)
Background: The National Four Tropical Weeds Eradication Program targets six species of four known weeds: Koster's curse (Clidemia hirta), Limnocharis or Yellow bur-head (Limnocharis flava), Miconia (Miconia calvescens), Miconia nervosa, Miconia racemosa and Mikania vine (Mikania micrantha). Following the discovery of the weeds in Queensland in 2003, a nationally cost-shared eradication program was implemented. A review of the outcomes of the program is currently underway.
Records: Observations (presence/absence) of the four weed species listed above – based on surveys every 3-6 months (depending on the species).
Database: Microsoft Access database.
Recording of data: Recorded by specialist, trained survey staff.
Reliability: Dependent on the experience and expertise of survey staff.
Interface: Simple Access-based form.

3.2.2.5 South Australia

Primary Industries and Resources South Australia (PIRSA), specifically the NRM Biosecurity unit, and the Department of Environment and Natural Resources maintain the primary pest management information systems in South Australia. Three of these systems are described below.

Information System: Pest2000+
Background: Pest2000+ is a stand-alone database of plant and animal pests that uses a local database to record information. Only 17 of 27 South Australian Animal and Plant Control boards have taken up Pest2000+ and used it to varying degrees.
Records: Invasive species, address and contact details for the property affected, and (optionally) a latitude and longitude for the affected site.
Database: Microsoft Access databases (distributed to each of the South Australian Animal and Plant Control boards).
Recording of data: Information is recorded by property, with coordinates able to be recorded textually. This information needs to be manually exported into a GIS application for displaying spatially.
Reliability: Dependent on the skills and experience of South Australian Animal and Plant Control board staff.
Interface: Access-based form .

Information System: Primary Industries Information Management System (PIMS)
Background: The Primary Industries Information Management System (PIMS) is used by the Department of Primary Industries and Resources of South Australia (PIRSA) to register all livestock enterprises and to capture animal health information. PIRSA staff capture these data on property basis as part of the state's Stock Brands registration process; recording contact details and property boundaries (Weaver et al. 2003). PIIMS doesn't currently record pest animal data, however the Department of Water, Land and Biodiversity Conservation SA (DWLBC) were negotiating with PIRSA to expand the functionality of PIMS to incorporate pest plant and animal recording in 2006 (Paping 2006).
Records: A wide range of data related to stock registrations in South Australia, including laboratory results generated by the Gribbles service. Currently PIMS is not used to record information on invasive species.
Database: ORACLE database.
Recording of data: Data is recorded by trained PIRSA staff using web forms.
Reliability: Dependent on the expertise and experience of PIRSA staff in involved in data capture.
Interface: ORACLE Web forms.

Information System: Arid Lands Information System (ALIS)
Background: Land management system for used by field staff contracted by Natural Resource Management Boards. The Arid Lands Information System (ALIS) was established to enable Natural Resource Management Boards to manage and report on their spatial and textual data on land management issues.
Records: Records a range of land management data, including weed and pest animal presence.
Database: ESRI spatial SDE and SQL 2008 database
Recording of data: ALIS is used to present, report and summarise data collected in the field by contractors on behalf of the Natural Resource Management Boards.
Reliability: Dependent on the experience and expertise of contractors collecting data on behalf of the Natural Resource Management Boards.
Interface: On-line web map @ http://e-nrims.dwlbc.sa.gov.au/alis/

3.2.2.6 Tasmania

Two information systems, managed by Department of Primary Industries, Parks, Water and Environment (DPIPWE), are discussed in this report. One of these, GT-Spot, is being incorporated into the Natural Values Atlas. It should also be noted that Tasmania is involved in the BioSIRT Program (discussed under 3.2.2.1 National Systems).

Information System: GT-Spot
Records: Geo-temporal (GT) species point observations for native and pest plant and animal species.
Database: Genesis database. Spatial data is also available as Digital - ESRI ArcInfo Grid files.
Recording of data: Contains fields of observations from a number of flora and fauna datasets, including Tasmanian Parks and Wildlife Service (TASPAWS) database, Tasmanian forest habitats (TASFORHAB) database, orchid atlas, Tasmanian frog atlas, Tasmanian reptile atlas, wedge-tailed eagle database, Royal Australian Ornithologists Union (RAOU) database, invertebrate databases and the weed mapping database. External databases are also included, such as Botany Database (Forestry Tasmania), Tasmanian Herbarium Database, Queen Victoria Museum, and some observational data collected by individuals. The database was created to bring together an integrated database of all species which covers all of Tasmania including the Bass Strait islands.
Reliability: Dependent on the source (see Recording of data). However, all sources included are validated by science staff from the relevant agencies.
Interface: Data was previously searched and downloaded through an on-line form. This function has now been transferred to the Natural Values Atlas.

Information System: Natural Values Atlas
Records: Point, line and polygon observations for native and pest plant species.
Database: ORACLE spatial database.
Recording of data: Incorporates many of the databases formerly linked to the GT-Spot database. Enables recorded of point, line and polygons records for native species. Does not incorporate recording of pest animal species at this stage. However a weed module has recently been developed - based on WoNS attributes
Reliability: Dependent on the source (see Recording of data). However, all sources included are validated by science staff from the relevant agencies.
Interface: Custom Web interface. Textual/Spatial (point, line and polygon). Mapping functionality supported by LISTmap.

3.2.2.6 Victoria

The information systems considered in this project are maintained primarily by the Department of Primary Industries, Department of Sustainability and Environment and Parks Victoria.

Information System: Integrated Pest Management System (IPMS) Background: The Integrated Pest Management System (IPMS) is a networked database of plant & animal pests owned by the Department of Sustainability and the Environment (DSE Victoria) but operated by DPI Victoria (West et. al. 2006, West 2007,). IPMS was developed for the Department of Sustainability and the Environment by SpatialVision in 1999, and replaced the previous PMIS system. IPMS includes a web-based mapping component and tools for scheduling reassessments of infestation sites.
Records: Information is recorded on infestation details (including species, density and the areas affected), assessment of the impact of the infestation and recommended treatment.
Database: IPMS operates over the DPI Wide Area Network, and is based on the Sybase relational database management system. IPMS data is loaded each night onto the *Mapshare* Oracle RDBMS database and is accessed via a web site (Paping, P 2006).
Recording of data: Information is based on a property record (including contact details). Spatial data is recorded by storing latitude and longitude textually with an estimated area of infestation. These can then be output as data points to a GIS Webmap application called *Mapshare*.
Reliability: Dependent on the expertise and experience of the DPI staff that record data in this system.
Interface: IPMS includes a web-based mapping component and on-line forms.

Information System: Pest Animal Information System (PAIS)
Background: A database recording Wild dog data, stock losses and baiting activity information (West et. al. 2006). Replaced recently by the BioWeb – ISIS system (see description below).
Records: Wild dog sightings/destruction details, stock losses and distribution of baits for wild dogs (numbers and locations).
Database: ORACLE database.
Recording of data: Data is recorded by DPI staff, based on stock returns and reports from landholders.
Reliability: Dependant on reports from landholders and the expertise and experience of DPI staff recording these data.
Interface: Computer form screen access from a local PC.

Information System: DSE - Biodiversity Interactive Mapper
Background: Provide access for the general public to records of native plant and animal species, threatened species and disturbance from fire and timber harvesting. Also used by State agencies for planning activities.
Records: Provides access to data only. Not used to record data.
Database: ORACLE and ARC-SDE database; and MapShare web map application.
Recording of data: Not applicable.
Reliability: Dependant on reliability of base layers provided by DSE and other agencies. Locations of plant and animal species are based on validated specimens.
Interface: MapShare web map application accessed via http://mapshare2.dse.vic.gov.au/MapShare2EXT/imf.jsp?site=bim

Information System: Invasive Species Information System (ISIS)
Background: Integrates a number of existing information systems that are used to capture, managed and share information on invasive species in Victoria. The Victorian Government have funded a four-year project that will utilise the Victorian BioWeb Sharepoint framework to integrate information systems.
Records: The application is based around Case records – and includes spatial overlays and reporting and evaluation functions. A Case describes an infestation of a species that may occur over one, or more, locations or sites. Multiple cases (involving different species) may also occur at one location. ISIS has been designed to manage these data consistently against property and site information.
Database: ISIS uses an SQL enterprise, object-oriented database back-end and is a three-tier application (database - business rules - user interface). The application is web-based and designed to be used with minimal training. The application is accessed through the BioWeb Sharepoint framework at DPI – enabling users to access ISIS and other applications through a single sign-on.
Recording of data: ISIS moves from a property focus, the basis of data management in older information systems, to recording information against a broader range of contacts (entities - contact/party/property) and throughout the supply chain e.g. infected equipment) to enable improved tracing of issues. The system provides links to cases involving particular species and contacts (e.g. nurseries).
Reliability: Dependant on the experience and expertise of DPI staff capturing the data.
Interface: Silverlight application.

Information System: Victorian Biodiversity Atlas
Background: Currently under development as a replacement for a number of separate taxonomic records management systems.
Records: This application is not being designed to record information. It will be a taxonomic records management system.
Database: Under development (design stage).
Recording of data: Not applicable. This system is still in a design stage.
Reliability: Data would be drawn from existing, validated and reliable taxonomic records.
Interface: Not applicable. This system is still in a design stage.

Information System: Viridans Biological Databases (Flora Information System (FIS) and the Victorian Fauna Database (VFD)
Background: Viridans provides a range of flora and fauna tools for field naturalists, ecologists, teachers and students in Victoria.
Records: The Flora Information System (FIS) and the Victorian Fauna Database (VFD) are not used to record data. These are reporting tools providing information on validated taxonomic records.
Database: Microsoft Access databases.
Recording of data: Not applicable.
Reliability: Data is drawn from existing, validated and reliable taxonomic records.
Interface: Form-based application that includes pre-generated map products.

Information System: Environmental Information System (Parks Victoria) - ParkView NVM
Background: Focussed on Management Actions. ParkView was established in the 1990's to spatially report management actions. ParkView is used to manage all aspects of park management. A proposal to re-develop this application has been completed, based on the need for a more integrated system for planning and managing financial data. The application used to set priorities, planning and evaluation. ParkView NVM is designed to be used by all levels of business, from Park rangers to State management. The re-developed application is intended to integrate with other information systems such as e-Weed.
Records: A wide range of information related to park management, including the impacts of invasive species.
Database: Microsoft Access databases.
Recording of data: Significant investment has been made in Trimble PDAs for 'live' reporting. This capability is currently being rolled-out.
Reliability: Dependent on the expertise and experience of park management staff.
Interface: Form-based application.

Information System: e-Weed
Background: Established to address the growing demand for recording observations of weed species reported by the public. e-Weed is a web-based system used by DSE and Parks Victoria, and is used for all Eden projects as a model for all weed business. Run by external service provider.
Records: A wide range of information related to park management, including the impacts of invasive species.
Database: Microsoft Access database.
Recording of data: Data is recorded by DSE and Parks Victoria staff, based on observations by staff and reports from the public.
Reliability: Dependent on the expertise and experience of park management staff.
Interface: Form-based application.

3.2.2.7 Western Australia

The Department of Agriculture and Food WA (DAFWA) has oversight of vertebrate pest management across most of WA. It maintains a comprehensive database of all agricultural properties and their managers across the state as part of an agency wide centralised database called CPE (Client Property Event). A number of other databases within DAFWA have been incorporated into the CPE system as related modules over time. These share the same Property ID and Party ID reference numbers to identify properties and contacts of interest for pest management.

Most of the systems described below have been integrated with the CPE database. Details are provided separately as each of these applications has a separate business focus.

Information System: AgLine database
Background: AgLine was a free-call public service run by DAFWA (Department of Agriculture and Food WA) up to 2010 that provided specialist broad acre cropping, animal husbandry, veterinary and horticultural advice (DAFWA 2007). Funding for the service ended in September 2010. A log of all calls was kept in a database called the 'AgLine database', so it was also is a record of occurrences of disease, invasive plant and animal pests.
Records: Agricultural advice provided in response to phone calls from members of the public to DAFWA. This includes details of pest animals and control advice given.
Database: The information is stored in an Oracle database, and where possible linked to an agricultural property via the contacts Party record.
Recording of data: The AgLine database was populated by DAFWA staff based on details provided by landholders and the public during phone calls to DAFWA requesting advice. Callers are matched where possible to existing Party records in the DAFWA CPE database, which then indirectly ties individual phone calls to properties recorded in the DAFWA CPE database against those callers.
Reliability: Not directly recorded, but all data is from public calls and location data is only inferred from caller matching.
Interface: An internal intranet web form accessible by trained DAFWA staff.

Information System: Inspection Quarantine and Compliance (IQC) database
Background: The Inspection, Quarantine and Compliance (IQC) application records regulatory inspection data on declared pest plant and animal species generated by DAFWA (Department of Agriculture and Food WA) Biosecurity staff (De Milliano et.al. 2010). IQC is currently populated by data entry staff recording paper Field Reporting Forms (FRFs) into an Oracle data entry interface, with the data stored in an Oracle database against the Property ID of the property the inspection was made on. Property data is maintained in the CPE (Client Property Event) database. IQC is integrated with the CPE system (described above). Access to the inspection data and summary reports are generated through an Intergraph GeoMedia web map interface. **Records:** Regulatory inspection data on declared pest plant and animal species generated by DAFWA (Department of Agriculture and Food WA) Biosecurity staff. **Database:** Oracle Spatial
Recording of data: The database is currently populated by data entry staff recording paper Field Reporting Forms (FRFs) into an Oracle Forms data entry interface, with the data stored in an Oracle spatial database against the Property ID number of the property the inspection was made on. Property data is maintained in the CPE (Client Property Event) database.
Reliability: Dependent on the expertise and experience of the DAFWA officer recording the data.
Interface: Access to data and summary reports is provided via an internal intranet Intergraph GeoMedia web map interface with standardised queries.

Information System: Rainbow Lorikeet Database
Background: The Rainbow Lorikeet Database is an online system that is open to the general public to record and report on Rainbow Lorikeet occurrences in WA (De Milliano et.al. 2010). The database is used by DAFWA to help identify new incursions of the declared pest outside the Perth Metro area, where the species has become endemic after becoming established from escaped or released cage birds in the 1960's (Chapman & Massam 2007). Access to the Rainbow Lorikeet database is provided via an Intergraph GeoMedia web map interface with standardised queries.
Records: Reports by the general public on Rainbow Lorikeet occurrences in Western Australia – based on a set of coordinates at a point location.
Database: Intergraph GeoMedia warehouse (Microsoft Access).
Recording of data: The database is populated by members of the general public using an external Intergraph GeoMedia webmap with embedded web forms.
Reliability: Dependent on records provided by the general public, with location data taken from selecting a point on the web map, or entering coordinates.
Interface: Members of the public can see report data points via the external Intergraph GeoMedia web map reporting interface @ http://spatial.agric.wa.gov.au/lorikeets/framesetup.asp.

Information System: Starlings Database
Background: The Starlings Database is a tool for recording and reporting on occurrence and on-ground eradication activities of Starlings in the Great Southern region of Western Australia (De Milliano et.al. 2010). The location of all traps and the numbers of birds caught are recorded by trapping contractors and DAFWA (Department of Agriculture and Food WA) Biosecurity staff, along with a coordinate point for the site. Information on birds shot is recorded separately in the IQC database. With the recent Starling infestation now reduced to a small number of birds the interface is no longer in regular use.
Records: Starling trapping activity by DAFWA contractors and staff
Database: Oracle database.
Recording of data: Staff and contractors recorded trap setting operational details, including dates and times, GPS points of trap runs, time spent, birds trapped and lure bird mortality (for animal welfare review)
Reliability: Dependent on the expertise and experience of DAFWA staff and contractors. Data reliability is not directly recorded, but able to be inferred as DAFWA contractors and staff use standard GPS units to locate trap sites and staff member identifier is recorded.
Interface: Data is recorded and accessed via an internal intranet web form with built in queries and reports.

Information System: State Barrier Fence / Wild Dogs Interface
Background: The State Barrier Fence / Wild Dogs Interface is a tool for collating wild dog information and reports from across DAFWA and DEC in a single location to facilitate reporting and the management of operational issues such as targeting baiting, monitoring changes in dog numbers over time, monitoring the impacts of control programs, and coordinating State barrier fence maintenance.
Records: Reports by the general public on wild dog activity (recorded by DAFWA staff), DAFWA dogger contractor actions (tracking and destruction), baiting program run by DAFWA and the Department of Environment and Conservation (DEC) and DAFWA State barrier fence maintenance issues and actions.
Database: Intergraph GeoMedia Warehouse (Microsoft Access)
Recording of data: An internal intranet Intergraph GeoMedia web map with embedded forms is used to record reports from members of the general public on sightings, baiting, trapping and shootings of wild dogs and stock loses to wild dogs against properties in the DAFWA CPE database. GPS points of aerial and ground-based wild dog baiting and other control activities by DEC and DAFWA officers are manually uploaded from data files recorded in the field and on aircraft using Intergraph GeoMedia GIS software.
Reliability: GPS coordinates are downloaded from data loggers on aircraft and used by ground-based staff and contractors. Public reports are recorded against a CPE database property polygon.
Interface: Data access is via the internal intranet Intergraph GeoMedia web map interface with built in queries.

Information System: WeedWatcher
Background: WeedWatcher was originally established in the early 2000's to emulate a system operating at that time in California to record observations of weed species by the general community. WeedWatcher was originally developed in Intergraph Geomedia Web Map; however the application has been migrated to an interface based on the Google Maps API and OpenLayers.
Records: Records the location (point, line or polygon) of infestations of WONS species, as well as the number of plants and/or area affected and any treatment applied to the infestation.
Database: Oracle database.
Recording of data: Entirely crowd-sourced from members of the public, landholders, Landcare and community groups.
Reliability: Coordinates can be captured through the web map interface. Participants do not have to register to record single sightings; however users are encouraged to register to make repeat observations and/or upload bulk records. The name of the individual and community group affiliation is recorded. Users are also asked to rate their own level of expertise in terms of their experience and role.
Interface: Google maps and OpenLayers – based web map available @ http://spatial.agric.wa.gov.au/weedwatcher

Information System: Vertebrates Contacts Database
Background: Developed in the early 2000's to record public enquiries to DAFWA regarding vertebrate invasive species (pre-dates the AgLine system described previously).
Records: Records contact name (where provided), and contact details, as well as a summary of the enquiry and advice provided.
Database: Microsoft Access database.
Recording of data: Recorded by DAFWA staff only.
Reliability: Dependent on details provided by those making an enquiry, and the accuracy of the information transcribed by DAFWA staff into each record.
Interface: Simple web form.

3.3 Comparative assessment

3.3.1 Rating and assessment scales

The following section provides a comparative rating for each information system described in this report - based on a series of seven criteria. These are objective criteria that rate each information system based on the scope and technical capability of each system, and number and quality of records in each system based on the process through which these records are captured.

Reporting: 1-No reporting; 2-Ad-hoc project reports only; 3-Ad-hoc regional or State-wide reporting; 4-Dynamic project reports; and 5-Dynamic regional or State-wide reports.

Mapping: 1-No location information; 2-Captures coordinates/addresses only; 3-Captures points, lines, polygons; 4-Dynamic capture of cords; and 5-Dynamic capture of points, lines, polygons.

Analysis: 1-No analysis applied; 2-Ad-hoc extraction of data for analysis; 3-Automated extraction of data for analysis; 4-Ad-hoc analysis embedded; and 5-Dynamic analysis embedded.

Potential for biased observations: 1-Relatively small number of records, no formal sampling strategy; 2-Relatively large number of samples, but no formal sampling strategy applied; 3-Comprehensive survey, but no formal sampling strategy applied; 4-Sampling strategy applied; and 5-Sampling strategy carefully designed to avoid bias.

Gap filling – Occurrence: 1-Data limited to local area/s only; 2-Data has regional or State coverage, but limited sample; 3-Comprehensive data over local area/s only (could be used to fill local gaps); 4-Data has regional or State coverage, but limited to a single time period; and 5-Extensive coverage and recorded over multiple time intervals.

Gap filling – Impacts: 1-Data limited to local area/s only; 2-Data has regional or State coverage, but limited sample; 3-Comprehensive data over local area/s only (could be used to fill local gaps); 4-Data has regional or State coverage, but limited to a single time period; and 5-Extensive coverage and recorded over multiple time intervals.

Modeling: 1-Data cannot be used to map occurrence; 2-Data can be used to map current occurrence only; 3-Data can be used to map occurrence and density; 4-Data can be used to map current occurrence and density over time; and 5-Data currently used to model and predict occurrence.

The results presented in section 3.3.2 include a description of each system with regard to the criteria discussed above, and a chart for each system assessed to facilitate a comparison between these systems. As discussed in section 2.4, higher ratings in each category do not imply a higher value for the information system or the data collected in each system. Rather, the ratings are intended to highlight the similarities and differences between each information system as an approach to understanding the opportunities and limitations of using information from each system.

3.3.2 Assessment of current and planned information systems

3.3.2.1 National systems

Information System: BioSIRT
Reporting: Reporting is delivered through Crystal reports. These reports can be customised by trained personnel and data summarised and exported to a variety of formats (usually excel and PDF).
Mapping: Mapping is delivered via Moximedia, with map layers generated by MapServer and GeoServer. This software enables users to capture and attribute points, lines and polygons in a shared web-based environment.
Analysis: The reporting capability provided by Crystal reports, and through summary forms in the J2EE-based application provides a limited ability to carry-out analysis of data within the application.
Potential for biased observations: Dependant on the business processes established to capture data for each program managed through BioSIRT. BioSIRT is used to manage a wide variety of biosecurity business programs. However, these generally involve only trained agency personnel.
Modeling: BioSIRT does not include a capability to forecast, or predict the distribution and abundance of invasive species. However, the data collected for invasive species programs managed by BioSIRT could be used for this purpose via other information systems.
Gap filling - occurrence: To-date very limited data on invasive species distribution and abundance has been collected via BioSIRT.
Gap filling - impacts: To-date very limited data on invasive species impacts and abundance has been collected via BioSIRT.

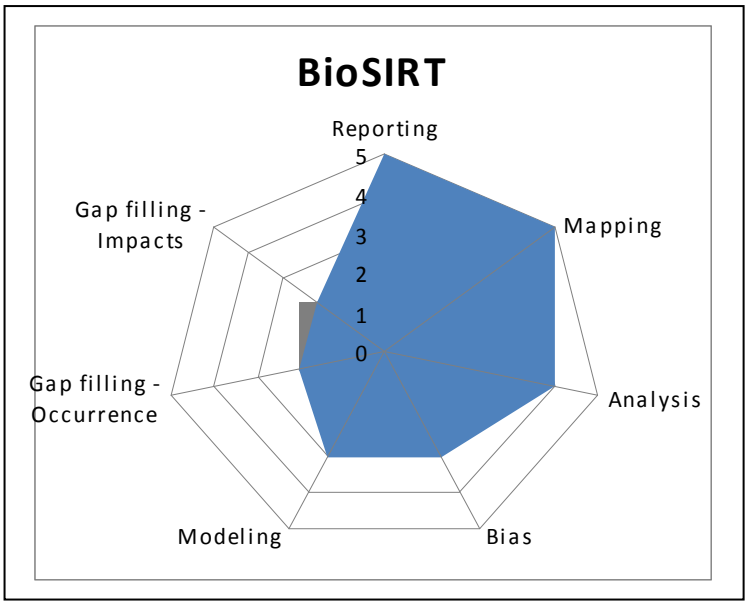


Figure 1. Comparative assessment of BioSIRT.

Summary: BioSIRT has relatively sophisticated reporting and mapping capabilities. Routines can be programmed to automatically extract data in standard formats for analysis in other information systems and tools. Relatively little data has been collected through BioSIRT at this stage, so there is limited scope to utilise existing data for gap filling and predictive modelling. There are no specific controls over bias in data collection. As BioSIRT can be used for a wide variety of applications, the system relies on controls established through the business processes through data is captured in BioSIRT.

Information System: Pest Maps
PestMaps is a collection of PDF maps on the occurrence, distribution and abundance of significant invasive animal species throughout Australia. The maps are from existing published maps and information researched by Invasive Animal Cooperative Research Centre (IACRC) supported projects, and are accessed via the PestMaps website (http://www.feral.org.au/pestmaps/) (Lapidge et. al 2004). Pest Maps is not an information system or database and has not been further assessed against the criteria for the purposes of this report.

Information System: FeralScan
Reporting: A simple Google webmap showing data points and a State/Territory summary count are available to the public**.**
Mapping: Users are able to record, a sighting, damage and control measures at a point, and to up-load a set of records.
Analysis: No in-built analysis capability.
Potential for biased observations: The interface relies entirely on crowd sourced information from the community and as a result the sightings recorded will tend to reflect the distribution of the community itself i.e. human population distribution and density. This is moderated to some degree by the use of a background map of 'known' distribution generated from formal surveys and other reliable sources. These background maps are used to guide participants in all but the Myna scan portals.
Gap filling - occurrence: The data managed through FeralScan may have significant potential in filling gaps in knowledge on the distribution and abundance of invasive species. However, there is significant bias in the information toward populated areas.
Gap filling - impacts: The data managed through FeralScan may have significant potential in filling gaps in knowledge on the impacts of invasive species. However, there is significant bias in the information toward populated areas.
Modeling: Yes. However, with a number of species being so well established across Australia there are few places entirely free of even low numbers.

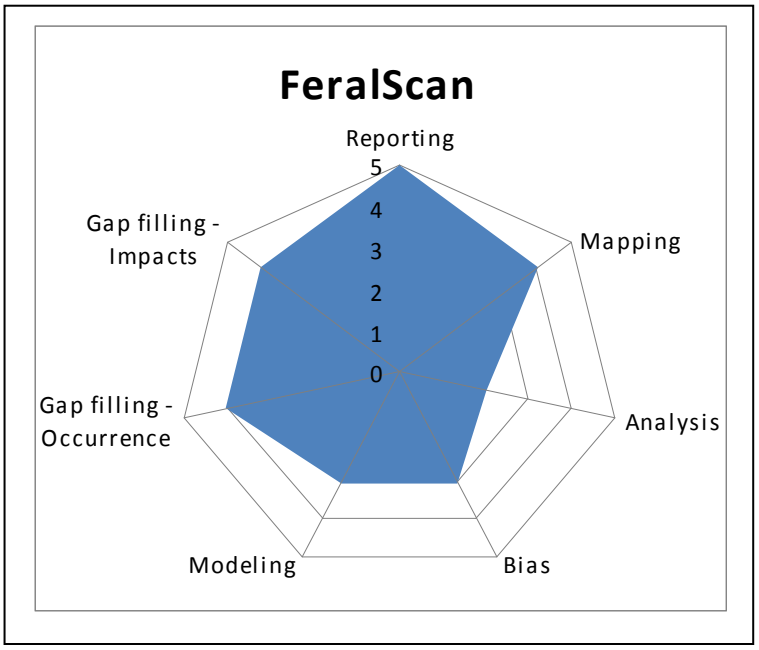


Figure 2. Comparative assessment of FeralScan.

Summary: FeralScan includes simple reporting and mapping capabilities designed to by used by the general public, or interest groups with little or no training. A significant number of records, captured by the community, have now been collected. These data are know to be of variable quality, although the spatial distribution of data collected largely corresponds to the known distributions of pests recorded. Further work is required to assess the reliability of data points recorded at the edges if currently known distributions. Based on work completed to-date, there does appear to be an opportunity to use these to augment data collected through more rigorous processes in order to fill gaps, particularly with regard to changes over time. There are no specific controls over bias in data collection and it is acknowledged that the nature of the 'crowd-sourcing' approach means that more data will be collected in areas of higher human density.

Information System: RabbitScan (now integrated with FeralScan)
Reporting: A simple Google webmap showing data points and a State/Territory summary count are available to the public**.**
Mapping: Users are able to record, a sighting, damage and control measures at a point.
Analysis: No in-built analysis capability.
Potential for biased observations: The interface relies entirely on crowd sourced information from the community and as a result the sightings recorded will tend to reflect the distribution of the community itself i.e. human population distribution and density.
Gap filling - occurrence: The data managed through RabbitScan may have significant potential in filling gaps in knowledge on the distribution and abundance of invasive species. However, there is significant bias in the information toward populated areas.
Gap filling - impacts: The data managed through RabbitScan may have significant potential in filling gaps in knowledge on the distribution and abundance of invasive species. However, there is significant bias in the information toward populated areas.
Modeling: Yes, but with Rabbits being so well established across Australia there are few places entirely free of even low numbers.
Summary: See FeralScan.

Information System: Atlas of Living Australia
Reporting: The spatial portal at www.spatial.ala.org.au includes relatively sophisticated reporting capabilities. Basic tools include the generation of species checklists over any defined area and sampling of combinations of environmental and contextual layers at a location. Results can be exported as CSV - formatted files. More advanced tools that use the environmental layers include scatter plots of taxa the classification of environments and spatial prediction (modeling) of species distributions, contextual layers at a location.
Mapping: The spatial portal includes relatively sophisticated mapping capabilities – including dynamic modeling of species distributions.
Analysis: The spatial portal includes relatively sophisticated on-line analysis capabilities – see Generation of reports.
Potential for biased observations: This databases linked to this system consist largely of field observations and bias may arise where observations have been collected opportunistically i.e. along roadsides or in reserves and parks.
Gap filling - occurrence: Data is largely limited to the distribution, or extent, of current populations.
Gap filling - impacts: Data is largely limited to the distribution, or extent, of current populations.
Modeling: Data available through the ALA have been used to model invasive species distributions.

Summary: Significant scope to leverage ALA to link currently separate sources of data, and to utilise an expanding set of on-line reporting, mapping and analysis tools being developed through the ALA. Limited data on invasive species is available through the ALA at this stage, and it is likely there will be significant challenges in linking some data to this system due to varying standards, attribution and data quality. However, the ALA provides a flexible platform through which this can be implemented and tested through a staged approach.

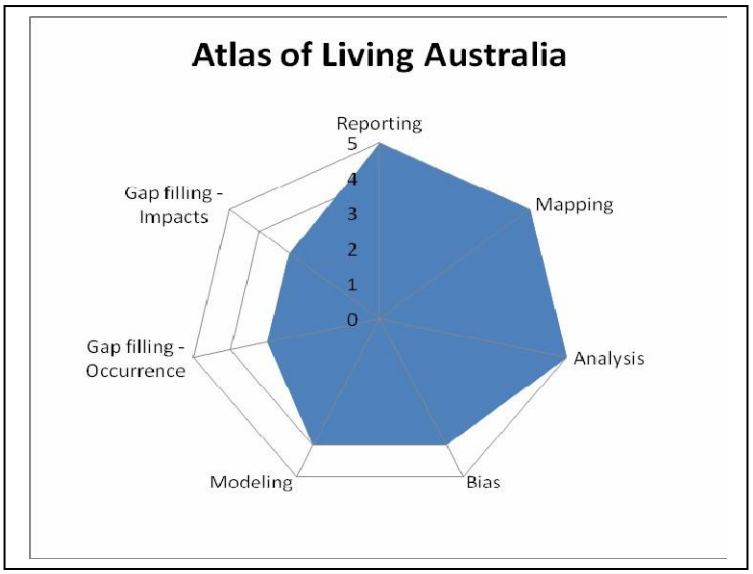


Figure 3. Comparative assessment of the Atlas of Living Australia.

Information System: CyberTracker
Reporting: The PDA-based software includes only simple data capture forms and a mapping interface. Associated PC-based software can be used to generate customised reports, tables, simple maps and charts.
Mapping: See notes on Reporting.
Analysis: No in-built analysis capability; although reports based on data downloaded from a PDA can be exported for analysis in other systems.
Potential for biased observations: Dependent on standards and procedures for the individual projects for which CyberTracker is being used.
Gap filling - occurrence: Limited data on the distribution and abundance of weed species has been collected through CyberTracker in Australia to-date.
Gap filling - impacts: Limited data on the impacts of weed species has been collected through CyberTracker in Australia to-date.
Modeling: See notes on Gap filling - occurrence:
Summary: Significant potential to support the capture of data in remote areas, where reliable mechanisms to collate data collected on separate hand-held units can be established and maintained. Very little data has been collected via CyberTracker in Australia to-date, limiting the use of these data for filling gaps in knowledge on the distribution, abundance and impacts of invasive species.

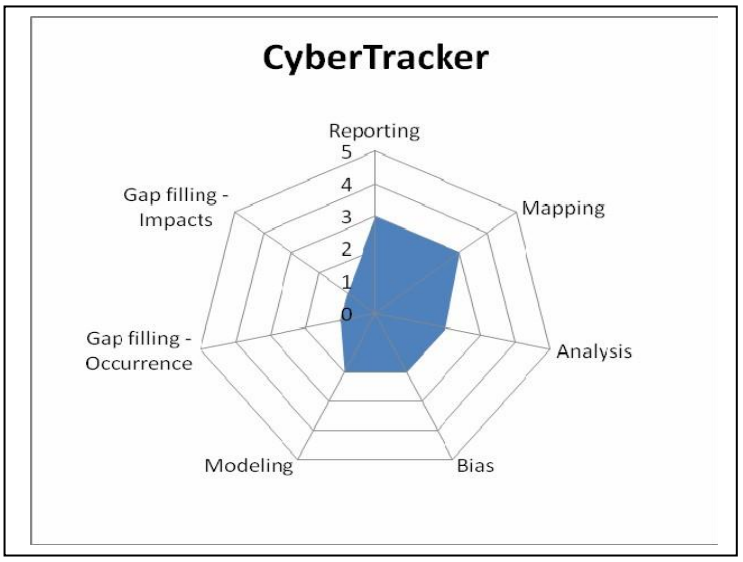


Figure 4. Comparative assessment of CyberTracker.

3.3.2.2 Australian Capital Territory

See NSW listings (3.2.1.3).

3.3.2.3 New South Wales

Information System: Pest Animal Survey 2002/03, Pest Animal Survey 2004-2005 and Pest Animal Survey 2009-2010 (unpublished)
Reporting: The survey results for each survey have been analysed to compare extent for each species with the results of the previous survey at the survey grid cell level, and to map the potential maximum range for each species. The allied NSW Local Government Weeds Survey is used to inform the decisions of weed control bodies, such as CMAs and state agencies involved in weed management. It is envisaged that the data collected will help local control authorities in identifying external weed threats from neighbouring regions and changes in priority weed distribution over time.
Mapping: Data on presence/absence and abundance was recorded on a grid-cell basis.
Analysis: No in-built analysis capability; although reports based on these surveys include an analysis of the data collected, which may be used to inform other programs.
Potential for biased observations: These surveys concern a set number of species, and rely on the subjective assessment of survey participants. Information gaps may arise where there are gaps in knowledge across survey participants. **Gap filling - occurrence:** Extent and abundance attributes are recorded for each survey and the data collected through these surveys have been used to fill gaps in knowledge on the distribution and abundance of invasive species. These can be compared over time as a common methodology and scale is used.
Gap filling - impacts: Impact attributes are recorded for each survey and the data collected through these surveys have been used to fill gaps in knowledge on the distribution and abundance of invasive species. These can be compared over time as a common methodology and scale is used.
Modeling: The data has been used to extrapolate the potential maximum distribution for each species.

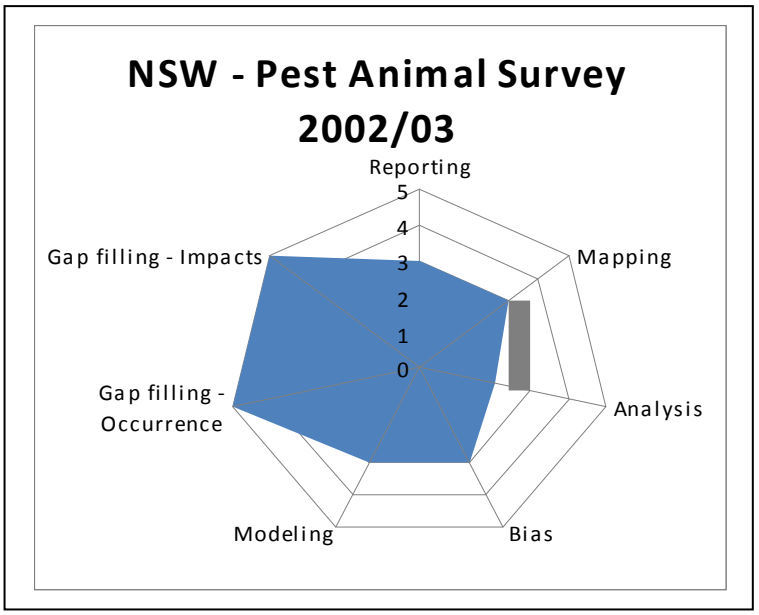


Figure 5. Comparative assessment of the Pest Animal Survey.

Summary:
Although the Pest Animal Survey is not an information system, the data collected represents a significant source of knowledge of pest distribution and abundance over time. For this reason the survey(s) are rated highly in terms of the opportunity to use these data to fill gaps in knowledge of pest distribution, abundance and impacts. The data is available spatially, and so also has value in mapping, further analysis and predictive modelling.

Information System: New and Emerging Pest Reporting
Reporting: Summary reports can be generated from the database.
Mapping: No in-built mapping capability; although a potential mapping function through Google maps is currently being investigated.
Analysis: No in-built analysis capability.
Potential for biased observations: These surveys record information on a limited number of species, and rely on the subjective assessment of survey participants. Information gaps may arise where there are gaps in knowledge across survey participants.
Gap filling - occurrence: It is unlikely that the data recorded in this system is currently useful in filling gaps in knowledge on invasive species distribution and abundance.
Gap filling – impacts: See comments under Gap filling – occurrence.
Modeling: See comments under Gap filling – occurrence.
Summary: Limited scope to utilise this information system and/or the data recorded outside this business application.

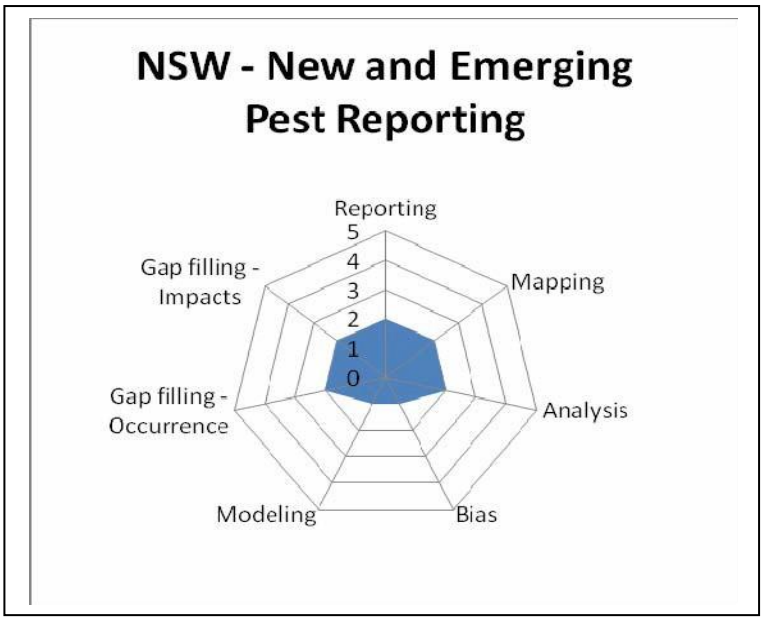


Figure 6. Comparative assessment of New and Emerging Pest Reporting.

Information System: New Aquatic Pests
Reporting: Summary reports can be generated from the spreadsheet.
Mapping: No in-built mapping capability.
Analysis: No in-built analysis capability.
Gap filling - occurrence: It is unlikely that the data recorded in this system is currently useful in filling gaps in knowledge on invasive species distribution and abundance.
Gap filling – impacts: See comments under Gap filling – occurrence.
Modeling: See comments under Gap filling – occurrence.
Summary: Limited scope to utilise this information system and/or the data recorded outside this business application.

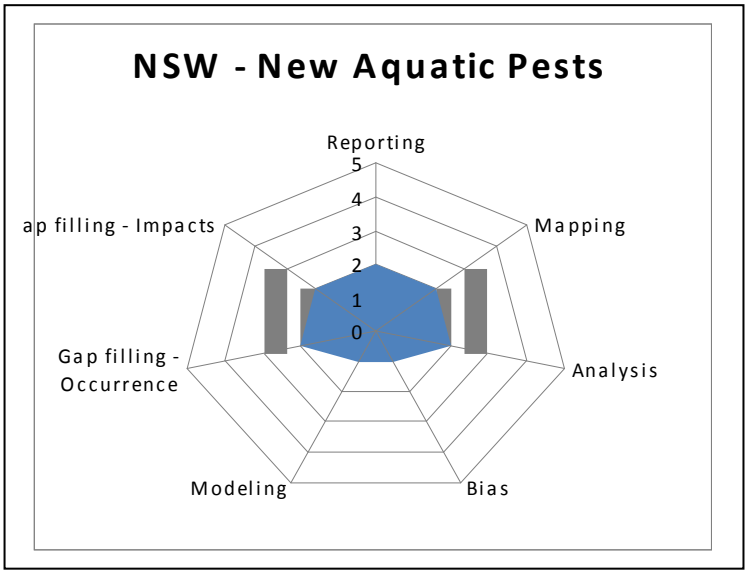


Figure 7. Comparative assessment of New Aquatic Pests

Information System: New Invasive Species / Emerging Invasive Species / Widespread Invasive Species
Reporting: Ongoing surveys have been conducted through local government weeds officers for weed species distribution. Data has been presented on fish pests, marine pests, pest animals (LHPA - camels, horses, donkeys, deer, cane toads and wild dogs. DECCW records fox and Bitou bush threat abatement plans and weeds (currently 134 species). DPI – Industry and Investment records new and emerging species only. Baseline distribution data was collected in 2007 with a second distribution survey to be completed by February 2011
Mapping: No in-built mapping capability.
Analysis: No in-built analysis capability.
Potential for biased observations: These surveys concern a set number of species, and rely on the subjective assessment of survey participants. Information gaps may arise where there are gaps in knowledge across survey participants.
Gap filling - occurrence: Extent and abundance attributes are recorded for each survey. These could be compared over time as a common methodology and scale is used.
Gap filling - impacts: Data on impacts are recorded for each survey. These could be compared over time as a common methodology and scale is used.
Modeling: Potentially, but this has not be done to-date.

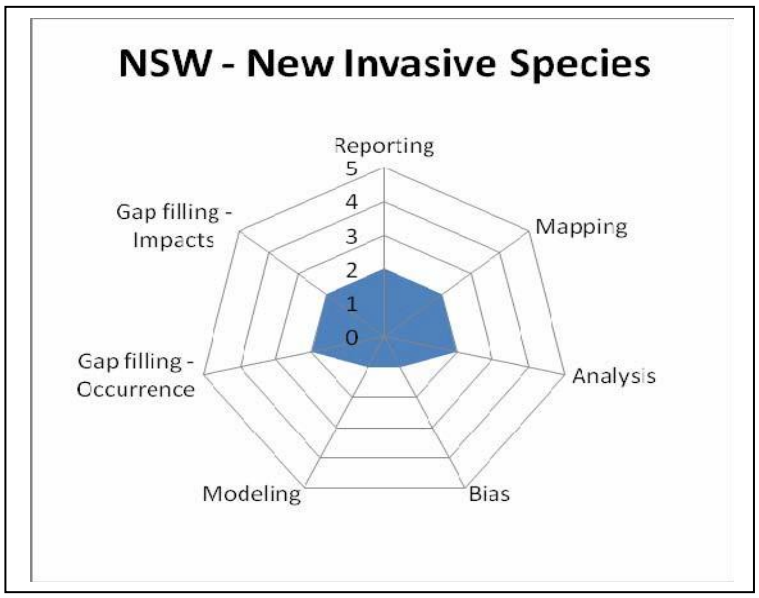


Figure 8. Comparative assessment of New Invasive Species / Emerging Invasive Species / Widespread Invasive Species

Summary: Limited scope to utilise this information system outside this business application. However the data recorded in this system may be useful in filling gaps in knowledge on the distribution and abundance of invasive species.

Information System: Riverine Eco-Systems
Reporting: Reports are generated every 3 years; however the collection of data for the fish indicator for both inland and coastal catchments is dependent on the continuation of the MDNA's Sustainable Rivers Audit.
Mapping: No in-built mapping capability.
Analysis: No in-built analysis capability.
Potential for biased observations: Minimised through use of a well established sampling strategy. Information gaps may arise is areas where there are few or no sampling points.
Gap filling - occurrence: There is some potential to use the data collected through this system to fill gaps in knowledge on the distribution and abundance of pest species, however this has not been done to-date.
Gap filling - impacts: See comments under Gap filling – occurrence.
Modeling: See comments under Gap filling – occurrence.
Summary: No scope to utilise this information system and/or the data recorded outside this business application. However the data recorded in this system is likely to be useful in filling gaps in knowledge on the distribution and abundance of invasive species, and in forecasting future distributions.

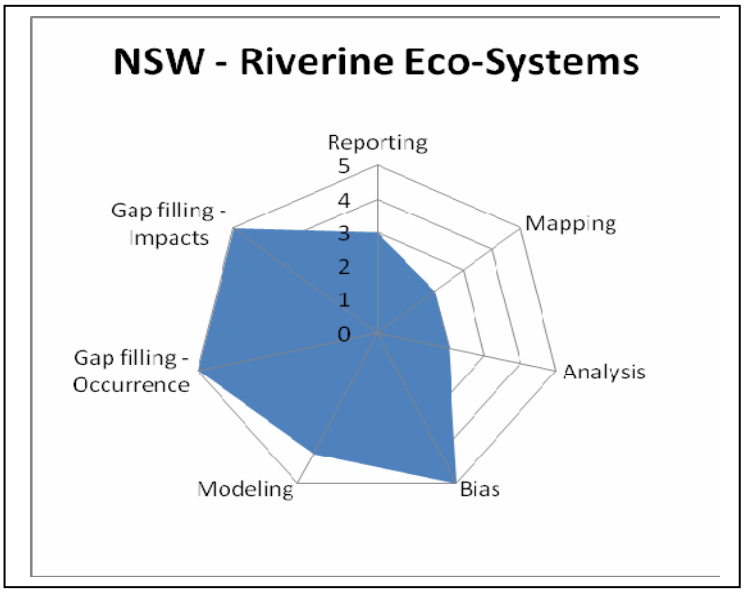


Figure 9. Comparative assessment of Riverine Eco-Systems

Information System: Insect and mite collection in Australia
Reporting: Summary reports can be generated from the spreadsheet.
Mapping: No in-built mapping capability.
Analysis: No in-built analysis capability.
Potential for biased observations: This system is reliant on specimens being forwarded to ASCU.
Gap filling - occurrence: There is some potential to use the data collected through this system to fill gaps in knowledge on the distribution and abundance of pest species, however this has not been done to-date.
Gap filling - impacts: See comments under Gap filling – occurrence.
Modeling: See comments under Gap filling – occurrence.
Summary: No scope to utilise this information system and/or the data recorded outside this business application. However the data recorded in this system may be useful in filling gaps in knowledge on the distribution and abundance of invasive species.

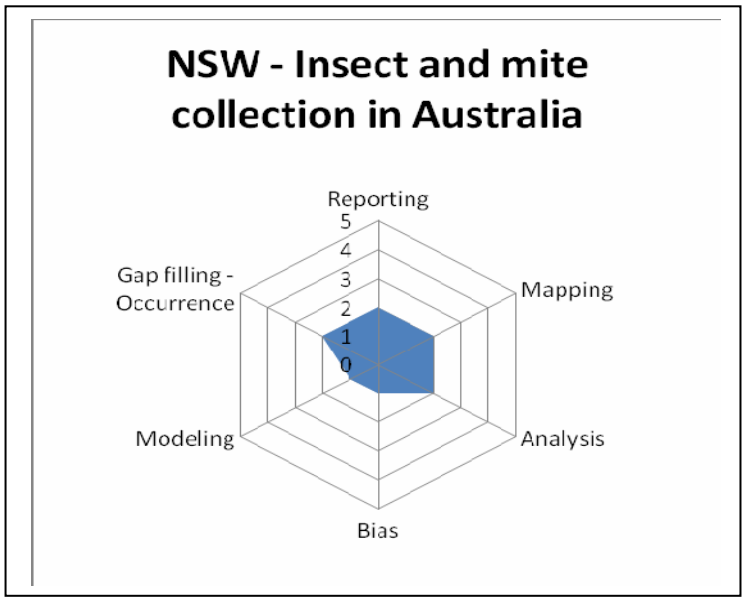


Figure 10. Comparative assessment of Insect and mite collection in Australia

Information System: Summary of Wild Dog Predation
Reporting: Summary reports can be generated from the spreadsheet.
Mapping: No in-built mapping capability.
Analysis: No in-built analysis capability.
Potential for biased observations: This system is reliant on reports of livestock predation to DPI – Industry and Investment.
Gap filling - occurrence: There is limited potential to fill gaps in knowledge on invasive species distribution as an indication of relative population density between areas could be inferred from predation reports.
Gap filling - impacts: See comments under Gap filling – occurrence.
Modeling: See comments under Gap filling – occurrence.

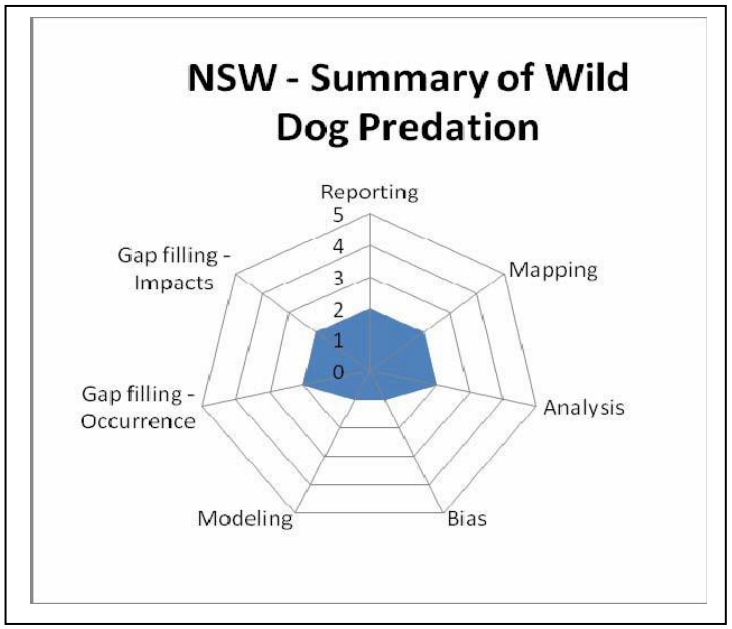


Figure 11. Comparative assessment of Summary of Wild Dog Predation

Summary: No scope to utilise this information system and/or the data recorded outside this business application. However the data recorded in this system may be useful in filling gaps in knowledge on the distribution and abundance of wild dogs.

Information System: Non-Indigenous Animals
Reporting: Data must be extracted manually, but is suitable for regional or State-wide reporting.
Mapping: Records are associated with property contact details only. Limited scope to map these records.
Analysis: No in-built analysis capability.
Potential for biased observations: Data is subject to bias due to the nature of data collection i.e. reports from the public.
Gap filling - occurrence: Data is unlikely to be useful in filling gaps in knowledge regarding the distribution and abundance of pests.
Gap filling - impacts: Data is unlikely to be useful in filling gaps in knowledge regarding the distribution and abundance of pests.
Modeling: Data is unlikely to be useful in forecasting future distribution and abundance of pests.

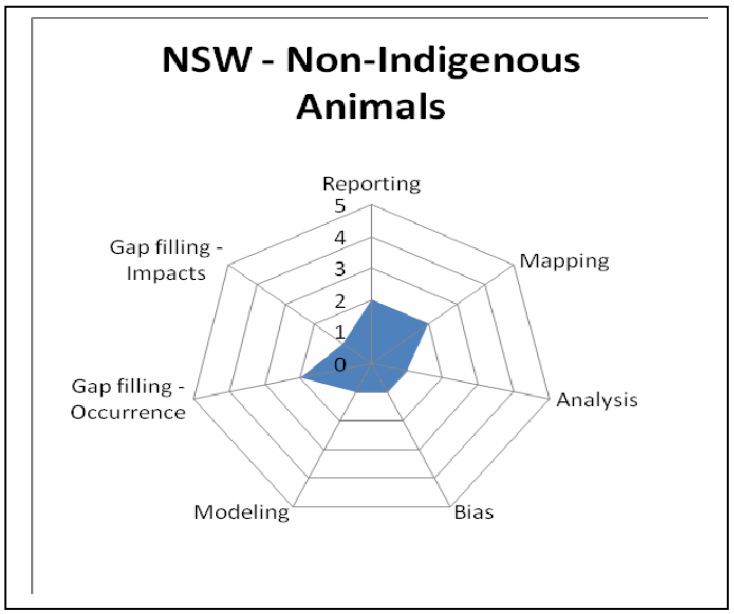


Figure 12. Comparative assessment of Non-Indigenous Animals

Summary: No scope to utilise this information system and/or the data recorded outside this business application.

Information System: Reporting Notifiable Weeds
Reporting: Data must be extracted manually, but is suitable for regional or State-wide reporting.
Mapping: No in-built mapping capability. However, records that include coordinates may be extracted and used to map occurrence and abundance via other information systems.
Analysis: No in-built analysis capability.
Bias: Data is subject to bias due to the nature of data collection i.e. reports from the Local Control Authorities.
Gap filling - occurrence: Data is currently unlikely to be useful in filling gaps in knowledge regarding the distribution and abundance of weeds.
Gap filling – impacts: Data is unlikely to be useful in filling gaps in knowledge regarding the distribution and abundance of weeds.
Modeling: Data is unlikely to be useful in forecasting future distribution and abundance of weeds.

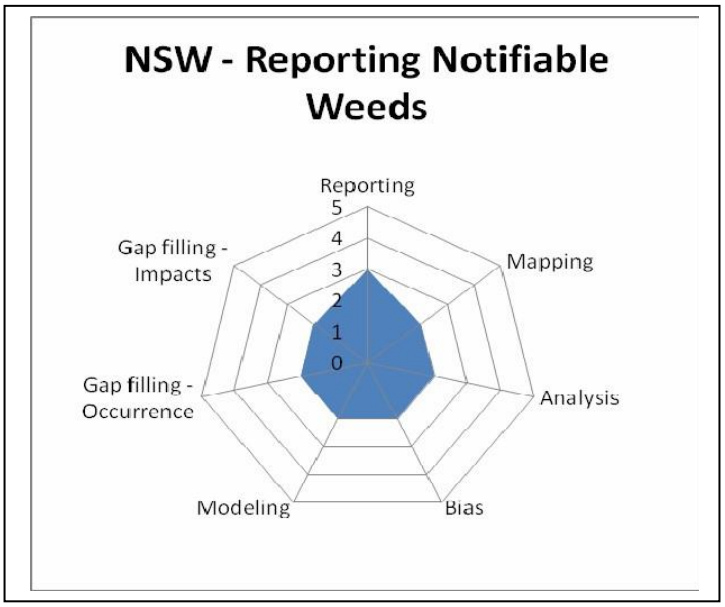


Figure 13. Comparative assessment of Reporting Notifiable Weeds

Summary: Limited scope to utilise this information system outside this business application. The data recorded in this system is unlikely to be useful in filling gaps in knowledge on the distribution and abundance of weed species.

3.3.2.4 Northern Territory

Information System: NT Fauna Atlas
Reporting: The NT NRM Infonet web portal allows the public to query a sub-set of the NT Fauna database to determine presence or absence of species from a selected area. The selected area may be a Park or Reserve, Indigenous Protected Area, Local Government area, NRM subregion, Bioregion, Catchment, Site of Conservation Significance, Project Area or other pre-loaded area, or self drawn.
A report can then be generated by selecting different details of interest, including Fire History, Threatened species, Native Species, Weeds and Pest Animals. In the next 12 months it is anticipated that the interface will be upgraded to allow land owners to login, and once logged in the creation of reports for their property showing GPS points of sightings.

Mapping: The NT NRM Infonet features a relatively sophisticated web map that includes navigation and reporting tools. However, this is not used to capture data.
Analysis: No in-built analysis capability.
Potential for biased observations: The main focus of the NT Fauna database is on Native Fauna of the Northern Territory. Because it is only populated by formal surveys and research projects there is opportunity for bias towards only those invasive species for which research or survey work has been funded by government (Territory and Commonwealth). Because of the sparsely populated nature and inaccessibility of large parts of the Northern Territory, large parts of the landscape away from the main North/South and East/West highways have very few sightings recorded (ie. the Tanami Desert).
Gap filling - occurrence: Because animal numbers are not recorded it is not possible to produce a population density map.
Gap filling - impacts: The NT Fauna database is mainly concerned with presence or absence it does not record impacts.
Modeling: Combined with climate, topographical and land-use data, there is potential for the information in the NT Fauna database to be used to predict occurrence, of pest animals in the NT.

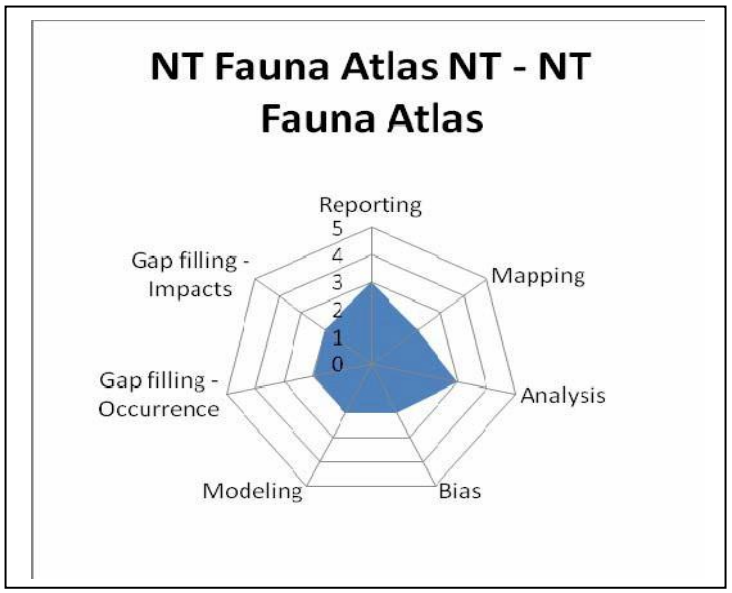


Figure 14. Comparative assessment of NT Fauna Atlas

Summary: The NT Fauna Atlas provides access to a significant amount of data on the distribution of invasive species in the Northern Territory. The application has also been used to provide public access to a wide range of other data and could be extended for a wide variety of business applications.

Information System: Northern Australia Quarantine Strategy (NAQS) survey database (AQIS)
Reporting: A BioSIRT template has been generated to run queries on samples submitted for laboratory analysis – based on date submitted, species, and collector details.
Mapping: The BioSIRT mapping module is not yet currently set up, although this is planned. This would enable spatial reports to be generated.
Analysis: No in-built analysis capability.
Potential for biased observations: The main focus of the NAQS project is to collect samples to test for exotic disease, especially in high risk areas of the Northern coastline. As a result their sampling is heavily biased towards 'higher risk' areas. The NAQS project is focussed on coastal areas. There are limited data available for inland areas.
Gap filling - occurrence: Because animal group numbers are not recorded, it is not possible to produce a population density map.
Gap filling - impacts: The NAQS database is a database that records laboratory results and does not record impacts of invasive species.
Modeling: Combined with climate, topographical and land-use data there is potential for the information in the NAQS database to be used to predict presence or absence of invasive species across Northern Australia.

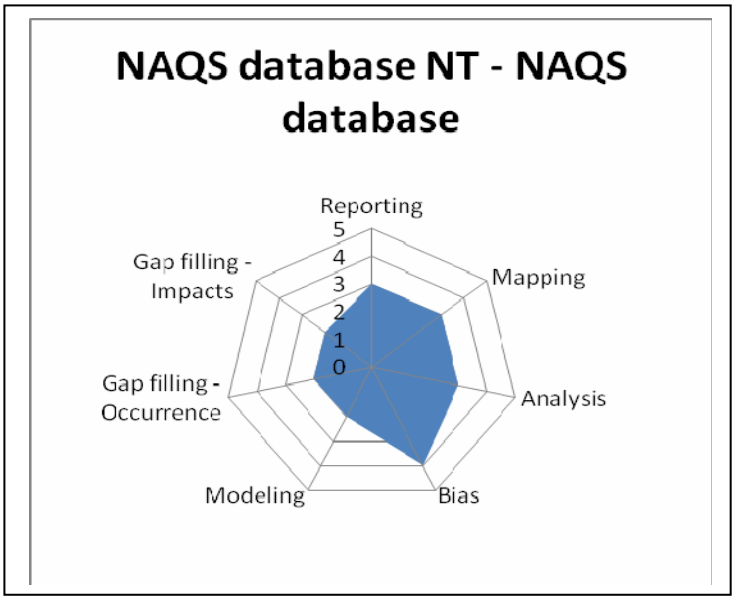


Figure 15. Comparative assessment of the Northern Australia Quarantine Strategy (NAQS) survey database.

Summary: The functionality of this system is provided by BioSIRT (see Section 3.3.2.1 National systems). However, a limited range of functionality available has been implemented at this stage. There is potential for the information in the NAQS database to be used to forecast occurrence, of pest animals in the Northern Territory.

3.3.2.5 Queensland

Information System: Queensland Murray-Darling Committee (QMDC) File Geodatabase system
Reporting: Data is queried using ArcGIS 9.3 as needed to respond to requests for reports for funding applications. Data on individual properties can only be released with permission of the landowner and is rarely released over a wide area due to the difficulties in securing large numbers of permission forms.
Mapping: ArcGIS provides a relatively sophisticated mapping capability. However, this is a desktop capability restricted to individual use.
Analysis: No in-built analysis capability.
Potential for biased observations: As this system is focussed on supporting volunteer community groups and managing government grants for specific projects there is opportunity for bias towards only those invasive species which the community and government (State and Federal) perceive as a priority. Working within the Queensland Murray-Darling catchment, there is the potential for information gaps to form in sub-catchments that do not have active catchment groups and landowners involved in QMDC associated projects.
Gap filling - occurrence: Pest animal densities are recorded, so it would be possible to produce population density maps.
Gap filling - impacts: Data on impacts are currently only recorded as evidence of presence at an individual site, so there is limited scope to produce maps on impacts from current data. However as the database and field PDA system is set up to collect information in the SPAS standard, maps of impacts could be produced if users populate the database with sighting 'evidence' e.g. stock attacked, damage to crops, pasture and infrastructure.
Modeling: Combined with climate, topographic and land-use data there is potential for the information in the QMDC database to be used to predict occurrence, of pest animals in the Queensland Murray-Darling catchment.

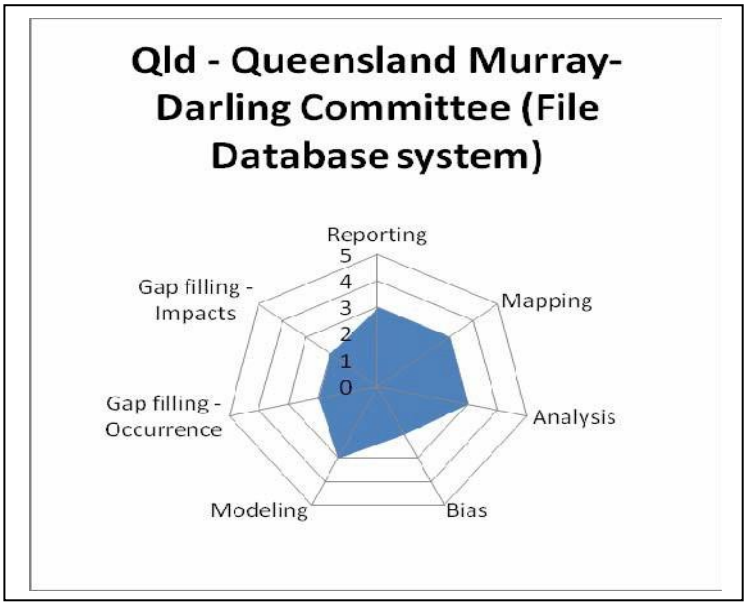


Figure 16. Comparative assessment of the QMDC File Geodatabase system

Summary: The QMDC File Geodatabase system could potentially be adapted to use for other pest animal management programs. The data available through the QMDC system may be useful in addressing gaps in regional knowledge of invasive species distribution and abundance, and in forecasting future distributions.

Information System: Pest Central (operated by XY Mapping)
Reporting: The desktop application available to subscribers includes a number of tools to analyse potential impacts and spread. All records are geo-located using subscriber PDAs.
Mapping: Pest Central collates data from the field using PDA devices. These data can be accessed and mapped through subscriptions to the service.
Analysis: No in-built analysis capability.
Potential for biased observations: As of October 2010 there were only three subscribers to the service due to cost (DEEDI and two of the larger local governments). This makes it likely observations will be recorded largely in local government areas that can afford the subscription costs and places that DEEDI has active projects operating.
Gap filling - occurrence: As the database is only recently created population density maps are not yet possible. Once sufficient data has been collected population density maps could be generated from the data.
Gap filling - impacts: As the database and field PDA system is set up to collect information in the SPAS standard, if users populate the database with sighting 'Evidence' (Stock bitten, Stock killed, Crop damage, Pasture damage, Infrastructure damage, Environmental impacts) limited damage maps can be produced.
Modeling: As the database is only recently created occurrence maps are not yet possible. Once sufficient data has been collected, combined with climate, topographical and land-use data there is potential for the information in the Pest Central database to be used to predict occurrence of pest animals.

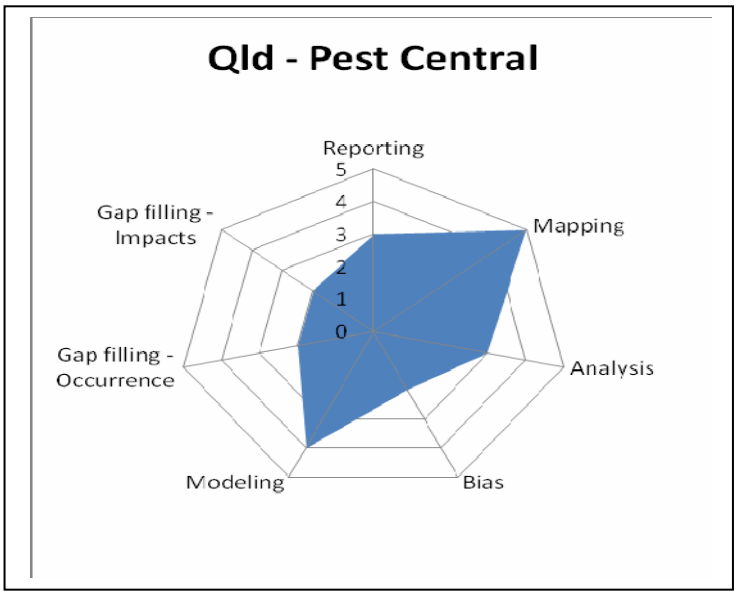


Figure 17. Comparative assessment of Pest Central.

Summary: Pest Central is unique in Australia as the only commercially hosted, cloud computing based service for recording invasive species data. The system is being used by the Government of Queensland to encourage the use of the Spatial Pest Attribute Standard (SPA Standard) to community groups and others subscribing to PestCentral.

Information System: Annual Pest Distribution Survey (APDS) databases
Reporting: Static PDF maps of species occurrence, distribution and density are generated from the data and made available to the public. Due to the nature of the survey the database does not record individual sightings or geo-locating method or rate the reliability of records.
Mapping: No in-built analysis capability. Maps are produced annually from survey records in a static form (PDFs).
Analysis: No in-built analysis capability.
Potential for biased observations: Due to the nature of the survey there is significant potential for biased observation of numbers, density and occurrence. Because of the sparsely populated nature and inaccessibility of parts of Queensland, large parts of the landscape in the North and interior are serviced by very few DEEDI staff i.e. the Simpson Desert & Cape York. This means some of the grid cells in the survey are likely to be more reliably populated than others.
Gap filling - occurrence: Estimates are made by DEEDI staff on population densities, and this information is used to create Population Density maps.
Gap filling - impacts: This information is not collected, so Damage maps cannot be produced.
Modeling: DEEDI staff record presence and absence of each invasive species in each grid cell across Queensland. Combined with climate, topographical and land use data there is potential for the information in the database to be used to predict occurrence of pest animals in similar regions in neighbouring states and territories.

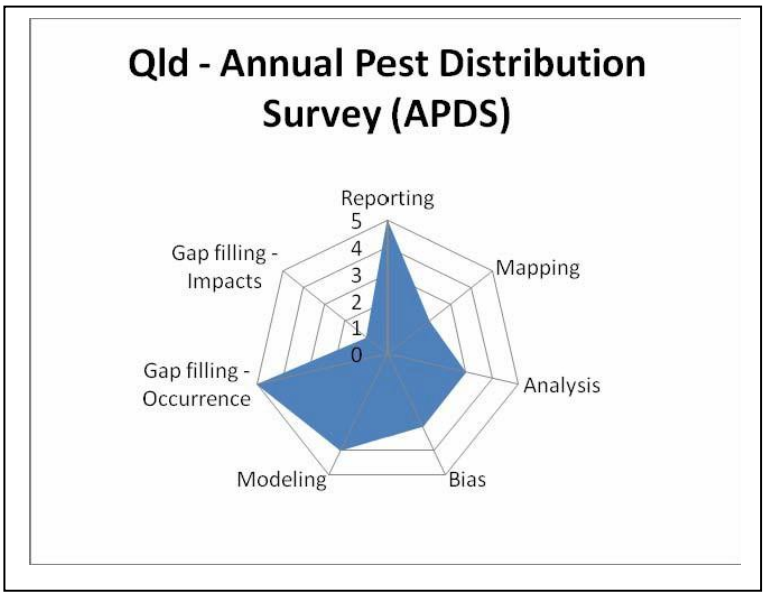


Figure 18. Comparative assessment of the Annual Pest Distribution Survey (APDS) databases.

Summary: Limited scope to utilise this information system outside this business application. However the data recorded in this system has been useful in filling gaps in knowledge on the distribution and abundance of invasive species.

Information System: ParkInfo (Queensland Parks and Wildlife Service). **Reporting:** The ParkInfo system is used to record fire and pest events, then to prioritise work and document proposed response measures. There are a number of preconfigured summary reports that can be generated about individual pest management activities. Staff can visually interrogate numerous layers and undertake simple analyses aimed at aiding management decisions.
Mapping: ParkInfo includes a relatively sophisticated mapping capability based on ArcView, which has been customised with a reduced set of functions for use by staff with minimal specialist training is GIS software.
Analysis: The system includes a range of pre-sent analysis routines for land management tasks.
Potential for biased observations: As all information is collected by park rangers there is potential for data collection to be biased towards perceived problem species only, especially those for which there is control work funded by government (State or Commonwealth). There is an inherent gap in ParkInfo because usually only information from the parks estate is recorded. Where possible rangers work with landholders bordering the park as appropriate for cross-boundary land management issues. Other gaps may form where ParkInfo is not used in the decision making process by individual rangers. In December 2005 74% of Queensland reserves had pest or fire information recorded (Kington 2006).
Gap filling - occurrence: As part of the management aspect of ParkInfo it requires pest density information before and after treatments, so the data could be used to produce population density maps.
Gap filling - impacts: While rangers may collect sighting evidence (Stock bitten, Stock killed, Crop damage, Pasture damage, Infrastructure damage, Environmental impacts) to prepare their applications for management actions, it does not appear to be recorded in the ParkInfo GIS modules, so damage maps are not able to be produced.
Modeling: Combined with climate, topographical and land use data there is potential for the occurrence and density information in ParkInfo to be used to predict occurrence and perhaps density of pest animals in bushland across Queensland.

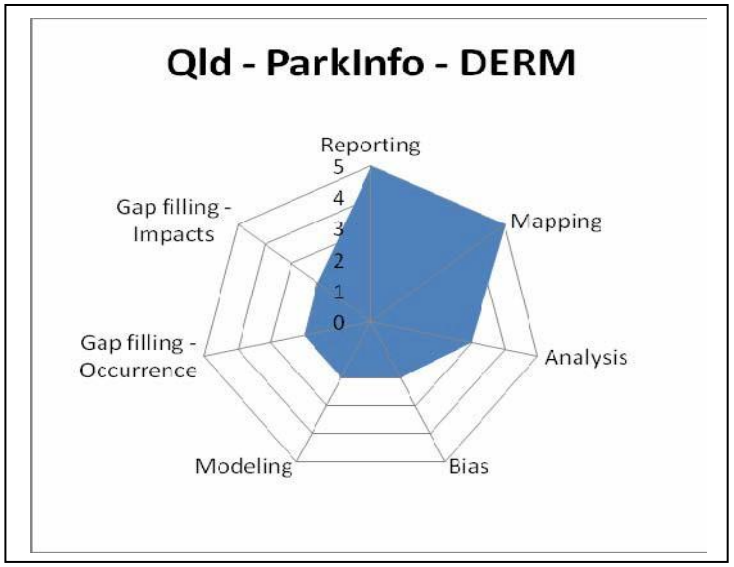


Figure 19. Comparative assessment of ParkInfo

Summary: ParkInfo has been designed specifically for the management of reserves, and therefore has limited potential for application in broader aspects of pest management. The data on invasive species recorded in PestInfo is likely to be of limited use in filling gaps in knowledge of invasive species distribution and abundance.

Information System: LARIE (Land and Resource Information Environment, DERM Qld) - Delbessie database
Reporting: Summary reports are generated from each Lease inspection, and used in negotiation of lease renewal land management agreements.
Mapping: LARIE includes a relatively sophisticated, web-based mapping capability based on Esri Dekho and ArcGIS. In the field, ArcEditor is used on a laptop, linked to a GPS and PDA to capture data. Information is synchronised back to a central database on return to the office.
Analysis: The system a number of standardised analysis routines for producing summary reports at various scales.
Potential for biased observations: Opportunity for bias within leases is minimised by the review criteria and operating procedures. The nature of the lease reviews ensures mostly leased properties due for renewal are populated in the database.
Gap filling - occurrence: There is some potential to use the data collected to fill gaps in knowledge on invasive species distribution and abundance.
Gap filling - impacts: There is some potential to use the data collected to fill gaps in knowledge on the impacts of invasive species.
Modeling: There is limited potential to use the data collected to model the future distribution of invasive species.

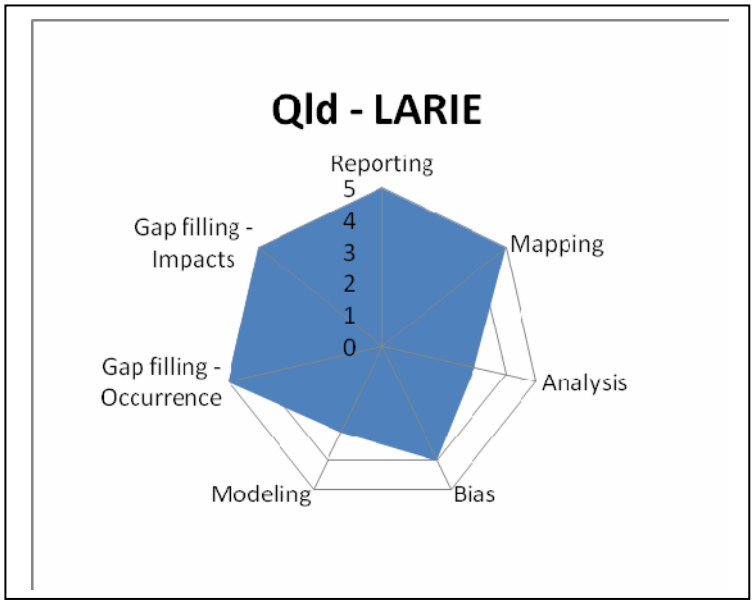


Figure 20. Comparative assessment of LARIE.

Summary: The LARIE system includes a range of capabilities, including a workflow for transferring field observations to a central database that would potentially be useful for invasive species management in other jurisdictions. The data on the presence and absence of invasive species and their impacts may, over time, be useful in filling gaps in knowledge regarding the distribution and abundance of invasive species.

Information System: The Herbert Resource Information Centre (HRIC)
Reporting: The database is still a prototype; however advanced reporting has been set up for the sugar industry using the same technology. The Spatial Pest Attribute Standard (SPAS) incorporates recording of technique and reliability of methods used for capturing spatial data.
Mapping: The HRIC information system has a relatively sophisticated mapping capability based on ArcSDE (on ArcServer).
Analysis: The system includes a limited range of pre-configured analyses to produce standardised reports. However, these could be expanded through ArcServer.
Potential for biased observations: As this database is still a prototype with relatively low take-up this criteria cannot be assessed at this stage.
Gap filling - occurrence: If this database moves beyond its initial prototype and useful amounts of population data are recorded in it, population density maps are possible because of its use of the SPAS standard.
Gap filling - impacts: If this database moves beyond its initial prototype and useful amounts of damage data are recorded in it, damage maps are possible because of its use of the SPAS standard.
Modeling: If this database moves beyond its initial prototype and useful numbers of population data are recorded - these data, combined with climate, topographical and land-use data may be useful in predicting the occurrence of pest animals.

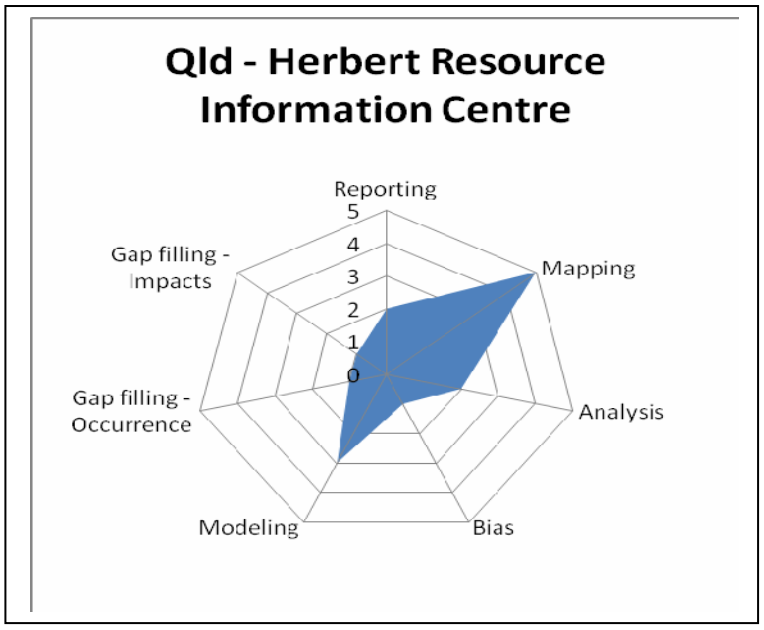


Figure 21. Comparative assessment of the Herbert Resource Information Centre (HRIC)

Summary: The HRIC system includes a range of capabilities, including a workflow for transferring field observations to a central database that would potentially be useful for invasive species management in other regions. The data on the presence and absence of invasive species and their impacts may, over time, be useful in filling gaps in knowledge regarding the distribution and abundance of invasive species in this region.

Information System: 1080 database
Reporting: No in-built reporting capability.
Mapping: No in-built analysis capability. Maps are produced annually from survey records in a static form (PDFs).
Analysis: No in-built analysis capability.
Potential for biased observations: Data is recorded only for properties included in the 1080 baiting program.
Gap filling - occurrence: As data is recorded on a land parcel (lot) basis, the data may potentially be mapped, and have use in filling gaps in knowledge of wild dog distribution.
Gap filling - impacts: See notes on Gap filling – occurrence.
Modeling: These data are not likely to be suitable for modelling or forecasting pest distributions.

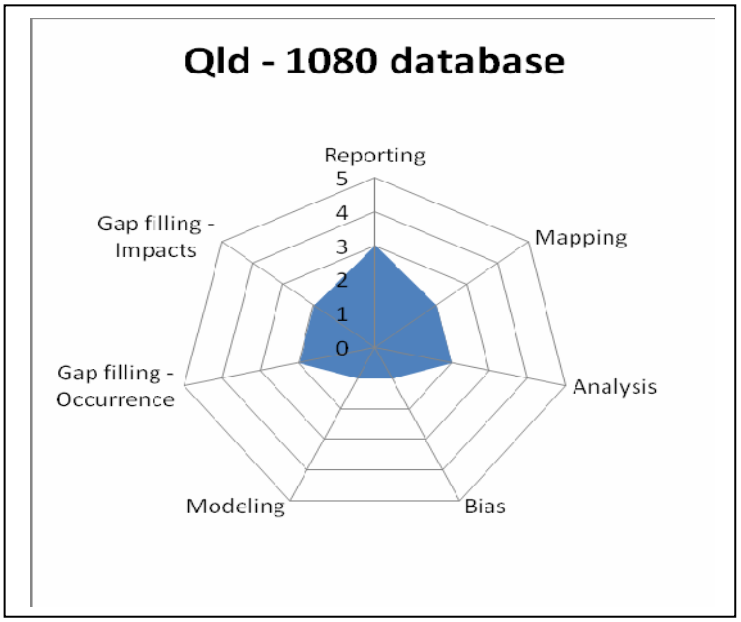


Figure 22. Comparative assessment of the 1080 database

Summary: No scope to utilise this information system outside this business application. However the data recorded in this system may be useful in filling gaps in knowledge on the distribution and abundance of invasive species.

Information System: PestInfo 4.3
Reporting: Limited reporting functionality – based on summarising grid-based data.
Mapping: Simple mapping interface designed to enable users with minimal training to capture a limited number of attributes for each survey grid cell.
Analysis: No in-built analysis capability.
Potential for biased observations: Dependent on the knowledge and experience of local users.
Gap filling - occurrence: The database was used as a primary source of information on the distribution and abundance on major invasive species in Queensland.
Gap filling - impacts: See notes on Gap filling – occurrence.
Modeling: Data have been used for modelling and risk assessment. Data provided to researchers and other agencies under data sharing arrangements.

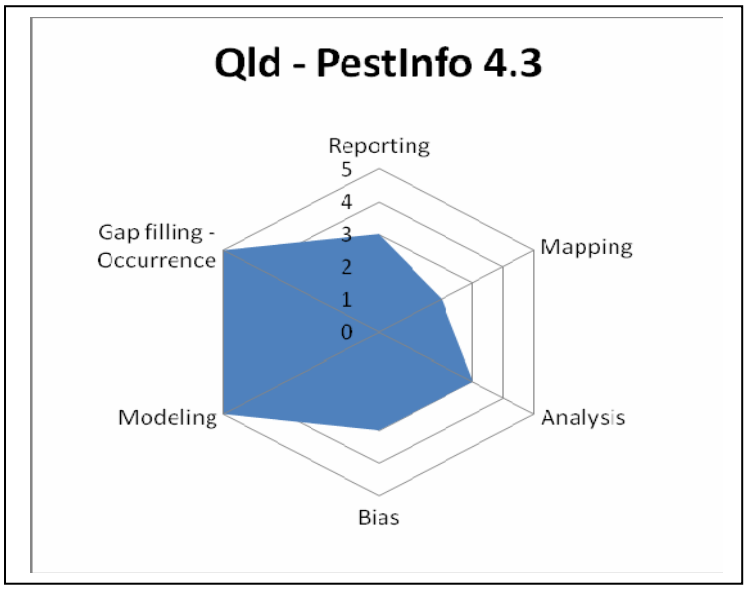


Figure 23. Comparative assessment of PestInfo 4.3

Summary: The PestInfo system was used as a primary source of information on the distribution and abundance on major invasive species in Queensland for over a decade. The technical architecture of this system is no longer supported and alternatives, such as Pest Central, are now being used.

Information System: Island Survey
Reporting: No in-built reporting capability.
Mapping: Limited mapping capability based on ArcView.
Analysis: No in-built analysis capability
Potential for biased observations: Low, based on standardised survey methodology.
Gap filling - occurrence: Data has limited coverage, but may be useful in addressing gaps in knowledge of invasive species distribution and abundance on off- shore islands.
Gap filling - impacts: See notes on Gap filling – occurrence.
Modeling: Data is unlikely to be useful in modelling or forecasting invasive species distributions.

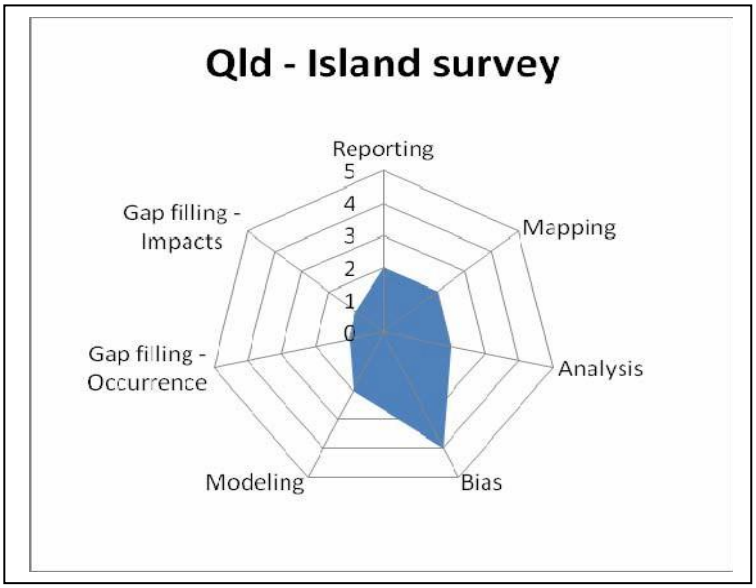


Figure 24. Comparative assessment of Island Survey

Summary: No scope to utilise this information system outside this business application. However the data recorded in this system may be useful in filling gaps in knowledge on the distribution and abundance of invasive species on off-shore islands.

Information System: Tropical Weeds database - Siam weed 'four tropical weeds program' (national cost sharing program)
Reporting: No in-built reporting capability.
Mapping: No in-built mapping capability.
Analysis: No in-built analysis capability.
Potential for biased observations: Low, due to carefully designed survey methodology.
Gap filling - occurrence: Data are used to map the occurrence and abundance of these four weed species.
Gap filling - impacts: See notes on Gap filling – occurrence.
Modeling: These data are used to model and forecast the potential distribution of these invasive species.

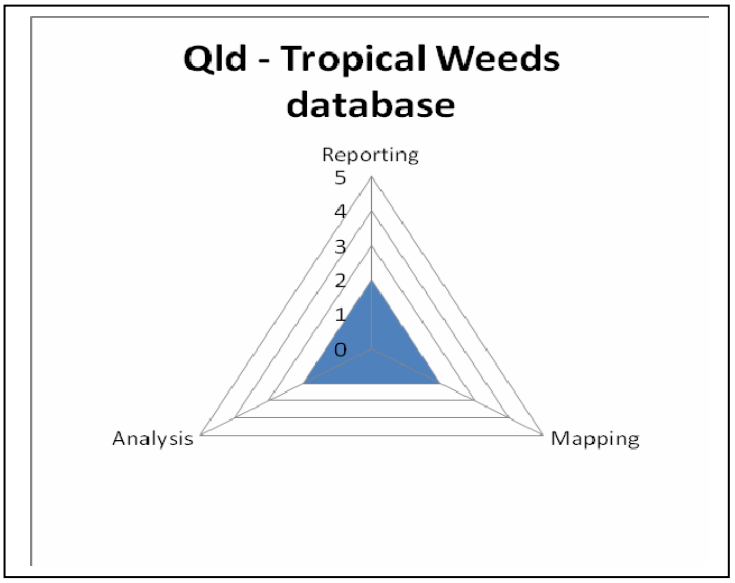


Figure 25. Comparative assessment of the Tropical Weeds database

Summary: No scope to utilise this information system outside this business application. However the data recorded in this system is the primary source of information on pest distribution and abundance used to manage this program.

3.3.2.6 South Australia

Information System: Pest2000+
Reporting: No in-built reporting capability.
Mapping: No in-built mapping capability.
Analysis: No in-built analysis capability.
Potential for biased observations: Data has been recorded for limited areas as only 17 of 27 South Australian Animal and Plant Control boards have taken up Pest2000+ and used it to varying degrees.
Gap filling - occurrence: Limited data available is not likely to be useful in addressing gaps in knowledge on the distribution and abundance of invasive species. **Gap filling - impacts:** See notes on Gap filling – occurrence.
Modeling: Limited data available is not likely to be useful in for modelling of forecasting the distribution of invasive species.
Summary: No scope to utilise this information system outside this business application. The data recorded in this system is likely of be of limited use in filling gaps in knowledge on the distribution and abundance of invasive species.

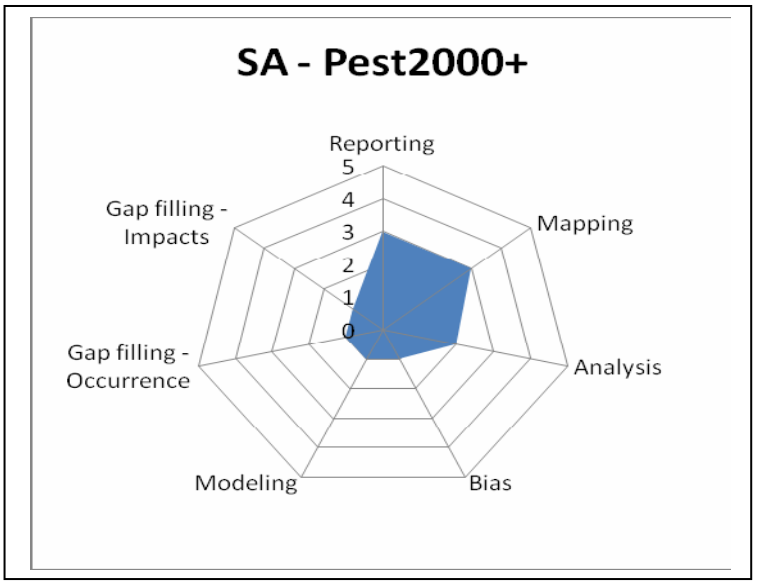


Figure 26. Comparative assessment of Pest2000+

Information System: Primary Industries Information Management System (PIMS)
Reporting: PIMS includes advanced reporting capabilities and is used as a fundamental information system for managing biosecurity issues in South Australia.
Mapping: PIMS has a relatively sophisticated mapping capability based on ArcGIS.
Analysis: PIMS has limited in-built analysis capability; however data are routinely extracted for analysis in other information systems.
Potential for biased observations: PIMS is primarily concerned with stock registrations, and so records information only for properties with registered stock species.
Gap filling - occurrence: PIMS on not currently used to record information on invasive species.
Gap filling - impacts: See notes on Gap filling – occurrence.
Modeling: See notes on Gap filling – occurrence.
Summary: PIMS is designed primarily for the management of the stock registration process and associated biosecurity regulation activities in South Australia. Although not currently used to manage invasive species, the system includes a number of capabilities (reporting and mapping) that may be useful for other biosecurity business applications.

Information System: Arid Lands Information System (ALIS)
Reporting: ALIS has a relatively sophisticated reporting capability for registered users via the on-line web map application. Limited reporting is available for public users.
Mapping: ALIS has a relatively sophisticated web-based mapping interface, although this is not currently used to record data on-line.
Analysis: ALIS has no in-built analysis capability.
Potential for biased observations: Data is limited to areas surveyed by contractors on behalf of the Natural Resource Management Boards.
Gap filling - occurrence: Only a limited amount of data on invasive species distribution is available at this stage. Consequently these data are likely to be of limited use in filling gaps in knowledge on invasive species distribution and abundance.
Gap filling - impacts: See notes on Gap filling – occurrence.
Modeling: See notes on Gap filling – occurrence.

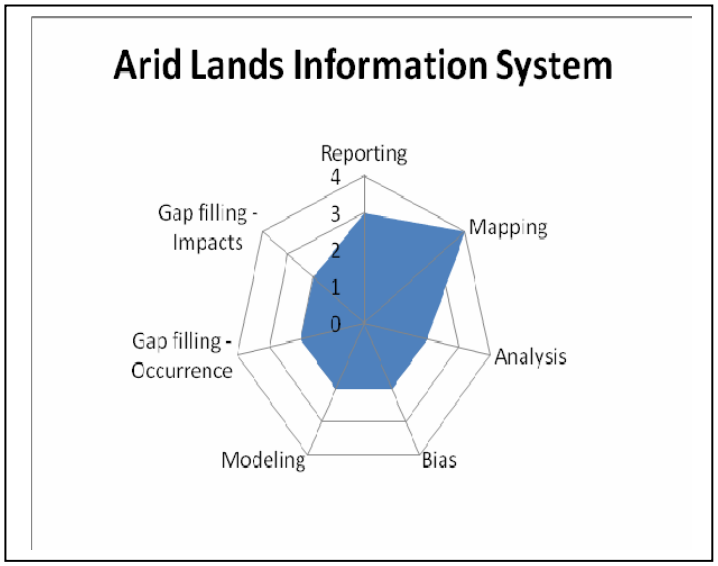


Figure 27. Comparative assessment of the Arid Lands Information System

Summary: ALIS includes a range of capabilities (reporting and mapping) that may be useful for a broader range of biosecurity applications, including an expanded range of invasive species management applications. Only a limited amount of data on invasive species distribution is available at this stage. Consequently these data are likely to be of limited use in filling gaps in knowledge on invasive species distribution and abundance.

3.3.2.7 Tasmania

Information System: GT-Spot
Reporting: Data was previously searched and downloaded through an on-line form. This function has now been transferred to the Natural Values Atlas.
Mapping: GT-SPOT had a relatively sophisticated web-based mapping interface based on ArcGIS, although this was not used to record data on-line.
Analysis: GT-SPOT had no in-built analysis capability.
Potential for biased observations: This databases linked to this system consist largely of field observations and bias may arise where observations have been collected opportunistically i.e. along roadsides or in reserves and parks.
Gap filling - occurrence: Data has been used to map the distribution and abundance of invasive species in Tasmania.
Gap filling - impacts: See notes on Gap filling – occurrence.
Modeling: Data on the distribution, or extent, of populations from some source databases linked to the system have been used with climate models to predict occurrence.

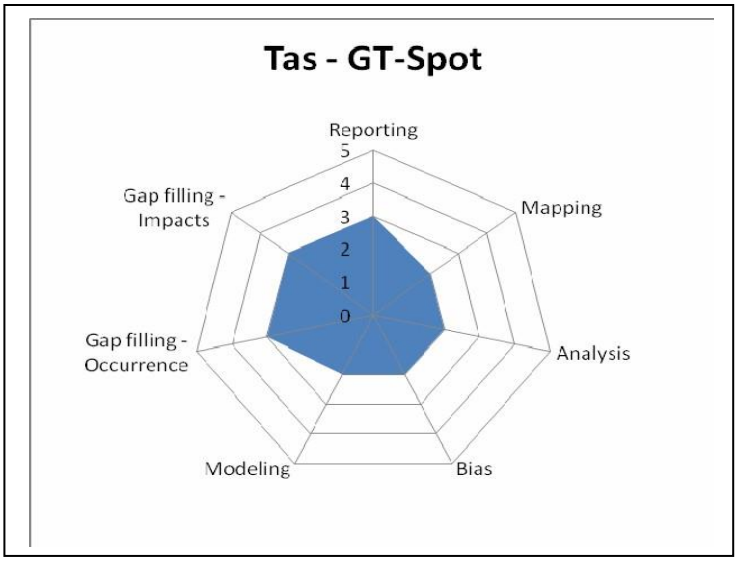


Figure 28. Comparative assessment of GT-Spot

Summary: The functionality of this system has been superseded by the Tasmanian Natural Values Atlas (see the assessment below). Data accessed through GT-Spot has also been transferred to the Atlas system.

Information System: Natural Values Atlas
Reporting: Natural Values reports (including weeds) can be generated over a defined spatial area. Data can be extracted as a shape file for detailed analysis.
Mapping: The Natural Values Atlas has a relatively sophisticated web-based mapping interface based on ArcGIS, although this was not used to record data on-line.
Analysis: The Natural Values Atlas had no in-built analysis capability.
Potential for biased observations: This databases linked to this system consist largely of field observations and bias may arise where observations have been collected opportunistically i.e. along roadsides or in reserves and parks.
Gap filling - occurrence: Data is largely limited to the distribution, or extent, of current populations.
Can the data be used to produce a Damage map: Data is largely limited to the distribution, or extent, of current populations.
Gap filling - impacts: Data on the distribution, or extent, of populations from source databases can be used to generate habitat maps. DPIPWE are working with CSIRO to map potential current and future weed distribution using CLIMEX.

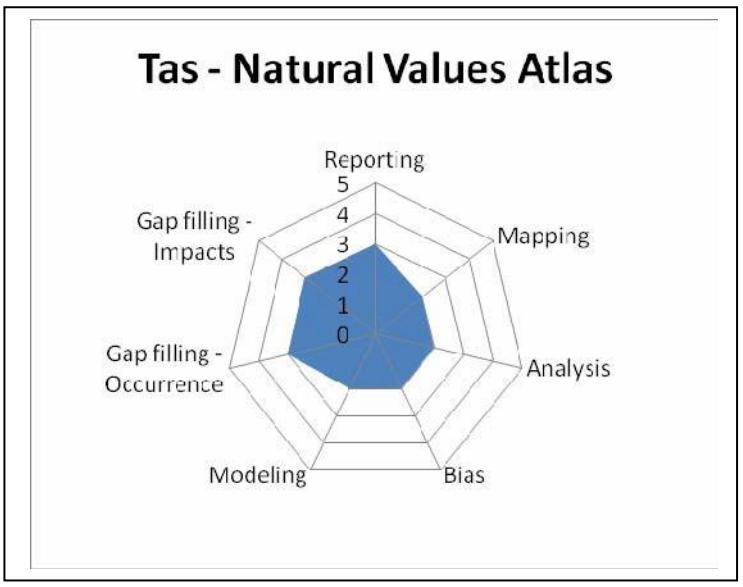


Figure 29. Comparative assessment of the Natural Values Atlas

Summary: The Tasmanian Natural Values Atlas has a range of functionality (reporting and mapping) that may be useful for extended applications in invasive species management. The data available through the Atlas is already being used to model and forecast the distribution of invasive species.

3.3.2.8 Victoria

Information System: Integrated Pest Management System (IPMS)
Reporting: IPMS includes a limited reporting capability based on desktop application forms.
Mapping: : IPMS has a relatively sophisticated mapping capability based on Moxi Media.
Analysis: IPMS has no in-built analysis capability.
Potential for biased observations: Low, based on the comprehensive nature of the pest management program.
Gap filling - occurrence: Although based on land parcels, the data are likely to be useful for filling gaps in knowledge on invasive species distribution and abundance.
Gap filling - impacts: Although based on land parcels, the data are likely to be useful for filling gaps in knowledge on the impacts of invasive species.
Modeling: Although based on land parcels, the data are likely to be useful for modelling and forecasting the distribution of invasive species.

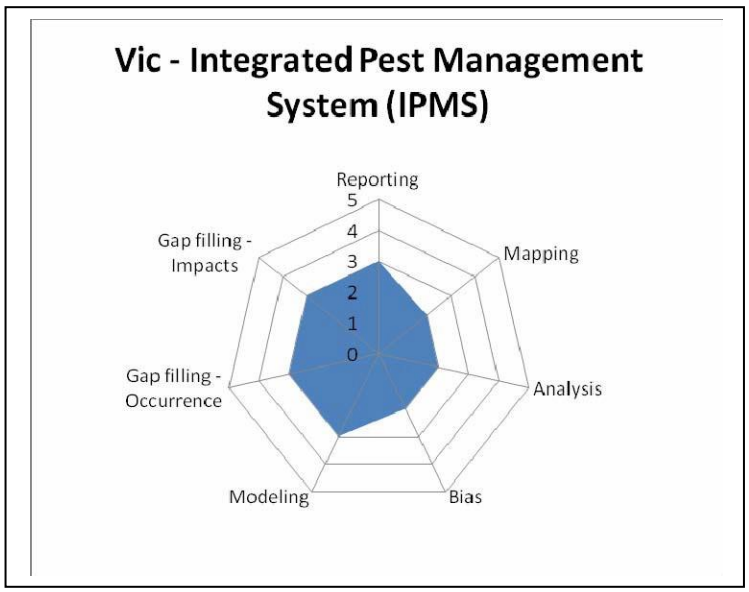


Figure 30. Comparative assessment of the Integrated Pest Management System

Summary: Although superseded by newer applications, such as ISIS, the data recorded in IPMS are likely to be useful in filling gaps in knowledge on distribution, abundance and impacts of invasive species, and forecasting their future distributions.

Information System: Pest Animal Information System (PAIS)
Reporting: No in-built reporting capability.
Mapping: No in-built mapping capability.
Analysis: No in-built analysis capability.
Potential for biased observations: High, as data are only recorded for properties impacted by the wild dog baiting program.
Gap filling - occurrence: As data are associated with property (actually land parcel) identifiers, the data may be useful in filling gaps in knowledge on the distribution and abundance of wild dogs.
Gap filling - impacts: See notes on Gap filling – occurrence.
Modeling: See notes on Gap filling – occurrence.

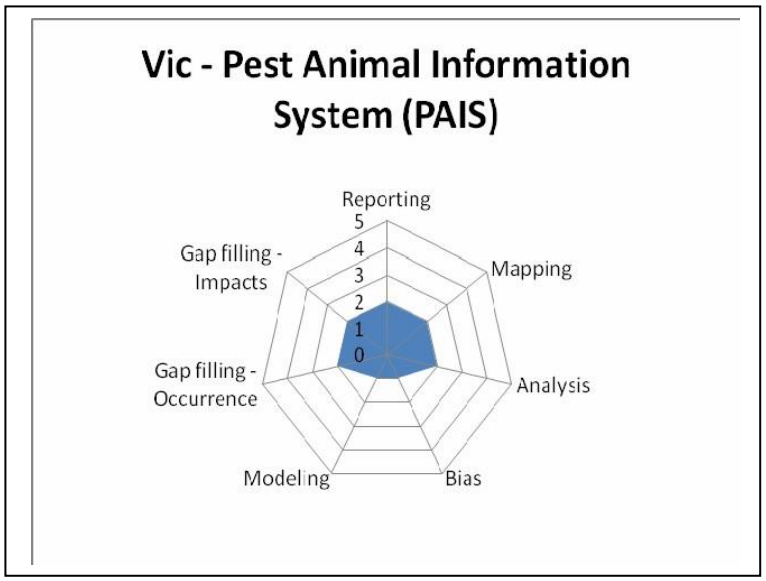


Figure 31. Comparative assessment of the Pest Animal Information System.

Summary: No scope to utilise this information system outside this business application. The data recorded in this system is being transferred to the ISIS system (assessed below) and may be useful in filling gaps in knowledge on the distribution and abundance of wild dogs.

Information System: DSE - Biodiversity Interactive Mapper
Reporting: Limited reports can be generated over a defined spatial area through the publically available web map application, although these reports do not currently include information on invasive species.
Mapping: The Biodiversity Interactive Mapper has a relatively sophisticated web-based mapping interface based on ArcGIS, although this is not used to record data on-line.
Analysis: The Biodiversity Interactive Mapper has no in-built analysis capability.
Potential for biased observations: This databases linked to this system consist largely of field observations and bias may arise where observations have been collected opportunistically i.e. along roadsides or in reserves and parks.
Gap filling - occurrence: The Biodiversity Interactive Mapper does not currently report on invasive species.
Gap filling - impacts: See notes on Gap filling – occurrence.
Modeling: See notes on Gap filling – occurrence.

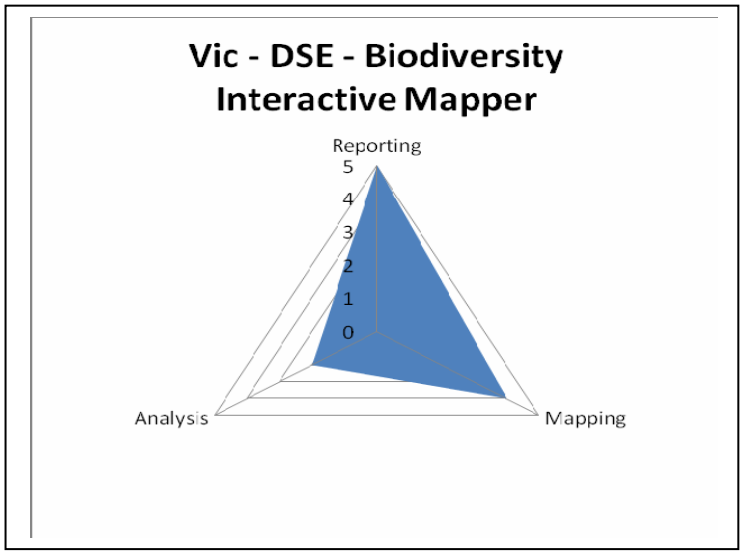


Figure 32. Comparative assessment of the Biodiversity Interactive Mapper

Summary: The Biodiversity Interactive Mapper has a range of functionality (reporting and mapping) that may be useful for applications in invasive species management; however this application does not currently manage information on invasive species.

Information System: Invasive Species Information System (ISIS)
Reporting: This system (currently under development) has a sophisticated reporting capability that can be customised for a wide range of applications.
Mapping: This system has the potential to deliver a sophisticated on-line mapping capability based on the existing BioWeb application. Current functionality is limited.
Analysis: This system has the potential to deliver a sophisticated on-line and dynamic analysis capability based on the existing BioWeb application. Current functionality is limited.
Potential for biased observations: Dependent on the expertise and experience of DPI staff involved in the capture of data.
Gap filling - occurrence: To-date very limited data on invasive species distribution and abundance has been collected via ISIS.
Gap filling - impacts: To-date very limited data on invasive species impacts and abundance has been collected via ISIS.
Modeling: See notes under Gap filling - occurrence.

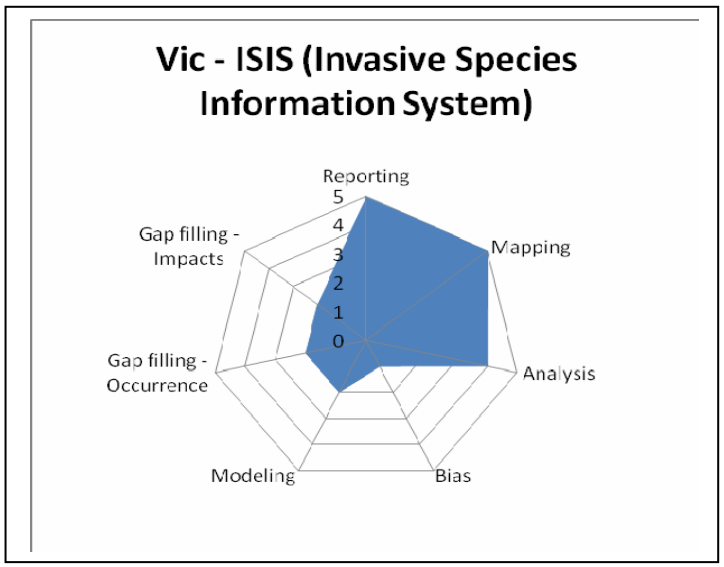


Figure 33. Comparative assessment of the Invasive Species Information System.

Summary: This application is currently under development, and the assessment is based on the existing BioWeb application on which ISIS is based. The application has the potential to be widely applicable for the management of information on invasive species in jurisdictions where supporting technical architecture is available.

Information System: Victorian Biodiversity Atlas
Reporting: Not applicable. This system is still in a design stage. It is anticipated that this system would deliver a reporting capability similar to the Atlas of Living Australia (see Section 3.3.2.1 National systems).
Mapping: See notes on Reporting.
Mapping: See notes on Reporting.
Potential for biased observations: This databases potentially linked to this system consist largely of field observations and bias may arise where observations have been collected opportunistically i.e. along roadsides or in reserves and parks.
Gap filling - occurrence: This system will draw-on existing taxonomic records that have been used to map the distribution and abundance of invasive species in Victoria.
Gap filling - impacts: See notes on Gap filling – occurrence.
Modeling: This system will draw-on existing taxonomic records that have been used to model or forecast the distribution and abundance of invasive species in Victoria.
Summary: Although still in a design phase, this system has the potential to enable reporting and mapping of existing taxonomic records that have already been used to address gaps in knowledge on the distribution and abundance on invasive species.

Information System: Viridans Biological Databases (Flora Information System (FIS) and the Victorian Fauna Database (VFD)
Reporting: The FIS and VFD include relatively sophisticated reporting capabilities that enable users to search and summarise records in the databases.
Mapping: The applications enable users to view pre-generated map products. The applications are not used to record mapped information.
Analysis: The applications do not have in-built analysis capabilities. **Potential for biased observations:** This databases linked consist largely of validated field observations and bias may arise where observations have been collected opportunistically i.e. along roadsides or in reserves and parks.
Gap filling - occurrence: The databases do not currently include information on the distribution and abundance of invasive species.
Gap filling - impacts: See notes on Gap filling – occurrence.
Modeling: See notes on Gap filling – occurrence.
Summary: The system provides reporting and mapping of existing taxonomic records that have already been used to address gaps in knowledge on the distribution and abundance on invasive species.

Information System: Environmental Information System (Parks Victoria) - ParkView NVM
Reporting: This application includes a limited reporting capability that delivers summary reports. It is noted that there is currently some duplication of reporting. Reporting is generally done manually by the Information Management Team at Parks Victoria. Data is extracted to Excel for further analysis.
Mapping: This application includes a limited mapping capability.
Analysis: see notes under Reporting.
Potential for biased observations: Data is limited to reserves.
Gap filling - occurrence: Data on invasive species is limited to information on impacts and management actions, and is not likely to be useful in addressing gaps in knowledge on invasive species distribution and abundance.
Gap filling - impacts: The data collected on local impacts on of invasive species may be useful in filling gaps in knowledge on the impacts of invasive species.
Modeling: The data collected in ParkView is unlikely to be useful in modelling or forecasting invasive species distribution.

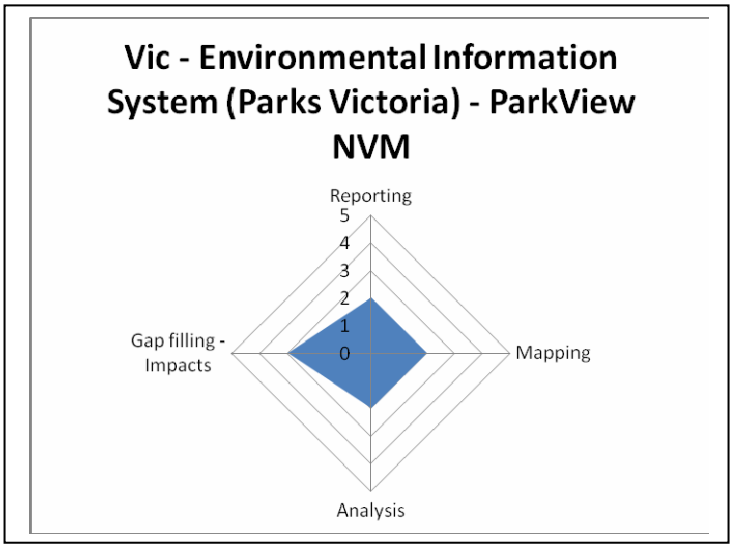


Figure 34. Comparative assessment of the Environmental Information System (ParkView NVM)

Summary: No scope to utilise this information system outside this business application. The data related to local impacts of invasive species may be useful in filling gaps in knowledge on the impacts of invasive species.

Information System: e-Weed (DSE)
Reporting: e-Weed has no in-built reporting capability. Data are extracted from the Microsoft Access database for analyses in other information systems.
Mapping: e-Weed has no in-built mapping capability. However, data are routinely extracted and geocoded to produce distribution maps for local areas.
Analysis: See notes on Reporting.
Potential for biased observations: High. No formal sampling strategy is used to collect data, which is captured by DSE staff based on observations by DSE operational staff and the public.
Gap filling - occurrence: e-Weed does not currently capture data related to pest animal species. However, the data captured in e-Weed has been used to generate maps of local distributions of weed species.
Gap filling - impacts: See notes on Gap filling – occurrence.
Modeling: See notes on Gap filling – occurrence.

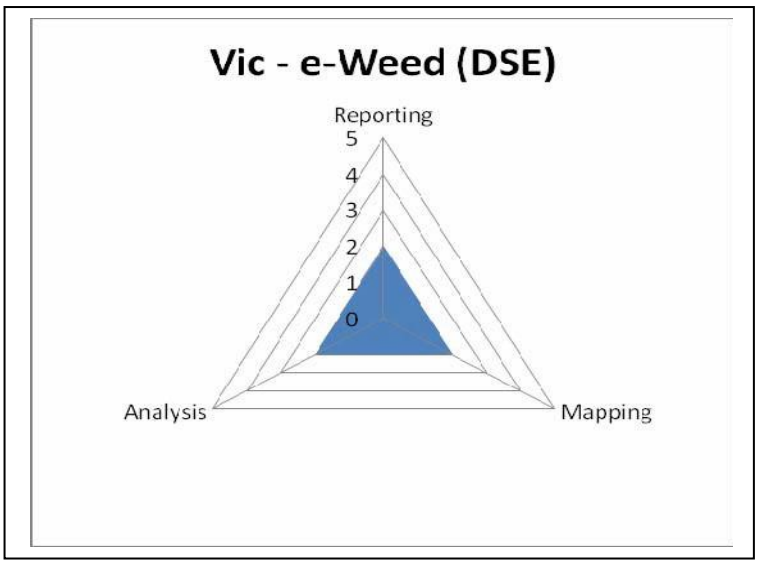


Figure 35. Comparative assessment of e-Weed

Summary: No scope to utilise this information system outside this business application. e-Weed is not currently used to collect data on pest animal species. However, the data captured in e-Weed has been used to generate maps of local distributions of weed species.

3.3.2.9 Western Australia

Information System: AgLine
Reporting: The AgLine web form interface allows generation of reports showing summary statistics by Region, Client type or Office, sub-filterable by date, contact method and division of call type. Lists of calls can be queried by *Program* (Project that dealt with the contact), *Subject, Enquiry type, Client type, DAFWA Region, District office, Shire, Advisor/Staff Member, Date* and *Contact method*.
Mapping: AgLine does not have an in-built mapping capability. However, the application is integrated with the CPE system and records that include a spatial reference (e.g. shire, property) may potentially be mapped.
Analysis: AgLine does not have an in-built analysis capability.
Potential for biased observations: As all records come from the general public seeking advice on agricultural and land management issues, records relating to invasive species tend to be biased towards more heavily populated areas of Western Australia e.g. life style block owners in the South West of WA.
Gap filling - occurrence: As invasive species numbers are not recorded it is not possible to produce a population density map.
Gap filling - impacts: While damage from invasive species is sometimes recorded in the comments field of the database (i.e. not structured or consistent), a large amount of manual processing would be required to map damage.
Modeling: Combined with climate, topographical and land-use data, there is some potential for the information in the AgLine database to be used to predict occurrence of invasive species in WA.

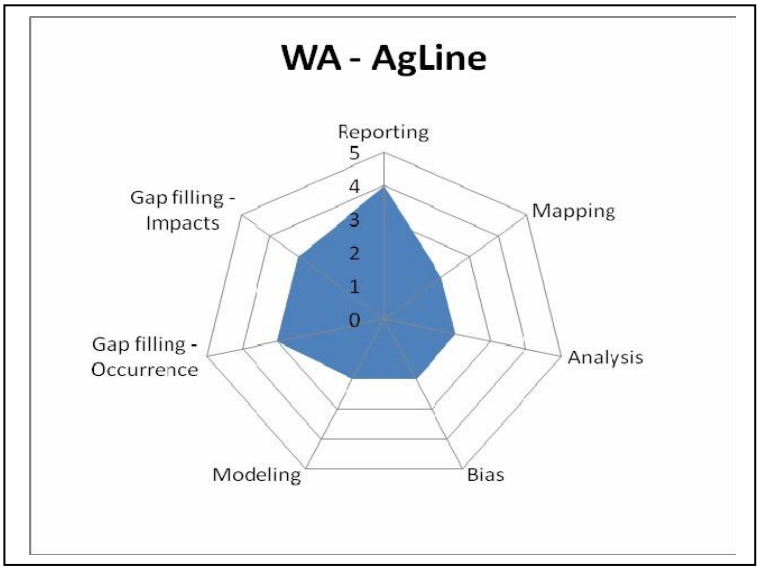


Figure 36. Comparative assessment of AgLine.

Summary: No scope to utilise this information system outside this business application. AgLine is no longer being actively used to capture data on public enquiries – including observations of invasive species impacts. However, the historical data may be useful in filling local gaps in knowledge on invasive species distribution and impacts.

Information System: Inspection, Quarantine and Compliance (IQC) database
Reporting: The internal intranet Intergraph GeoMedia web map interface allows generation of reports showing summary lists of inspections by Species, Staff Member, Activity, limited by date range. Records for individual properties inspected can be reviewed in detail.
Mapping: The web map capability of IQC is used only for reporting purposes. Data is not recorded through this application.
Analysis: IQC does not have an in-built analysis capability; however data can be summarised through structured queries and exported to other information systems for analysis.
Potential for biased observations: Moderate. Data available through IQC are captured through inspections by biosecurity officers, and a larger number of records have been recorded in the south-west agricultural regions where there are higher numbers of staff.
Gap filling - occurrence: Data is recorded on a property (polygon) basis. Depending on the size of properties in each region, there is some potential to produce maps of invasive species distribution and abundance. In practice it has been found that maps produced using IQC data are of limited value in understanding invasive species distribution and abundance at a particular point in time as limited data is available for specific time periods i.e. records are spread temporally over three decades.
Gap filling - impacts: See notes on Gap filling – occurrence.
Modeling: See notes on Gap filling – occurrence.

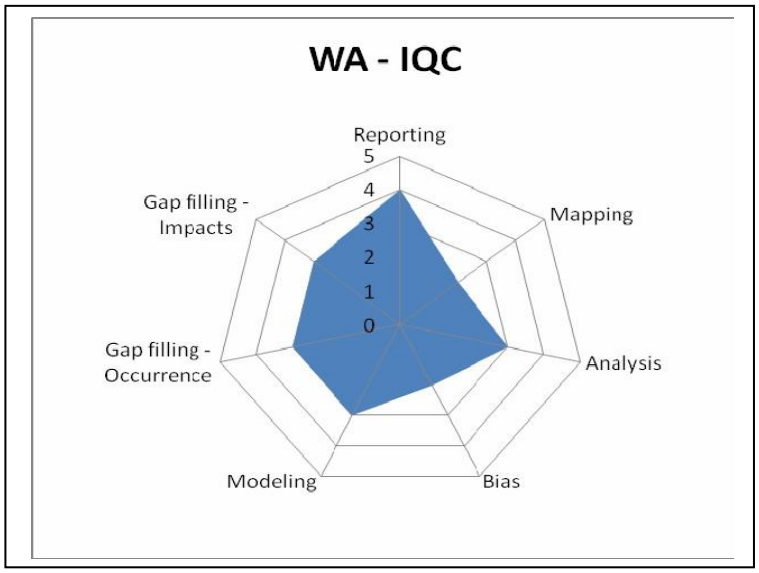


Figure 37. Comparative assessment of the IQC system.

Summary: This application is currently used to report information on for a wide range of biosecurity issues, including management of invasive species. The property-basis of data recorded through IQC currently limits the potential to use the application for an extended range of invasive species management activities, and to utilise data recorded in IQC to fill gaps in knowledge on invasive species distribution, abundance and impacts.

Information System: Rainbow Lorikeet Database
Reporting: DAFWA staff can access each individual report's complete details after logging into the page with a user id/password. There are no pre-generated summary statistics or reports currently set up in the interface.
Mapping: The web map capability of the Rainbow Lorikeet Database enables users to dynamically capture point observations.
Analysis: The Rainbow Lorikeet Database does not have an in-built analysis capability.
Potential for biased observations: High, as most records come from the general public and will reflect areas of higher human density. Rainbow lorikeets are currently only established in the Perth Metropolitan area, particularly the western suburbs. However once outside the metropolitan area there are far fewer potential reporters to record their presence, especially in the state forest immediately to the East and South-East of Perth.
Gap filling - occurrence: The data recorded in the Rainbow Lorikeet Database is likely to be of limited use in mapping the distribution and abundance of this invasive species.
Gap filling - impacts: Yes. Each report contains an estimate number of birds. With some factor of error the number and density of reported sightings could be combined to produce a density map within the Perth metropolitan area.
Can the data be used to produce a Damage map: See notes on Gap filling – occurrence.
Modeling: See notes on Gap filling – occurrence.

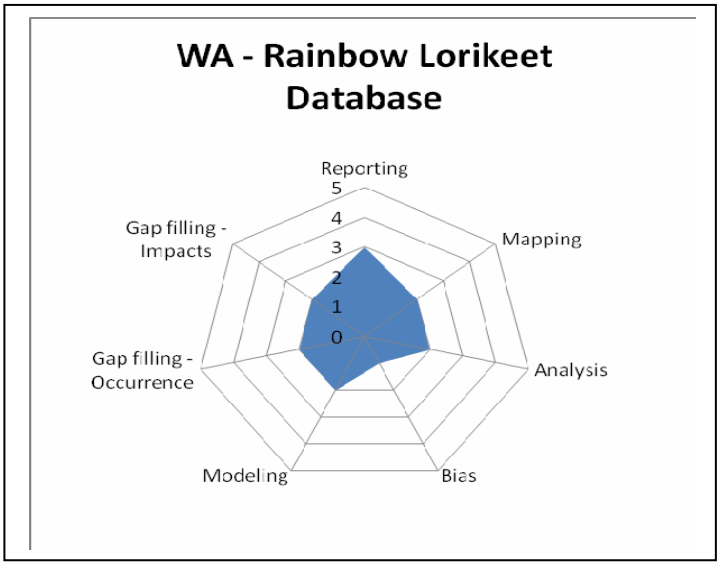


Figure 38. Comparative assessment of the Rainbow Lorikeet Database

Summary: There is limited potential to utilise this application for an extended range of invasive species management activities. A number of other DAFWA information systems utilise the same architecture – based on Intergraph Geomedia web map. Currently, only a limited number of records (less than 200) have been recorded in the Rainbow Lorikeet Database, limiting the potential to utilise these data to map the distribution, abundance and impacts of this invasive species.

Information System: Starlings Database
Reporting: The internal intranet web form has built in summary queries including: Traps Set, Trap active days and Effort (hours spent), number of Starlings caught, number of other birds caught and number of Starling 'Lure' bird mortalities.
Mapping: The Starlings Database does not have an in-built mapping capability. However, this database is integrated with the CPE system and Starlings Database records have been mapped through CPE.
Analysis: The Starlings Database does not have an in-built analysis capability.
Potential for biased observations: High. Unfortunately only some field officers reliably used the interface to record their work. As a result the records are biased towards the areas where the more experienced field officers were deployed.
Gap filling - occurrence: With reference to the limitations listed above, these data have been used to augment data from other databases to map the distribution and abundance of starlings.
Gap filling - impacts: Damage to crops, infrastructure and the environment from starlings was not recorded in this database.
Modeling: See notes on Gap filling – occurrence.

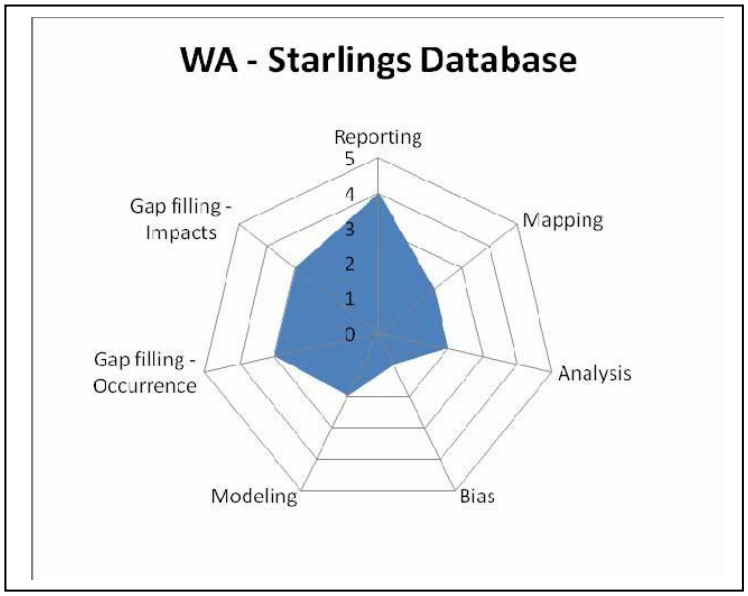


Figure 39. Comparative assessment of the Starlings Database

Summary: No scope to utilise this information system outside this business application. The Starlings Database is no longer being actively used to monitor starlings in Western Australia. However, the historical data may be useful in filling local gaps in knowledge on invasive species distribution.

Information System: State Barrier Fence / Wild Dogs Interface
Reporting: The internal intranet Intergraph GeoMedia web map interface allows generation of summary reports showing numbers of wild dogs destroyed and stock lost by region and shire, limited by date range. More complex reports are generated as needed from the database using desktop GIS.
Reporting: The internal intranet Intergraph GeoMedia web map interface allows generation of reports showing summary lists of inspections by Species, Staff Member, Activity, limited by date range. Records for individual properties inspected can be reviewed in detail.
Mapping: The web map capability of Wild Dogs Interface is used only for reporting purposes. Data is not recorded through this application.
Potential for biased observations: High. Data is only recorded for areas in proximity to the State barrier fence.
Gap filling - occurrence: The data recorded in the database is used to generate wild dog density maps using desktop GIS.
Gap filling - impacts: See Gap filling – occurrence.
Modeling: Potentially. Further investigation is required to verify that these data can be used to model distribution.

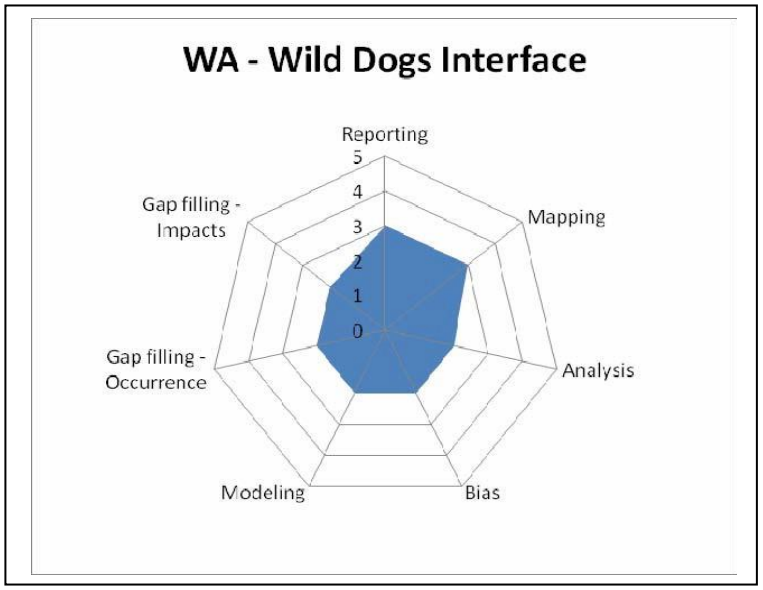


Figure 40. Comparative assessment of the State Barrier Fence / Wild Dogs Interface

Summary: This application has limited scope to be extended beyond its current business focus. However, the data recorded in this system has some potential to be used to fill localised gaps in knowledge on wild dog distribution and abundance.

Information System: WeedWatcher
Reporting: WeedWatcher provides has limited reporting functionality, enabling users to select and display records for a particular species.
Mapping: WeedWatcher has a simple web map interface that displays data recorded, and enables users to capture point-based records interactively through a Google Maps based web map.
Analysis: WeedWatcher does not have a built-in analysis capability.
Potential for biased observations: As for FeralScan (see section 3.3.2.1 National systems), this system relies entirely on crowd sourced information from the community and as a result the sightings recorded will tend to reflect the distribution of the community itself i.e. human population distribution and density. This is moderated to some degree by the use of a background map of 'known' distribution generated from formal surveys and other reliable sources i.e. distribution maps generated from expert knowledge through the National Land and Water Resources Audit.
Gap filling - occurrence: WeedWatcher does not record data on animal invasive species. The data recorded in WeedWatcher may potentially be useful in filling gaps in knowledge on the distribution of weed species. However, there is significant bias in the information toward populated areas.
Gap filling - impacts: WeedWatcher does not record data on animal invasive species. The data recorded in WeedWatcher may potentially be useful in filling gaps in knowledge on the impacts of weed species. However, there is significant bias in the information toward populated areas.
Modeling: WeedWatcher does not record data on animal invasive species. The data recorded in WeedWatcher may potentially be useful in modelling or forecasting the distribution of weed species. However, there is significant bias in the information toward populated areas.

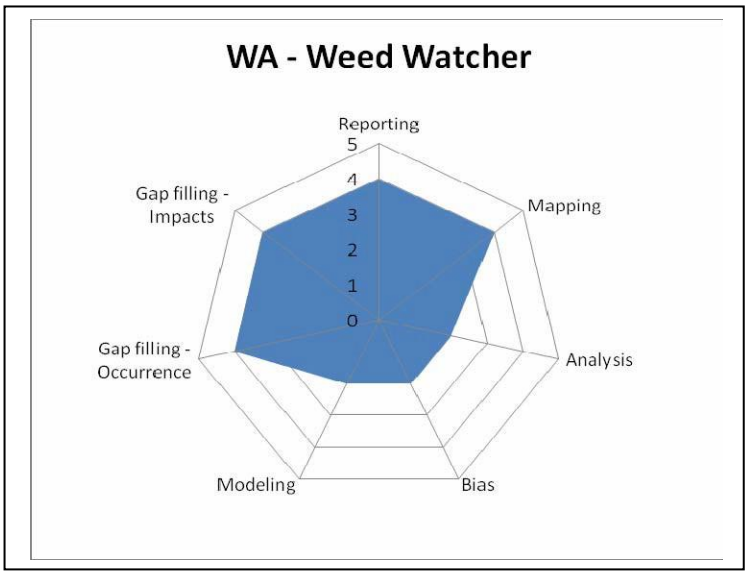


Figure 41. Comparative assessment of the State Barrier Fence / Wild Dogs Interface

Summary: WeedWatcher is one of a number of information systems, such as RabbitScan and FeralScan that have been specifically designed to capture observations from the community i.e. crowd source data. By design, these applications are simple and have limited functionality. WeedWatcher is currently being expanded to capture information on a broader range of weed species, and to add additional functionality to capture additional attributes and better control data quality. Limited data has been recorded in WeedWatcher to-date; however these data may have limited use in filling gaps in knowledge on the distribution, abundance and impacts of weed species.

Information System: Vertebrate Pests Survey (2005)
Reporting: Consists of spatial data used to support the preparation of the 2005 Distribution and abundance of pest animals in Western Australia : a survey of institutional knowledge (Woolnough 2005).
Mapping: Based on a 30km square grid across Western Australia.
Analysis: Analysis was carried-out in Intergraph Geomedia web map software.
Potential for biased observations: As the data is based on a survey of expert knowledge, there is some potential for bias in terms of varying interpretations of distribution and abundance of invasive species across the State.
Modeling: The data have been used for limited spatial modelling of invasive species distribution.
Gap filling - occurrence: These data have been used as an important source of information to address gaps in knowledge on invasive species distribution and abundance.
Gap filling - impacts: These data have limited value in understanding the impacts of invasive species.

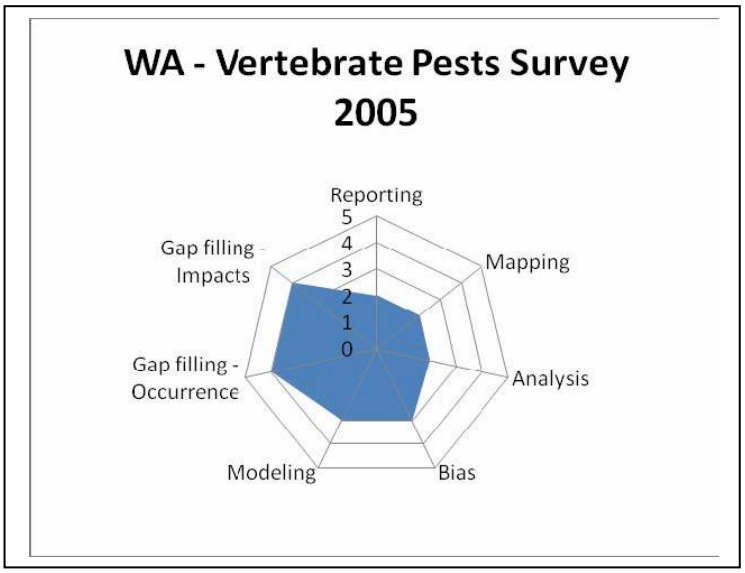


Figure 42. Comparative assessment of the Vertebrate Pests Survey (2005).

Summary: Consists of a dataset, rather than information system. These data have been captured in the DAFWA CPE database system (see description above). The data have been used in Western Australia to fill previous gaps in knowledge on invasive species distribution and abundance.

Information System: Vertebrates Contacts Database
Reporting: Simple reporting function used to summarise records only.
Mapping: The database has no in-built mapping capability; however, the system is linked to the CPE system managed by DAFWA, and records that include contact details could potentially be mapped.
Analysis: The database has no in-built analysis capability.
Potential for biased observations: High, as the records are based on reports from the general public and industry.
Modeling: The data are unlikely to be useful for modelling the distribution and abundance of invasive species.
Gap filling - occurrence: The data are unlikely to be useful for filling gaps in impacts of invasive species.

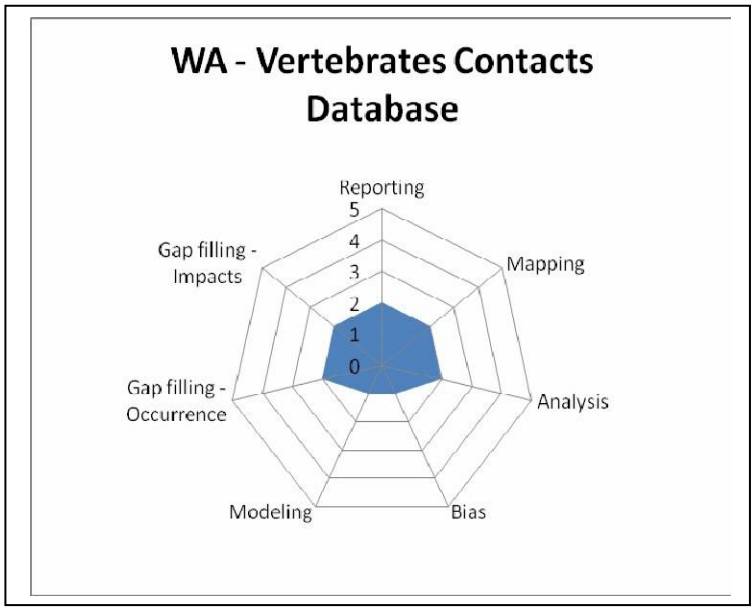


Figure 43. Comparative assessment of the Vertebrates Contacts Database.

Summary: No scope to utilise this information system outside this business application. The data recorded in this system are unlikely to be useful for filling gaps in knowledge on the distribution, abundance and impacts of invasive species.

3.3.3 System capabilities and the potential for extended use of data

A total of 49 systems were assessed using the comparative criteria described in section 2.4. A summary of the comparative scores for each system is provided in Table 4.

All 49 systems assessed were scored according to reporting capability. All systems were rated at least score 2 (ad-hoc project reports only). A total of 10 systems were rated at 5 (able to generate dynamic regional or State-wide reports). A comparison of these ratings is illustrated further in Figure 44.

All 49 systems were scored according to mapping capability. All systems were rated at least score 2 (captures coordinates/addresses). A total of 7 systems were rated at 5 (able to dynamically capture points, lines, polygons). A comparison of these ratings is illustrated further in Figure 45.

All 49 systems were scored according to analysis capability. Scores ranged between 1 (no in-built analysis capability) to 5 (dynamic analysis capability embedded). Only a single system, the Atlas of Living Australia was assigned this rating. A comparison of these ratings is illustrated further in Figure 46.

A total of 44 of the 49 systems assessed were rated for potential bias in observations. The 5 systems not rated collect data only for weeds and/or no invasive species data under current arrangements. Only one system, the Riverine Eco- Systems database from New South Wales was rated at 5 (sampling strategy carefully designed to avoid bias). A comparison of these ratings is illustrated further in Figure 47.

Similarly, 44 of the 49 systems assessed were rated for modeling capability – based on either the information system capability or usefulness of the data for this purpose. The same five systems as excluded for the assessment of bias were excluded from this assessment for the same reason. A total of 5 systems were rated above 4 (data can be used to map current occurrence and density over time). A comparison of these ratings is illustrated further in Figure 48.

A total of 44 of the 49 systems assessed were rated for the capability for data to be used to fill gaps in knowledge on the distribution and abundance of invasive species. The same five systems as excluded for the assessment of bias were excluded from this assessment for the same reason. A total of 12 systems were rated above 4 (data has regional or State coverage, but limited to a single time period). A comparison of these ratings is illustrated further in Figure 49.

Finally, 40 systems were assessed for potential to fill gaps in knowledge on the impacts of invasive species. The 9 systems excluded from this assessment are not used to collect data on the impacts of invasive species. A total of 8 systems were rated at 4 or higher (data has regional or State coverage, but limited to a single time period). A comparison of these ratings is illustrated further in Figure 50.

It is important to note that the variable scores across each of the information systems assessed generally reflect the widely varying business drivers for each of the information systems, rather than unmet requirements in the design or implementation of systems reflected by lower scores in particular categories. However, the data are instructive with regard to systems and sources of data that have the potential to be used for an expanded range of application in the monitoring and management of invasive species.

The potential for each system, and the data managed by these, to be used for an extended range of applications in invasive species management is summarised in Table 5. A total of 16 systems have at least some potential to be used for a broader range of applications in managing invasive species. A total of 34 systems contain data that is likely to be useful in addressing gaps in knowledge in invasive species distribution, abundance and/or impacts. The implications of these results for extending the use of the appropriate information systems, and the data managed through these systems are discussed further in section 4.

Table 4. Comparative scores for information systems assessed through this project.

Information System	Reporting	Mapping	Analysis	Bias	Modeling	Gap filling - Occurrence	Gap filling - Impacts
Arid Lands Information System	3	4	2	2	2	2	2
Atlas of Living Australia	5	5	5	4	4	3	3
BioSIRT	5	5	4	3	3	2	2
CyberTracker	3	3	2	2	2	1	1
FeralScan	5	4	2	3	3	4	4
NSW - Insect and mite collection in Australia	2	2	2	1	1	2	N/A
NSW - Invasive Species Monitoring	3	3	2	3	3	2	N/A
NSW - New and Emerging Pest Reporting	2	2	2	1	1	2	2
NSW - New Aquatic Pests	2	2	2	1	1	2	2
NSW - New Invasive Species	2	2	2	1	1	2	2
NSW - Non-Indigenous Animals	2	2	1	1	1	2	1
NSW - Pest Animal Survey 2002/03	3	3	2	3	3	5	5
NSW - Pest Animal Survey 2004-2005	3	3	2	3	3	5	5
NSW - Pest Animal Survey 2009-2010 (unpublished)	3	3	2	3	3	5	5
NSW - Reporting Notifiable Weeds	3	2	2	2	2	2	2
NSW - Riverine Eco-Systems	3	2	2	5	4	5	5
NSW - Summary of Wild Dog Predation	2	2	2	1	1	2	2
NT - NAQS database	3	3	3	4	2	2	2
NT - NT Fauna Atlas	3	2	3	2	2	2	2
Qld - 1080 database	3	2	2	1	1	2	2
Qld - APDS	5	2	3	3	4	5	1
Qld - Herbert Resource Information Centre	2	5	2	1	3	1	1
Qld - Island survey	2	2	2	4	2	1	1
Qld - LARIE	5	5	3	4	3	5	5
Qld - ParkInfo	5	5	3	2	2	2	2
Qld - Pest Central	3	5	3	2	4	2	2
Qld - PestInfo 4.3	3	2	3	3	5	5	N/A
Qld - QMDC (File Database system)	3	3	3	2	3	2	2
Qld - Tropical Weeds database	2	2	2	N/A	N/A	N/A	N/A
SA - Pest2000+	3	3	2	1	1	1	1
Tas - GT-Spot	3	2	2	2	2	3	3
Tas - Natural Values Atlas	3	2	2	2	2	3	3

Table 4. Cont. Comparative scores for information systems assessed through this project.

Information System	Reporting	Mapping	Analysis	Bias	Modeling	Gap filling - Occurrence	Gap filling - Impacts
Vic - DSE - Biodiversity Interactive Mapper	5	4	2	N/A	N/A	N/A	N/A
Vic - e-Weed	2	2	2	N/A	N/A	N/A	N/A
Vic - Flora Information System (DSE)	3	2	2	N/A	N/A	N/A	N/A
Vic - IPMS	3	2	2	2	3	3	3
Vic - ISIS	5	5	4	1	2	2	2
Vic - ParkView	2	2	2	N/A	N/A	N/A	3
Vic - Pest Animal Information System	2	2	2	1	1	2	2
Vic - Victorian Biodiversity Atlas	5	2	3	3	2	5	N/A
Vic - Wildlife Atlas	5	2	3	3	2	4	N/A
WA - AgLine	4	2	2	2	2	3	3
WA - IQC	4	2	3	2	3	3	3
WA - Rainbow Lorikeet Database	3	2	2	1	2	2	2
WA - Starlings Database	4	2	2	1	2	3	3
WA - Vertebrate Pests Survey 2005	2	2	2	3	3	4	4
WA - Vertebrates Contacts Database	2	2	2	1	1	2	2
WA - Weed Watcher	4	4	2	2	2	4	4
WA - Wild Dogs Interface	3	3	2	2	2	2	2

Table 5. Potential to extend the application of information systems and data for management of invasive species.

Jurisdiction	System name	Potential to re-use applications	Potential to re-use data	Notes
National	Atlas of living Australia (ALA)	Yes	Yes	Significant potential for broader use of the application and data
National	BioSIRT	Yes	No	Significant potential for broader use of the application and data. Very limited records on invasive species to-date
National	CyberTracker	Yes	No	Very limited localised data only
National	FeralScan	Yes	Yes	Significant potential for broader use of the application and data. Crowd sourced data only.
National	RabbitScan			See FeralScan
New South Wales	Insect and mite collection in Australia	No	Yes	Invertebrate taxonomic records only
New South Wales	New and Emerging Pest Reporting	No	No	
New South Wales	New Aquatic Pests	No		Very limited localised data only
New South Wales	New Invasive Species / Emerging Invasive Species / Widespread Invasive Species	No	Yes	Localised data only
New South Wales	Non-Indigenous Animals	No	No	
New South Wales	Pest Animal Survey 2002/03, Pest Animal Survey 2004-2005 and Pest Animal Survey 2009-2010 (unpublished)	No	Yes	State-wide data
New South Wales	Reporting Notifiable Weeds	Yes	No	Limited localised data only
New South Wales	Riverine Eco-Systems	No	Yes	Localised data only
New South Wales	Summary of Wild Dog Predation	No	Yes	Limited localised data only
Northern Territory	Northern Australia Quarantine Strategy (NAQS) survey database (AQIS)	Yes	Yes	Localised data only. See also BioSIRT
Northern Territory	NT Fauna Atlas	Yes	Yes	Largely taxonomic records

Table 5. Cont. Potential to extend the application of information systems and data for management of invasive species.

Jurisdiction	System name	Potential to re-use applications	Potential to re-use data	Notes
Queensland	1080 database	No	Yes	Localised data only
Queensland	Annual Pest Distribution Survey (APDS) database	No	Yes	State-wide data
Queensland	Island Survey	No	Yes	Localised data only
Queensland	LARIE (Land and Resource Information Environment, DERM Qld) - Delbessie database	Yes	Yes	Localised data only
Queensland	ParkInfo	No	Yes	Localised data only
Queensland	Pest Central	Yes	Yes	Localised data only
Queensland	PestInfo 4.3	No	Yes	State-wide data
Queensland	Queensland Murray-Darling Committee (QMDC) File Geodatabase system	Yes	Yes	Limited potential to extend the use of the application and data
Queensland	The Herbert Resource Information Centre (HRIC)	Yes	No	Limited localised data only
Queensland	Tropical Weeds database	No	Yes	Weeds only
South Australia	Arid Lands Information System (ALIS)	Yes	Yes	Localised data only
South Australia	Pest2000+	No	No	Localised data only
South Australia	Primary Industries Information Management System (PIMS)	Yes	No	Currently no invasive species data
Tasmania	GT-Spot	No	Yes	See Natural Values Atlas
Tasmania	Natural Values Atlas	No	Yes	Taxonomic records only
Victoria	DSE - Biodiversity Interactive Mapper	Yes	No	Currently no invasive species data
Victoria	Environmental Information System (Parks Victoria) - ParkView NVM	No	Yes	Localised impacts data only
Victoria	e-Weed	No	Yes	Weeds only
Victoria	Integrated Pest Management System (IPMS)	No	Yes	See ISIS
Victoria	Invasive Species Information System (ISIS)	Yes	Yes	Significant potential for broader use of the application and data
Victoria	Pest Animal Information System (PAIS)	No	Yes	See ISIS
Victoria	Victorian Biodiversity Atlas	No	Yes	Taxonomic records only
Victoria	Viridans Biological Databases	No	No	Taxonomic records only, no invasive species data

Table 5. Cont. Potential to extend the application of information systems and data for management of invasive species.

Jurisdiction	System name	Potential to re-use applications	Potential to re-use data	Notes
Western Australia	AgLine	No	Yes	State-wide data, very limited records
Western Australia	Inspection, Quarantine and Compliance (IQC) database	No	Yes	State-wide data, limited records
Western Australia	Rainbow Lorikeet Database	No	Yes	Crowd sourced data
Western Australia	Starlings Database	No	Yes	Localised data only
Western Australia	State Barrier Fence / Wild Dogs Interface	No	Yes	Localised data only
Western Australia	Vertebrate Pests Survey (2005)	No	Yes	State-wide data
Western Australia	Vertebrates Contacts Database	No	No	
Western Australia	WeedWatcher	Yes	Yes	Weeds only

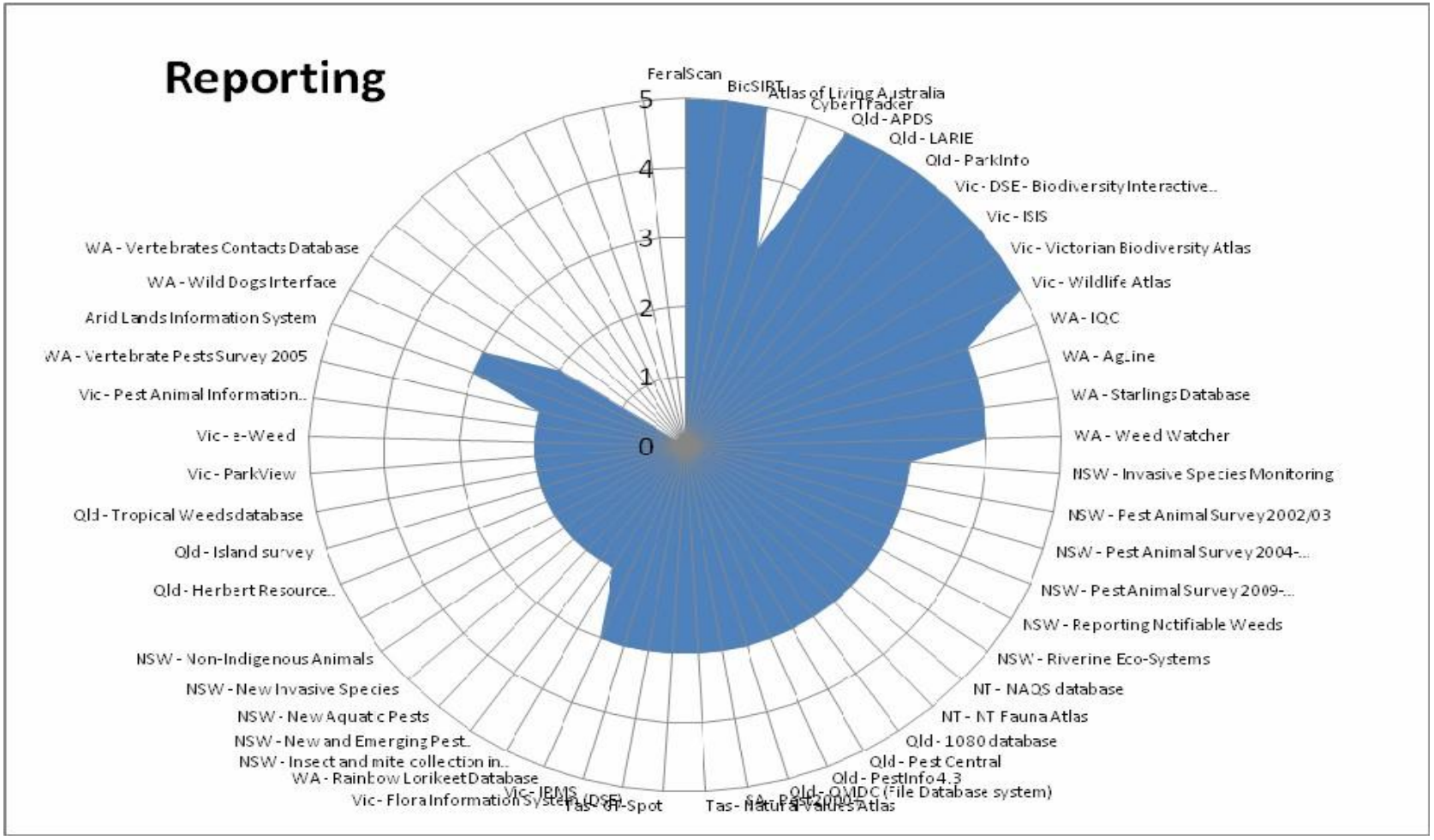


Figure 44. Comparison of the reporting capabilities of information systems used to capture, manage and report on invasive species in Australia.

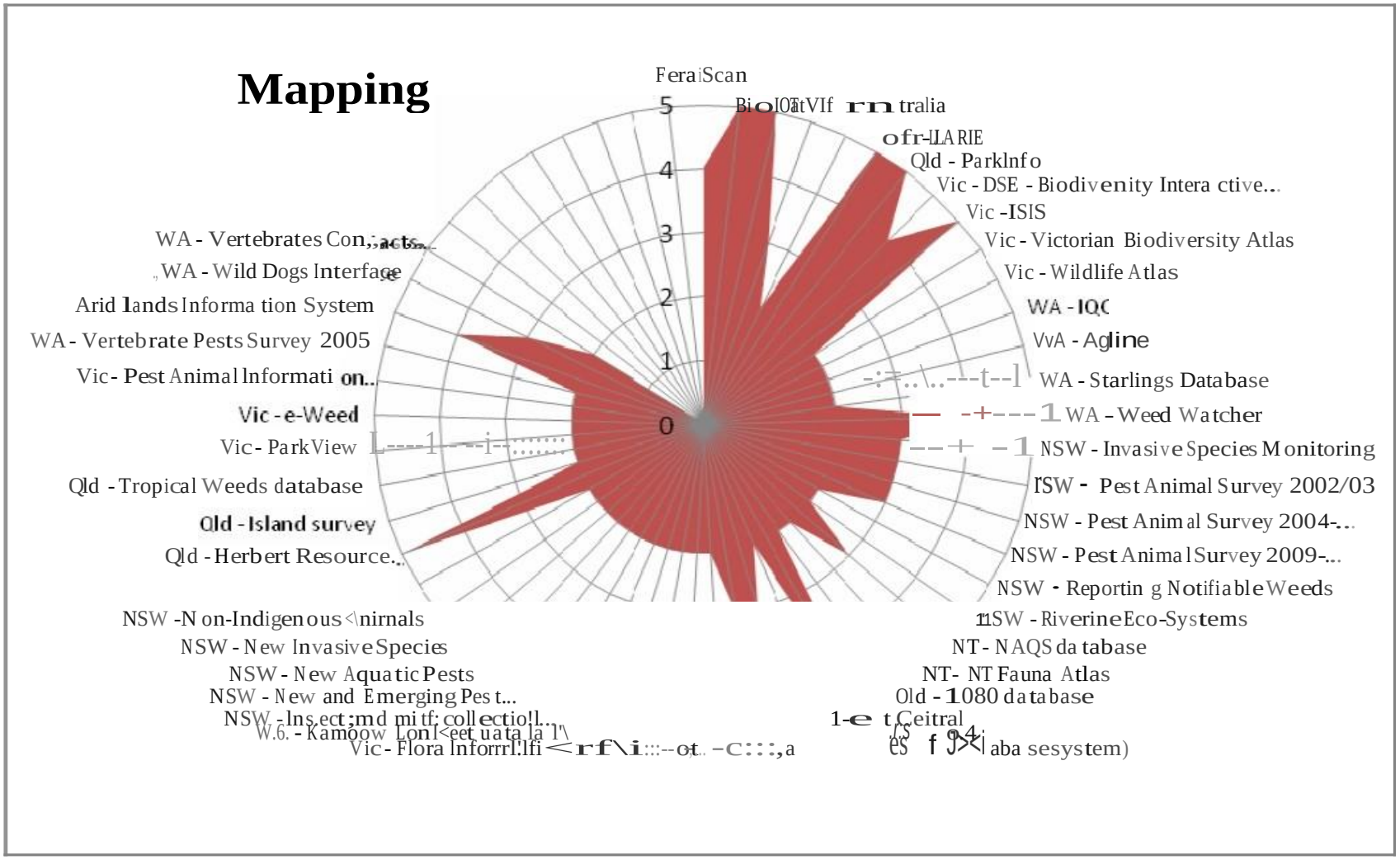


Figure 45.Comparison of the mapping capabilities of information systems used to capture, manage and report on invasive species in AustraJia.

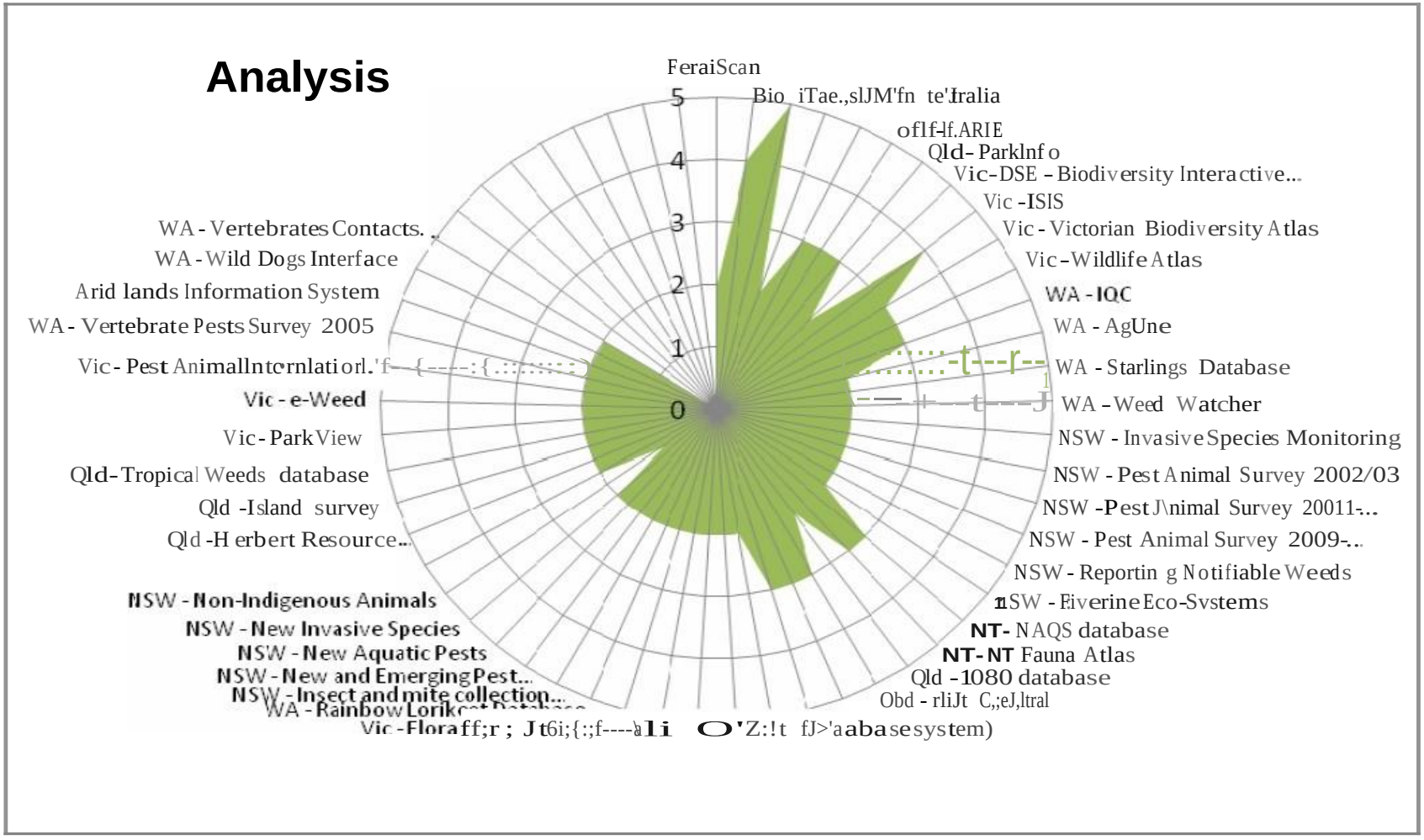


Figure 46. Comparison of the mapping capabilities of information systems used to capture, manage and report on invasive species in Australia.

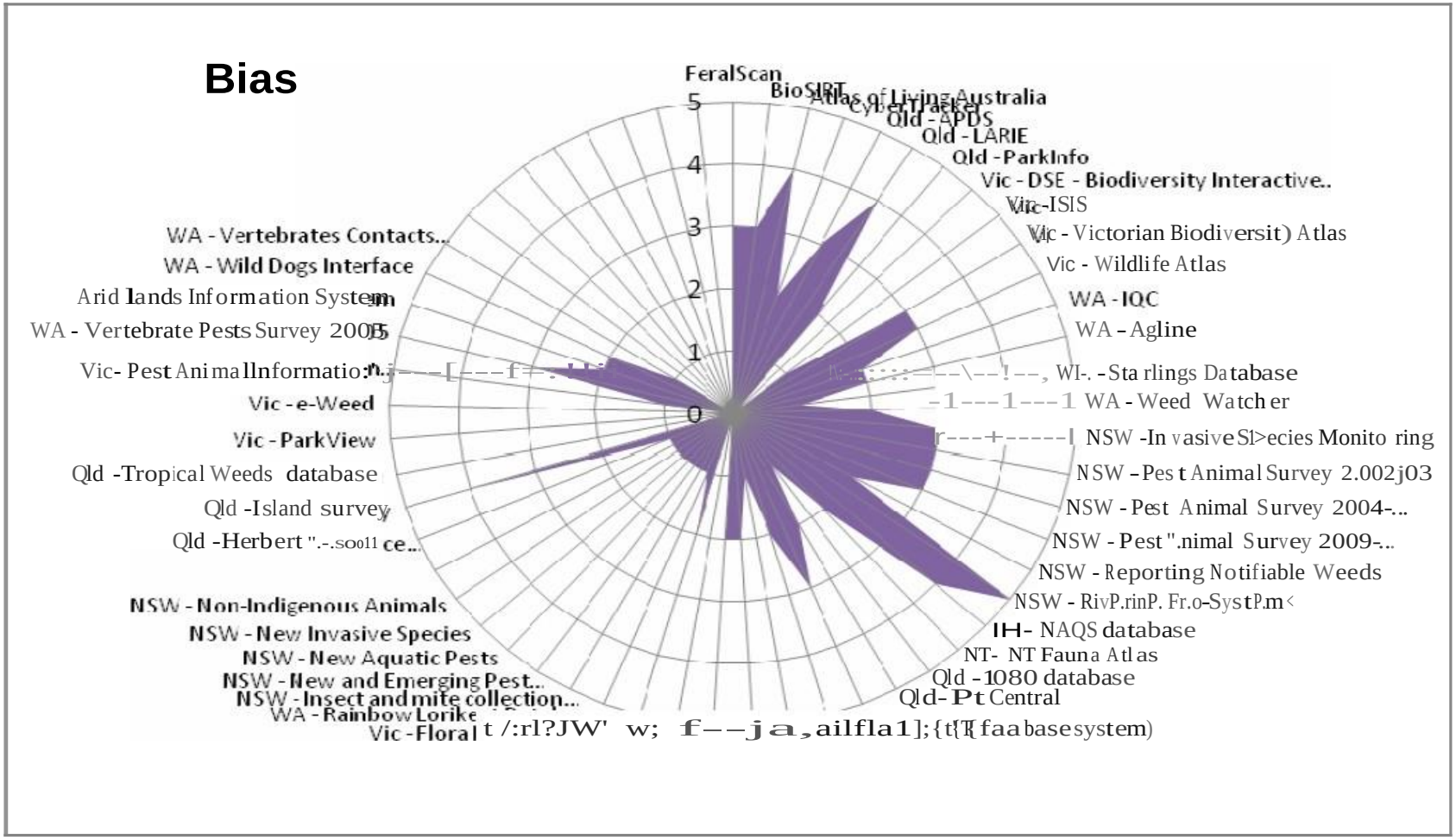


Figure 47.Comparison of the potential bias in information systems used to capture, manage and report on invasive species in Australia.

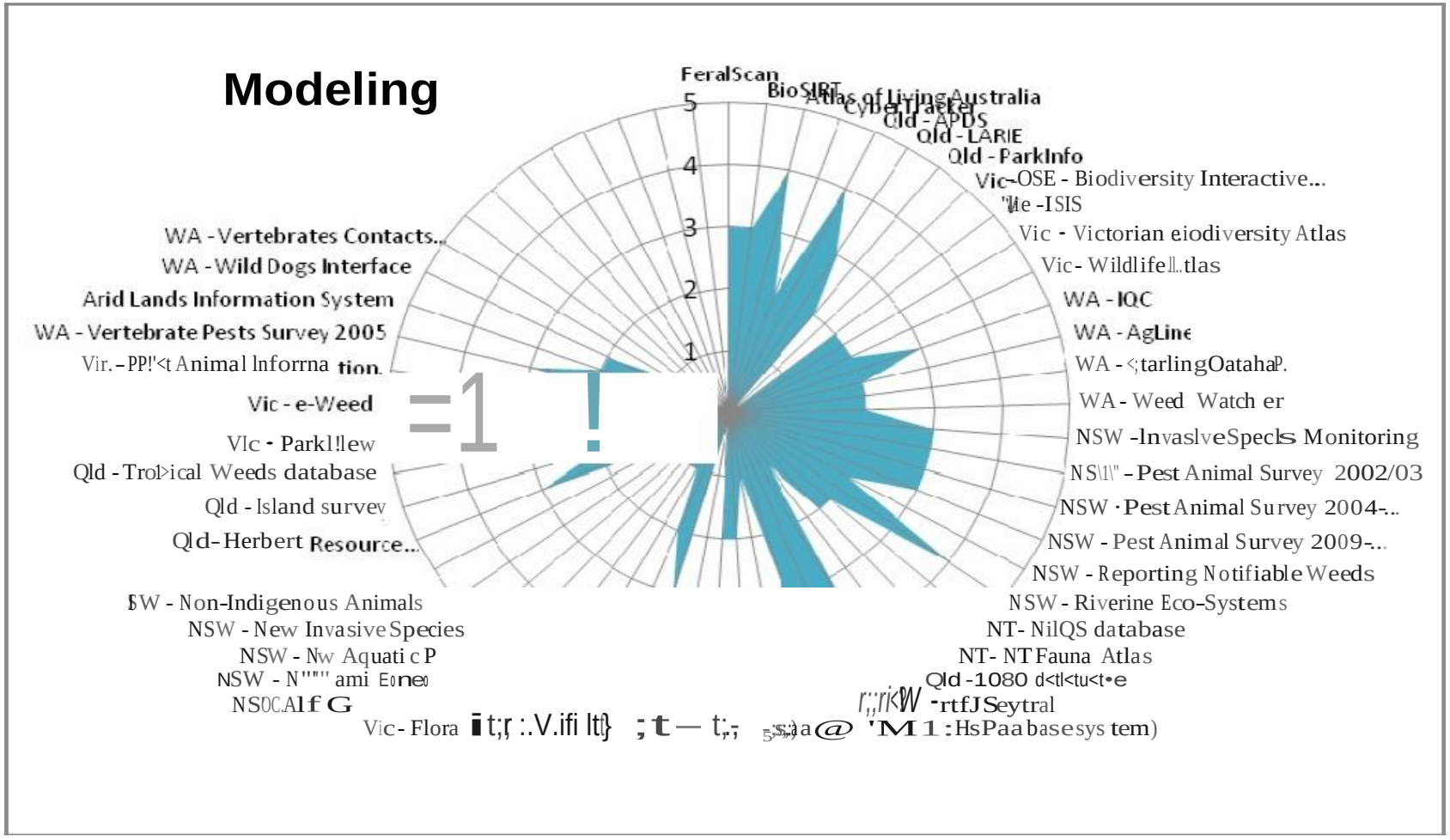


Figure 48.Comparison of the modeling capability of information systems used to capture, manage and report on invasive species in Australia.

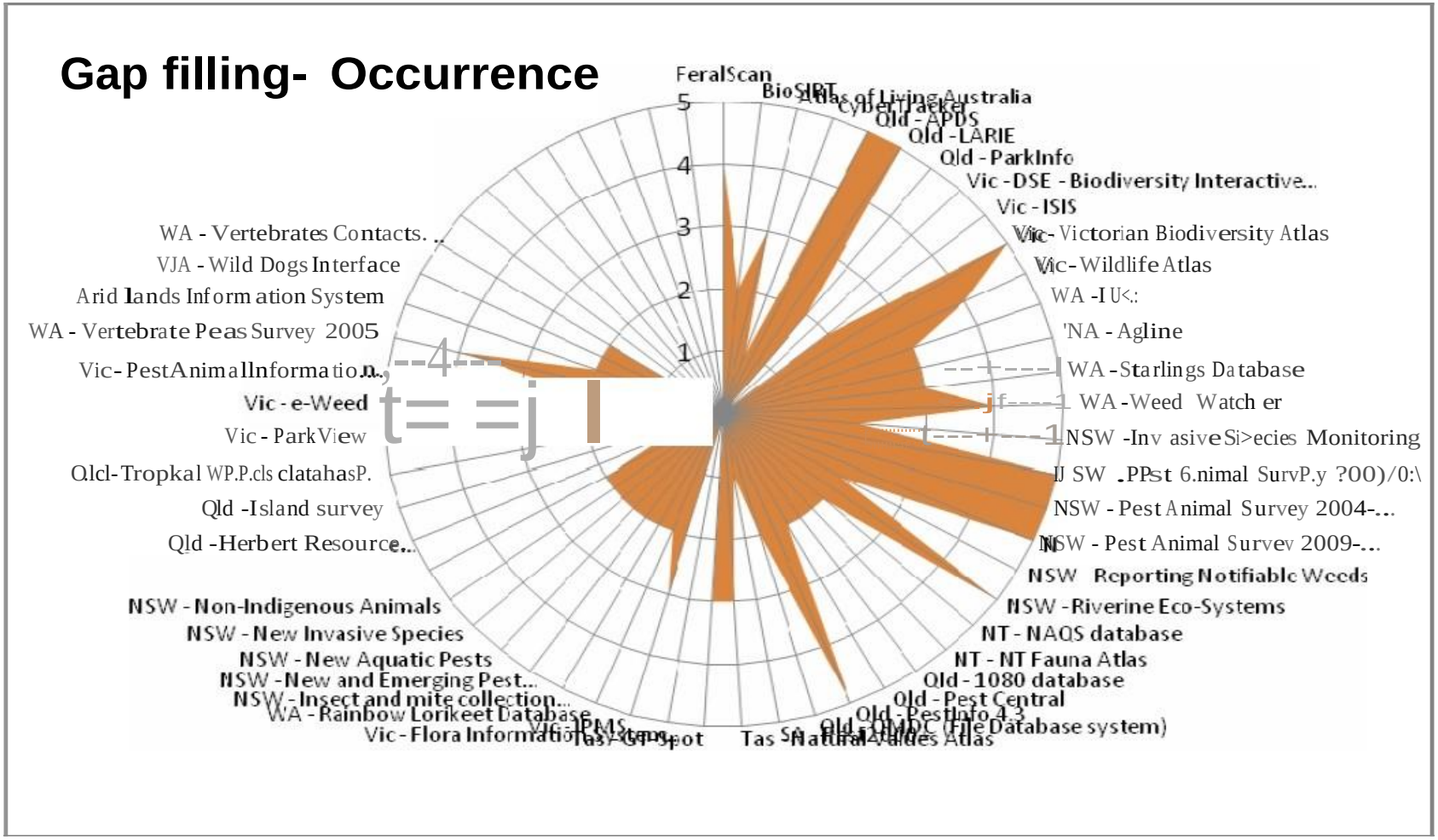


Figure 49.Comparison of the potential to fill gaps in knowledge on the distribution and abundanee of invasive species.

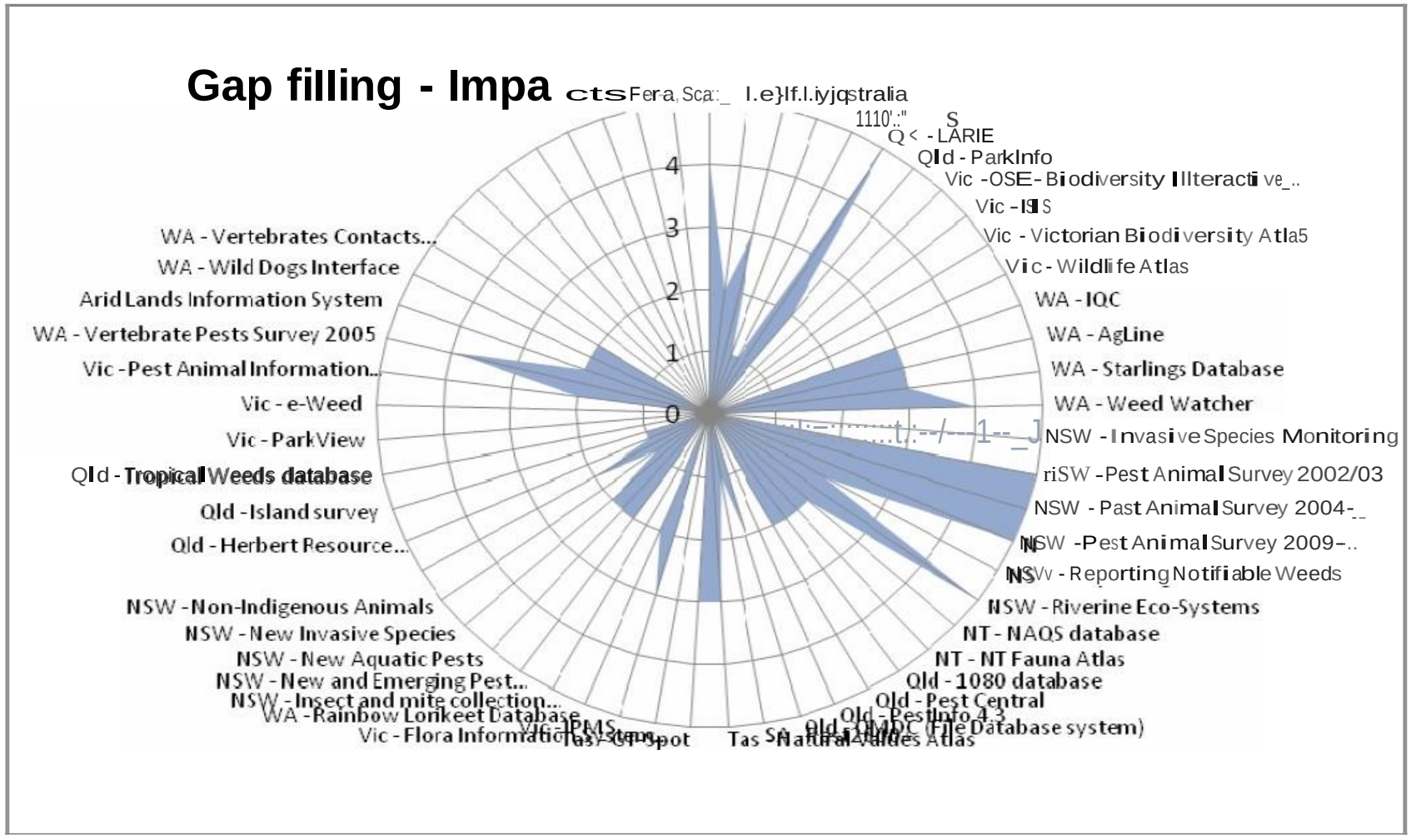


Figure 50.Comparison of the potential to fill gaps in knowledge on the impacts of invasive species_

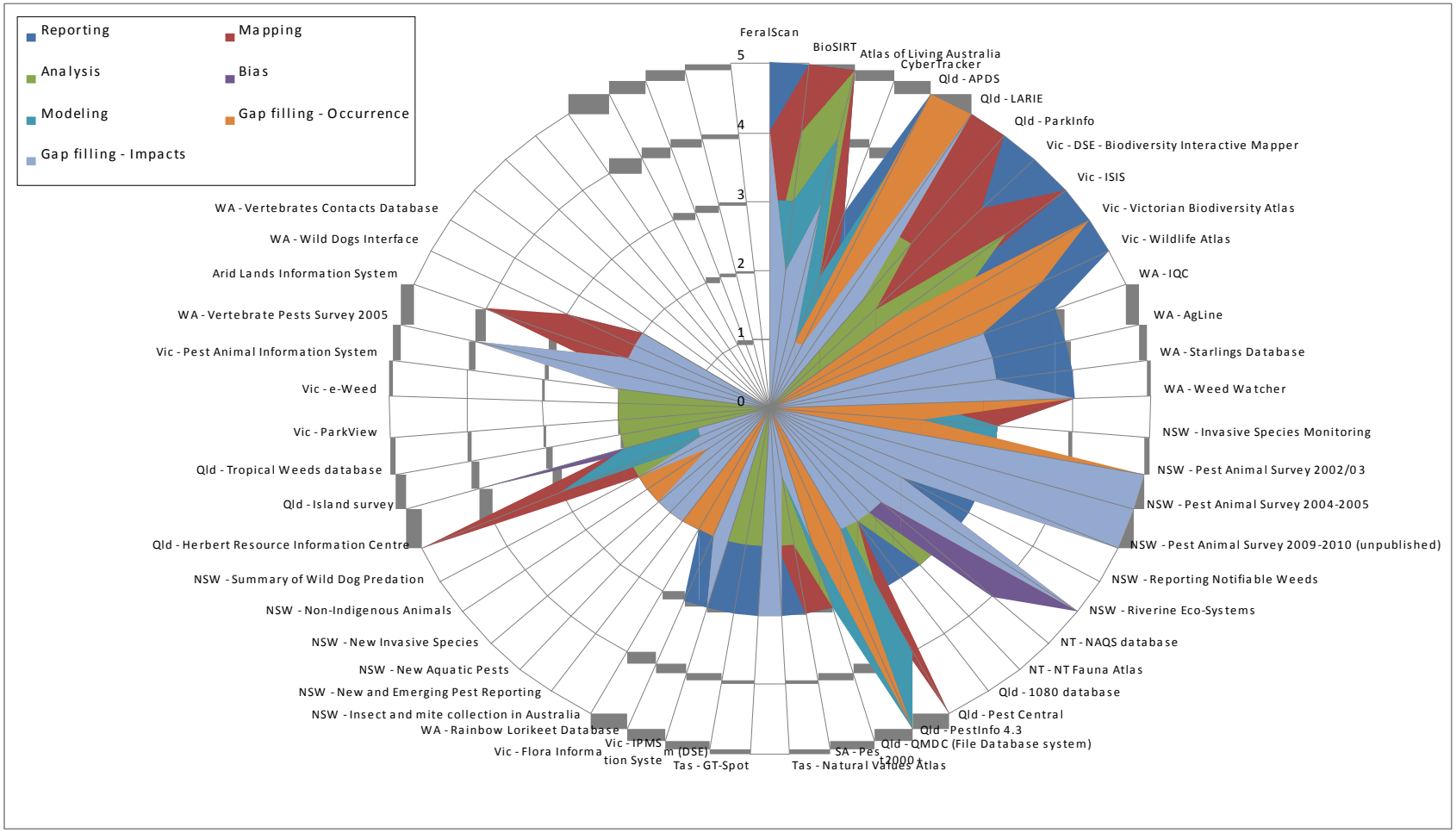


Figure 51. Comparison of all criteria used to assess the information systems.

4. Summary and Conclusions

The results of the national stock take of information systems described in section 3 of this report highlight the great diversity of information systems and repositories that have developed since the 1980's and 1990's, when some of the oldest databases described in this report were first developed. For the reasons outlined in section 3.1, this project has considered information systems that are used more broadly than for the management of pest animal systems. Consequently the results should be interpreted in consideration of the wide range of business drivers that have produced this diversity of approaches.

The variety of business drivers across jurisdictions, and at varying management scales, is likely to continue to see a wide range of systems developed into the future for reasons discussed in section 4.1 below. Indeed, given the wide availability of open source software now available, it is likely that the development of information systems used at the local level will accelerate.

However, it is possible to identify from the results of this project a number of approaches that have been successful in enabling data and information captured through a disparate array of information systems to be integrated to some degree, usually through a mix of technology and/or a community of research and operational personnel that are supported by this technology. These approaches are discussed in section 4.2.

4.1 Business drivers for the management of data and information

The development, or re-development, of information systems for invasive species management and processes to support these systems is currently particularly active in Queensland and the Northern Territory, Victoria, and through Commonwealth and/or cross-jurisdictional initiatives. These provide an important indication of the key business drivers for management of data and information on invasive species.

The need for "A collaborative approach to collecting, collating, analysing, storing and sharing biosecurity information to improve decision making and enhance operational efficiency" recognised in the Intergovernmental Agreement on Biosecurity (see section 1.1) is driving ongoing work across sectoral committees, including the Vertebrate Pests Committee address this issue.

The recent development of new data management infrastructure, such as the Australian Biosecurity Intelligence Network (ABIN), funded through Department of Innovation, Industry, Science and Research - National Collaborative Research Infrastructure Strategy (NCRIS), is also facilitating the drive towards improved sharing of biosecurity data, information and knowledge. However, agreements to share information that protect the privacy of individuals and security of market access are still required to enable information to be shared effectively through this infrastructure. For this reason there has been a significant focus and investment in technical security measures through the development of ABIN. ABIN also aims to leverage other shared information systems, such as BioSIRT and the Atlas of Living Australia (discussed further in section 4.2).

At the State-scale, a similar approach is being adopted by jurisdictions such as Victoria. Victoria has been developing the BioWeb system as a mechanism or technical framework through which as wide range of biosecurity data can be shared, integrated and analysed. The Invasive Species Information System (ISIS), included in this assessment, is being developed within this environment. Both national infrastructure and systems such as ABIN and BioSIRT, and State-level systems like ISIS leverage the same types of technology, discussed further in section 4.2.

A significant ongoing obstacle to realising the full potential benefit of this infrastructure at a national level is the diversity of attributes and formats that hinder the collation and interpretation of data and information from different sources. Again, work is underway across a number of national sectoral committees, such as the AWC/VPC National Indicators Working Group, to agree on core attributes and common standards to address this issue. For invasive species, this is leveraging standards recently through the work of the NLWRA and Invasive Animals CRC, and through standards developed more recently in Queensland (Spatial Pest Attribute Standard) and the Northern Territory (Guidelines for Weed Data Collection). A list of these standards is provided in Table 6, below.

Table 6. Standards for the collection or data and reporting on invasive species.

Attribute standard	Jurisdiction / Agency	Last revised
Spatial Pest Attribute Standard (SPA Standard)	Queensland	Currently being refined
A field manual for surveying and mapping nationally significant weeds	Bureau of Rural Sciences / Weeds Australia	2008
Guidelines for Weed Data Collection in the Northern Territory	Northern Territory	May 2007
Extent, density and distribution of weeds Protocol	National Land & Water Resources Audit (NLWRA)	March 2007
Extent of active management Protocol	NLWRA	May 2008
Impact of Weeds on assets Protocol	NLWRA	June 2007
Distribution and abundance of significant invasive vertebrate pests Protocol	NLWRA	March 2007
Impacts of significant invasive vertebrate pests Protocol	NLWRA	March 2007

While these standards represent a core set of attributes that have been identified as either common to many individual data collections and information systems, and are being used to standardise the data collected in new information systems; this project has highlighted that there is diverse array information systems that exist, or continue to be developed at the local scale. The standardisation of data collected and managed through these systems to data may be exchanged efficiently as required clearly remains a significant challenge.

4.2 Integrating technology and communities of practice

The development of infrastructure such as ABIN, and information systems such as the Atlas of Living Australia, are high-profile examples of a number of systems that operate by integrating data from a range of sources without transferring or copying the data from the original sources i.e. via web services. A similar approach has been, or will be adopted by jurisdictional systems, such as the Natural Values Atlas in Tasmania, and Victorian Biodiversity Atlas, and through BioSIRT as a shared system across the most of the States and Territories.

The use of web services has overcome a number of issues arising from the historical need to physically transfer or copy data from one system to another – often leading to the establishment of separate, unsynchronised copies of the same data being used by different groups. To some degree web services can also help overcome the issue of differing standards by automatically translating data between systems, where a set of rules can be developed that identify equivalent measures between attribution standards.

The mechanisms through which data is collected in the field are evolving rapidly through the availability of increasingly sophisticated, yet user-friendly, mobile devices – particularly smart phones. These devices have largely replaced the use of Personal Digital Assistants (PDAs) in recent years; particularly in areas where mobile phone coverage enables users to transfer data directly to a centralised database e.g. PestCentral. It appears that the continued uptake of these devices for remote data collection, particularly in Queensland and the Northern Territory, is a significant driver for the development or revision of standards for data collection, highlighting the need to address this at the national level.

Since the 2006 review by Paping (2006), the use of crowd sourcing to capture data on the distribution, abundance and impacts of invasive species has grown significantly through projects. Initiatives such as the Atlas of Living Australia and FeralScan are currently working through a number of issues (discussed in section 3.1.2.5) that potentially impact the ability to share these data and use it to augment data collected through more traditional approaches. A number of these systems have now been operating long enough to demonstrate that a significant amount of data can be collected through this mechanism, although the value of these data to the management of invasive species still needs to be further assessed. However, given widespread interest in using these systems, it is important that approaches to managing these issues are resolved through the same collaborative approach that has now been adopted to address issues such as common standards.

Initiatives such as ABIN, the Atlas of Living Australia and FeralScan have highlighted the importance of supporting various communities of practice involved in the collection, management and analysis of data on invasive species. In the case of ABIN and the Atlas of Living Australia, these are research communities that benefit from the ability of these systems to integrate a large number of previously separate data sources. However, the same technology can also be used to support the broader communities, such as local pest and weed action networks that are now contributing data through initiatives like FeralScan. The use of this technology to share the information and knowledge derived from base data has only recently begun to be explored through the use of this technology and is likely to be of significant interest in addressing the need to share information discussed in section 4.1.

5. Recommendations

This project has highlighted that a wide variety of information systems continue to be used to collected, manage and share data and information on invasive species across Australia; and that a significant number of new systems are currently being planned and/or developed using a wide range of technology. However, it is clear that the technology that is underpinning the development of many of the new or upgraded systems also provides means through which long-standing issues impacting the ability to share this information, such varying standards and formats, may be overcome.

The following recommendations are based on both the ongoing issues in collecting and managing data highlighted by this study, and the opportunities that rapidly evolving technology provides in addressing these issues. The recommendations are that:

1) Projects funded or otherwise supported through Commonwealth programs should clearly identify a mechanism through which any new data on invasive species distribution, abundance and impacts collected or managed in these systems will be made accessible to other systems. This may be via web services in the case of new or re-developed information systems funded by the Commonwealth, or through transfer to an information system that can make these data available e.g. via web services.

2) Projects funded or otherwise supported through Commonwealth programs that involve the collection and/or management of data on the distribution, abundance and impacts of invasive species should record data in a form consistent with a recognised attribution standard (see Table 6 and Recommendation 3), or (where this is not possible) provide a means through which the data collected can be translated to a common standard.

3) Further work be undertaken by sectoral commissions (particularly the VPC and AWC), or associated working groups, to identify a common set of core attribution standards between the standards identified in Table 6 to support Recommendation 2.

4) A set of guidelines consistent with recommendations 1, 2 and 3 be developed at the national level for the collection of data on the distribution, abundance and impacts via crowd sourcing. These guidelines should address the management of personal information, the use of collection standards to facilitate the use of these data by other systems, and the protection of the rights and interests of individuals to the use and enjoyment of land.

5. References

Beaten Track Group (2004). Assessment of Data Requirements and Availability to Address Natural Resource Condition and Trend Indicators – Part B: Identification of data needs and potential datasets. September 2004. National Land and Water Resources Audit, Canberra.

BIOSIRT (Commonwealth of Australia). 2010. *What is BioSIRT?*, Accessed 4th May 2010 at http://www.daff.gov.au/animal-plant-health/emergency/biosirt

Chapman, T. and Massam, M. 2007. *Rainbow Lorikeet: Pestnote*, Department of Environment and Conservation WA & Department of Agriculture and Food WA.

Cowled, BD., Aldenhoven, J., Odeh, I.O.A., Garrett, T., Moran, C. & Lapidge S.J. 2007. 'Feral pig population structuring in the rangelands of eastern Australia: applications for designing adaptive management units'. *Conservation Genetics (2008)*, 9:211-224

Department of Agriculture and Food Western Australia. 2007. *AgLine : phone 1300 725 572*, Department of Agriculture and Food WA. Accessed 11th June 2010 at http://www.agric.wa.gov.au/PC_90013.html

De Milliano, JW., Woolnough, A., Reeves, A. & Shepherd, D. 2010. *Ecologically* significant invasive species: A monitoring framework for natural resource management groups in Western Australia. Prepared for the Natural Heritage Trust 2 program, Department of Agriculture and Food, Western Australia, South Perth

Google. 2010. Northern Territory Government of Australia employs Google Earth to improve government services and enhance public safety. Accessed 18th June 2010 at http://www.google.com/earth/enterprise/nt_government.html

Government of South Australia. 2010. *Community Monitoring*, South Australian Murray-Darling Basin Natural Resources Management Board. Accessed 4th May 2010 at http://www.samdbnrm.sa.gov.au/BoardProjects/MonitoringandEvaluation/CommunityMonitoring.aspx

Grove-White, R., Waterton, C., Ellis, R., Vogel, J. and Stevens, G. 2005. *Amateurs as Experts – Harnessing New Knowledge Networks for Biodiversity*, viewed 4th May 2010, <http://www.lancs.ac.uk/fss/projects/ieppp/amateurs/>

Cooperative Research Centre for Invasive Animals. 2009. National Invasive Animals Monitoring and Reporting Workshop – Summary of workshop outcomes and recommendations, Canberra 2009.

Kraak, M.J. and Brown, A. 2001. *Web Cartography – Developments and prospects*, Taylor and Francis, New York

Lapidge, Bourne, Braysher, and Sarre. 2004. *About Pest Maps*, Invasive Animals CRC, University of Canberra and the Bureau of Rural Sciences.

Natural Values Atlas 2009, *Natural Values Atlas*, Biodiversity Conservation Branch, Department of Primary Industries, Parks, Water and Environment (Tasmania). Accessed 17th June 2010 at www.naturalvaluesatlas.tas.gov.au.

National Land and Water Resources Audit. 2008. Developing an Invasive Species Information System for reporting against the National Monitoring & Evaluation Framework using BioSIRT, Final Project Report, National Land and Water Resources Audit (NLWRA) Prepared by Land Management Services / Client and Resource Information – Department of Agriculture and Food Western Australia.

Parks Victoria. 2010. *Publications - Order Form - State of the Parks 2007*. Parks Victoria 2010. Accessed 17th June 2010 at http://www.parkweb.vic.gov.au/1process.cfm?subj=29&publication=15>

Paping, P. 2006. *Invasive species information systems*. Report to the National Land & Water Resources Audit, Canberra.

Quinn, A.J. & Bederson B.B. 2009. *A Taxonomy of Distributed Human Computation*, University of Maryland, Department of Computer Science Human-Computer Interaction Lab.

RabbitScan Challenge. 2009. *What is Rabbit Scan*. Accessed 5th May 2010 at http://www.rabbitscan.net.au

Rebelo, H. & Jones, G. 2010. Ground validation of presence-only modelling with rare species: a case study on barbastelles Barbastella barbastellus (Chiroptera: Vespertilionidae), Journal of Applied Ecology 10. Pages 1365-2664.

Thomas, P.A. & J.K. 2004. *Galapagos invasive species: With the community*, Charles Darwin Foundation and the Galapagos National Park. Accessed 4th May 2010 at http://www.hear.org/galapagos/invasives/topics/awareness/monitoring.htm

Weaver, J.P., Cock, J., Pulford, T.J., & Curran, M. 2003, *PIIMS – Designing and implementing an integrated database for animal health in South Australia*, Department of Primary Industries and Resources of South Australia, Sigma Computing, DMR Consulting Group.

West, P., and Saunders, G. 2006. Pest Animal Survey - A review of the distribution, impacts and control of invasive animals throughout NSW and the ACT, Vertebrate Pest Research Unit, NSW Department of Primary Industries.

West, P., Auricht, C., Franco, M. & Alexandra, J. 2006. *National Weeds and Invasive Animals Information Workshop – Report on workshop outcomes*, National Land and Water Resources Audit, Canberra.

West, P. 2007. *Significant invasive species (vertebrate pests),* National Land and Water Resources Audit, Canberra.

Woolnough, A.P., Gray, G.S., Lowe, T.J., Kirkpatrick, W.E., Rose, K., and Martin, G.R. 2005. *Distribution and Abundance of Pest Animals in Western Australia: A Survey of Institutional Knowledge*, Vertebrate Pest Research Section, Department of Agriculture WA.

XY Mapping 2010. *Pest Central*, XY Mapping. Accessed 10th May 2010 at http://www.xymapping.com.au/35/Pest+Central