PRIORITISATION OF HIGH CONSERVATION STATUS MAINLAND ISLANDS

Prepared for
Department of the Environment, Water, Heritage and the Arts

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Prioritisation of High Conservation Status Mainland Islands

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Abbreviations

ABBREVIATION	DESCRIPTION
ACLUMP	Australian Collaborative Land Use Mapping Program
ANHAT	Australian Natural Heritage Assessment Tool
BRS	Bureau of Rural Sciences
CAPAD	Collaborative Australian Protected Area Database
DAFF	Commonwealth Department of Agriculture, Fisheries and Forestry
DEWHA	Commonwealth Department of the Environment, Water, Heritage and the Arts
ELA	Eco Logical Australia
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ERIN	Environmental Resources Information Network
GIS	Geographic Information System
HCVAE	High conservation value aquatic ecosystem
IBRA	Interim Biogeographic Regionalisation of Australia
NES	National Environmental Significance
NVIS	National Vegetation Information System
TAP	Threat Abatement Plan
VPC	Vertebrate Pests Committee

Executive Summary

Introduced vertebrate species have colonised large areas of mainland Australia and cause severe environmental damage, particularly in areas of high conservation value. Managing the threat posed by invasive pests is a high priority of the Australian Government. Several Australian Government Threat Abatement Plans identify the need to prevent invasive species from "occupying new areas in Australia and to eradicate feral animals from high-conservation-value 'islands'". 'Islands' are defined as both offshore islands and as mainland islands that are isolated and/or do not currently have invasive species.

The Department of the Environment, Water, Heritage and the Arts (DEWHA) engaged Eco Logical Australia (ELA) to identify high conservation value "mainland islands" and prioritise them according to risk from vertebrate pest species. An analysis of the management regimes in place for the highest priority islands was also required.

Currently, there is no agreed definition of what constitutes a mainland island and consequently, there is no central database of the location of high conservation value "mainland islands". Therefore the first step of this project was to define and identify the location of high conservation value mainland islands. The definition of mainland islands was developed collaboratively by DEWHA and ELA and was based on twelve biodiversity and conservation criteria. Analyses were based on existing datasets that were available and consistent at a national level.

In total, 471 mainland islands were identified. Islands were found in all states and territories, however, they were primarily located along the east coast (over 80% of islands were in NSW, Qld and Victoria). The main factor driving the location of mainland islands was the combination of high species richness and high endemism. Factors including threatened species/communities and World Heritage Areas were also influential.

Mainland islands were prioritised based on an assessment of their overall conservation value and level of threat, particularly threats from vertebrate pests. High conservation value islands were located across Australia, while threats were concentrated along the eastern seaboard. Consequently, the top 100 highest priority islands were concentrated along the east coast of Australia. Other top 100 islands located away from the east coast include Shark Bay and Stirling Range National Park (WA), Kakadu and the MacDonnell Ranges (NT), the Coorong (SA) and the Tasmanian Wilderness.

Management of vertebrate pests in Australia is undertaken by all levels of government as well as private land-holders and managers. Consequently, management of pests on mainland islands falls within a sometimes complicated array of tenures. Pest management on mainland islands can be categorised in one of three ways: islands covered entirely by one specific management arrangement; islands not covered by specific management arrangements and islands covered by a combination of management arrangements.

There were several limitations associated with each stage of this project. The definition of mainland islands was restricted by nation-wide consistency of data, data biases and resolution, delineating boundaries and the overall availability of relevant datasets. The results of the prioritisation analysis should be interpreted with care, as the occurrences and impacts of pests used in the analysis are

potential rather than actual. Finally, consideration of management regimes for mainland islands was based on publically available information only. Overall, much information about pest management in Australia is diffuse and difficult to access, and consequently it is hard to gauge the degree to which pest management has occurred / is occurring at many sites around Australia.

Several recommendations stem from this project. Overall, it is recommended that the outputs of this study be used as a strategic guide rather than a definitive list of areas requiring significant pest management. Additional recommendations are provided with respect to pest management, this and future studies and data resources.

1 Introduction

1.1 BACKGROUND

Introduced vertebrate species, and in particular mammals, have been a major cause of extinction and decline of biodiversity worldwide. Introduced vertebrate species have colonised large areas of mainland Australia and cause severe environmental damage, particularly in areas of high conservation value. Managing the threat posed by invasive pests is a high priority of the Australian Government.

The serious nature of the impact of vertebrate pests on areas of high conservation value is highlighted in several Australian Government Threat Abatement Plans (TAPs) prepared under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The first objective of several TAPs (e.g. feral cat, European fox[1]) is to prevent the invasive species from "occupying new areas in Australia and to eradicate ferals from high-conservation-value 'islands'". 'Islands' are defined as both offshore islands and as mainland islands that are isolated and/or do not currently have invasive species.

1.2 PROJECT AIMS

The overall objective of this project is to develop a priority listing of Australian mainland islands of high conservation value which may be adversely affected, or are at high risk of being adversely affected, by vertebrate invasive species.

Currently, there is no agreed definition of what constitutes a mainland island and consequently, there is no central database of the location of high conservation value mainland islands. The first aim of this project is to define mainland islands and determine their location throughout Australia. Following this, the islands' conservation values will be assessed and prioritised, particularly with respect to the impacts of vertebrate invasive species on the biodiversity values of the islands.

The final aim of this project is to gather and synthesise information about the current management of high priority islands e.g. the extent to which islands are covered by pest management plans, the scope of these plans and the resources available for their implementation. It is suggested that the information for individual islands may help to contribute to "best practise" pest management.

1.3 SCOPE

The Department of the Environment, Water, Heritage and the Arts (DEWHA) engaged Eco Logical Australia (ELA) to identify high conservation value mainland islands, prioritise them according to risk from vertebrate pest species and undertake an analysis of the current management regimes in place for the top 30 ranked islands.

[1] *Threat abatement plan for predation by feral cats*, *Threat abatement plan for predation by European red fox* (DEWHA 2008)

The study area encompassed the entire Australian mainland and Tasmania. A list of vertebrate pest species to be considered in this study was provided by DEWHA (Table 1).

It should be noted that the agreed scope of this project was to work with existing data only. Many potentially useful datasets have not been compiled with nation-wide coverage. The compilation of new data e.g. location of eradication programs and exclusion areas, was beyond the scope of the resources allocated to this project. Therefore, the level of information available to the project is a major influencing factor on the final analyses.

Table 1: Vertebrate pest species considered in this study

Common name	Scientific name
Cane toad	*Bufo marinus*
Carp, European carp	*Cyprinus carpio*
European red fox	*Vulpes vulpes*
European wild rabbit	*Oryctolagus cuniculus*
Feral camel	*Camelus dromedaries*
Feral cat	*Felis catus*
Feral deer	Family Cervidae
Feral donkey	*Equus asinus*
Feral goat	*Capra hircus*
Feral horse	*Equus caballus*
Feral pig	*Sus scrofa*
Feral water buffalo	*Bubalus bubalis*
Indian Myna, Common Myna	*Acridotheres tristis*
Mosquito fish, Plague Minnow	*Gambusia holbrooki*
Red-eared slider turtle	*Trachemys scripta elegans*
House mouse[1]	*Mus musculus*
Tilapia, Mozambique Tilapia	*Oreochromis mossambicus*
Weather loach; Oriental weather loach	*Misgurnus anguillicaudatus*
Wild dog	*Canis lupus familiaris*

1: Rodents were initially flagged for inclusion, however, DEWHA does not have distribution maps for the house mouse or feral rat species. However, *Mus musculus* is considered to be in all areas of Australia, *Rattus rattus* and *Rattus norvegicus* are restricted to exterior areas of the continent and *Rattus exulans* only occurs on offshore islands. On this basis, only the house mouse *Mus musculus* was included in the analyses and was considered to occupy all areas of mainland Australia.

2 Identifying Mainland Islands

2.1 INTRODUCTION

The concept of "mainland islands" stems from several Australian Government Threat Abatement Plans (e.g. fox, rabbit, goat, cat), which state as their first objective:

> Prevent foxes/rabbits/goats/cats from occupying new areas in Australia and eradicating them from high conservation value "islands".

The TAPs go on to distinguish between offshore islands and isolated "mainland islands", however there is little direction provided as to what, specifically, might constitute a mainland island. This presents a particular challenge of this project. Any identified 'mainland islands' will be influenced by varying ideas about what features are important in such a definition and also by the availability, scale and comprehensiveness of data.

2.2 DATA

ELA convened a workshop with staff from DEWHA and the Bureau of Rural Sciences (BRS) to determine an agreed definition of mainland islands. Workshop attendees[2] decided that mainland islands would be defined as discrete areas on the Australian mainland that are of high conservation value. The following conservation values were included in the definition:

- EPBC Act listed threatened species and ecological communities
- EPBC Act listed migratory species
- World Heritage Areas and National/Commonwealth Heritage Places listed for their natural heritage values
- Ramsar wetlands
- DIWA-listed wetlands and other high conservation value aquatic ecosystems (HCVAEs)
- Species richness
- Level of endemism
- Presence of native vegetation
- Arid and semi-arid refugia
- Presence of vertebrate pest species (20 species considered in this study, Table 1)

It is acknowledged that this list is not a comprehensive account of all conservation values that could be included in a definition of mainland islands. The above values were chosen primarily because these

[2] Representatives from DEWHA (Environmental Biosecurity, Species Listing and Ecological Communities Sections, and the Environmental Resources Information Network) and the Bureau of Rural Sciences.

values have been developed using consistent criteria (e.g. EPBC Act listing criteria), and data was available for each at a nation-wide scale. The first four criteria represent matters of National Environmental Significance (NES) under the EPBC Act, which are recognised for their conservation value at an Australia-wide scale.

State-level data was not included in the analysis. There are many constraints to using state-level data for nation-wide analyses. These include consistency, resolution/scale and timeframes for acquisition. Workshop attendees resolved that state-level data would not be included in the definition of mainland islands due both to the difficulties associated with the data and a feeling that the nation-wide data listed above would be sufficient. However, it was deemed important that state/territory agencies have an opportunity to comment on the mainland islands identified during this project and to highlight any additional areas they would consider to be a mainland island. More details of the outcomes consultation with state/territory agencies are provided below.

2.3 ANALYSES

2.3.1 Stage 1 Analyses

Mainland islands were identified using a data overlay approach. This approach followed a number of steps:

1. All data layers were provided by DEWHA's Environmental Resources Information Network (ERIN).

2. All data were converted to grids with a 0.05 x 0.05 degree cell size (this was the minimum cell size of threatened/migratory species and threatened communities and is approximately 2,500 ha in size).

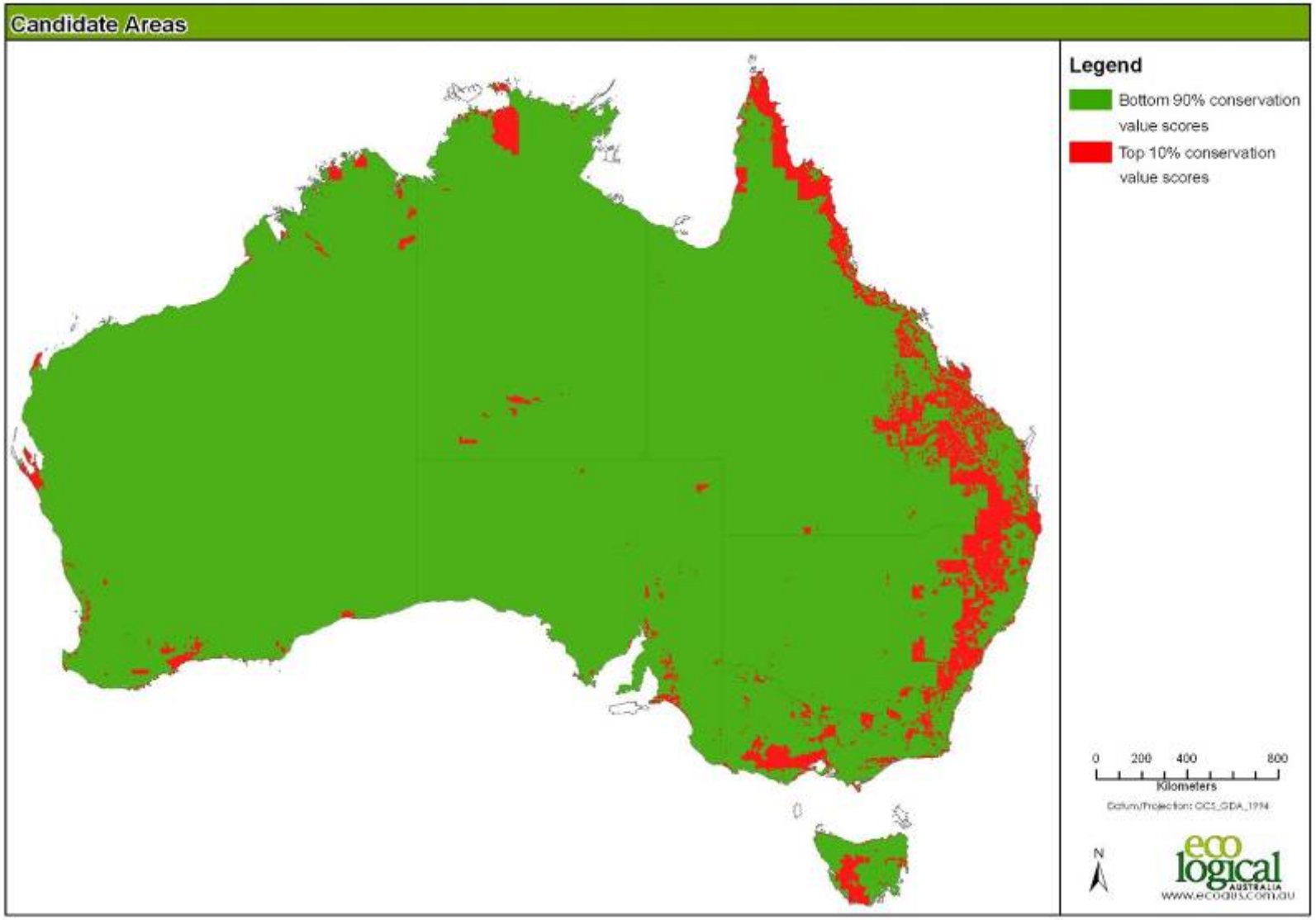
3. All data were clipped to the Australian mainland (including Tasmania) to ensure offshore islands were not included in the analyses.

4. All conservation values were assigned weightings (see below): 0 or 1/4/8 for presence-absence data or 0-12 for categorical data.

5. All data layers were overlayed and the weightings for each conservation value added together for each grid cell.

6. Grid cells with the highest aggregate conservation value scores (top 10%) were considered to be candidates for mainland islands (Figure 1).

Figure 1: Candidate areas for mainland islands.



2.3.2 Weighting conservation values

The overlay approach required some data to be defined categorically and weighted e.g. density of threatened species represented as high, medium and low. Other data were included in the analyses as presence-absence e.g. Ramsar wetlands. Weightings allocated to each data layer were determined by ELA during internal workshops and were based on conservation considerations e.g. Ramsar wetlands are internationally listed and therefore were weighted higher than nationally-listed DIWA wetlands and high conservation value aquatic ecosystems. Weightings are presented in Table 2 below.

2.3.3 Stage 2 Analyses

For some areas of Australia, the initial overlay analysis was not sufficient to identify discrete units that could be considered mainland islands. Some regions, particularly along the east coast of Australia, had large areas with high conservation value scores (see large blocks of red in Figure 1). These areas required further consideration in order to reduce their size and define the boundary of what would be considered the mainland island.

The candidate areas were visually inspected and a boundary digitised around an area that was to be considered a “mainland island”. Boundaries were defined based on several inputs including:

- Bioregional boundaries (using IBRA sub-regions)
- Conservation value (i.e. mainland island definition score)
- Isolation
- Physical barriers e.g. dog/rabbit proof fences
- Potential connectivity
- Protected areas
- Size
- Topography

2.3.4 State/Territory Consultation

ELA engaged state and territory agencies through the relevant Vertebrate Pest Committee representative. Each representative was provided with a brief outline of the project, the methodology for determining the location of islands and a map of the islands identified in their state. Representatives were asked to consult with relevant colleagues about the identified islands and to highlight any additional areas that they would consider to be a mainland island.

Some states and territories provided suggestions for additional areas that could be considered mainland islands. These areas were included in the prioritisation analysis (see Section 2.5 below).

Table 2: Weightings used in definition of mainland islands.

Conservation value	Weighting scheme	Weighting boundaries	Value of weighting
Threatened species	None	0 species	0
	Low	1-9 species	3
	Medium	10-19 species	6
	High	20-29 species	9
	Very High	30-58 species	12
Threatened communities	None	0 communities	0
	Low	1-2 communities	6
	High	3-5 communities	12
Migratory species	None	0 species	0
	Low	1-4 species	1.5
	Medium	5-9 species	3
	High	10-19 species	4.5
	Very High	20-29 species	6
Species richness	Low	0-243 species	3
	Medium	244-388 species	6
	High	389-615 species	9
	Very High	616-1920 species	12
Endemism	Low	0-54	3
	Medium	55-126	6
	High	127-330	9
	Very High	331-11497	12
World Heritage Areas	Absent		0
	Present		8
National heritage (National and Commonwealth)	Absent		0
	Present		4
Ramsar wetlands	Absent		0
	Present		8
Nationally important aquatic ecosystems	Absent		0
	Present		4
Refugia	Absent		0
	Present		4
Native vegetation	Absent		0
	Present		1
Pest species	Absent		4
	Present		0

Note: Endemism scores and species richness were summed across all taxa. The endemism and richness weighting boundaries were the 0-25, 26-50, 51-75, 76-100 percentiles. Pest species were considered as present or absent only, and the identity or density of pest species not considered. These pest-related factors are considered in the prioritisation analyses, and were therefore not used to define Mainland Islands.

2.4 RESULTS

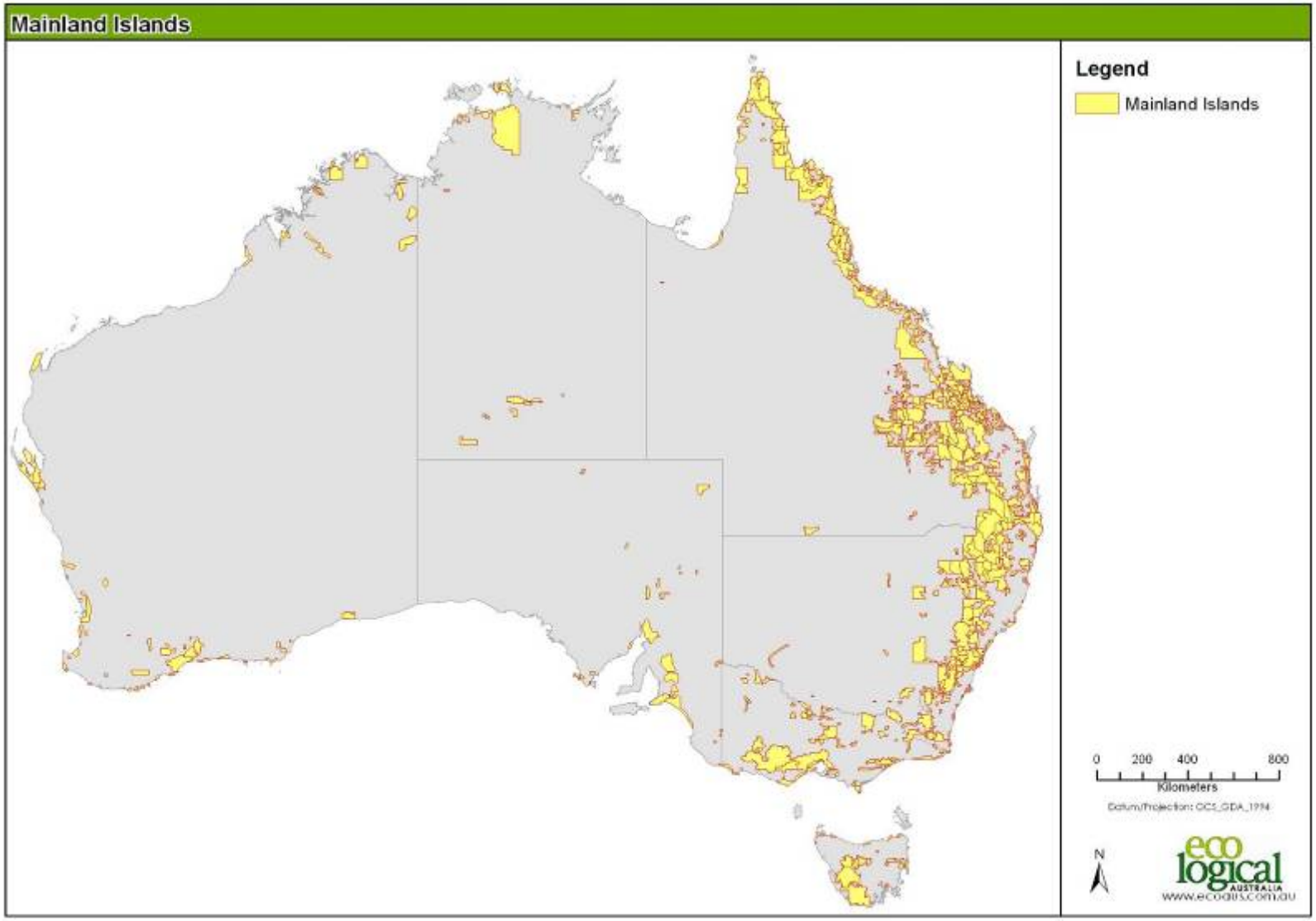
The process outlined above identified 471 mainland islands (Figure 2), distributed across Australia as outlined in Table 3.

Table 3: Distribution of mainland islands by state/territory.

State/Territory	Number of islands	Percentage of total number of islands
Australian Capital Territory	2	0.4%
New South Wales	131	28%
Northern Territory	16	3%
Queensland	244	52%
South Australia	25	5%
Tasmania	15	3%
Victoria	40	8%
Western Australia	51	11%

Note: Islands which overlap state/territory boundaries are included in the count for all the states/territories in which they occur.

Figure 2: Mainland islands



2.5 DISCUSSION

The main factor driving the location of mainland islands throughout Australia is the combination of high species richness and high endemism. In Australia, such areas are concentrated along the east coast, in south-western WA and in northern NT—north–west WA, and it is in these broad areas that the vast majority of mainland islands are located. In addition to having areas of very high species richness and endemism, the east coast of Australia also supports high densities of threatened species and communities. There are also many World Heritage Areas and Ramsar wetlands found on the east coast. It is the combination of these factors that has resulted in the concentration of mainland islands along the east coast and the relative lack of mainland islands in the other areas of high richness/endemism (i.e. NT, WA).

The data overlay approach used to define mainland islands means that many conservation/biodiversity values are aggregated. As a result, some areas will be excluded, even though they may seem to warrant inclusion as mainland islands, due to the presence of one or a few biodiversity values that are seen to be very important or of very high value. For example, South Australian agencies suggested that the areas occupied by the threatened plant species *Acacia araneosa*, *Acacia carneorum* and *Codonocarpus pyramidalis* should be considered as mainland islands. While these areas are regionally significant, when they are considered at a nation-wide scale and in conjunction with other conservation values (e.g. species richness and endemism, total number of threatened species) the overall conservation value score of such areas is relatively low.

2.5.1 Limitations of the analysis

The primary limitations of the mainland island identification analysis are associated with the available data.

Nation-wide consistency

Only existing datasets available at a nation-wide scale were used in the analysis. This limited the amount of data available to feed into the definition. For example, state listed threatened species/communities were not considered. The decision not to use state-level data was based largely on inconsistencies between methodologies used to list species/communities across states. For example, not all states list threatened ecological communities and there are often differences in the threatened species status of plants and animals that cross state borders. It was considered that patchy and/or missing data had the potential to skew the analyses to such a degree that including this type of data was not warranted.

Problems with nation-wide data consistency have also been highlighted for pest data. In the past, state and territory authorities have used a diverse range of methods to measure and report on invasive species populations. Consequently, information on pest animals across Australia varies in currency, scale, quality and reliability (National Land and Water Resources Audit 2008). For this reason, only pest distribution data (i.e. presence-absence) has been incorporated into this project. Furthermore, the distribution of some pest species is unknown in some states. Therefore, in implementing the precautionary principle and calculating a “worst case scenario”, pests were assumed to be present when their distribution was recorded as unknown.

Bias

There are several biases in the datasets used in this project that should be acknowledged. Firstly, there is a degree of taxonomic bias in the species richness and endemism datasets in that only eight taxonomic groups are represented in the ANHAT data used. Threatened species data also contains both taxonomic and geographic bias. Few invertebrate animals and non-vascular plants appear on threatened species lists, and the distribution of threatened species and ecological communities is concentrated along the Australian east coast (Adams 2002).

Resolution and boundaries

The resolution of datasets used in the analysis was mixed. At the coarsest scale, data for species richness and endemism and pest data were provided at a 0.5x0.5 degree scale. Other data, such as threatened species density, were available at a finer (0.05x0.05 degree) scale. High conservation value aquatic ecosystem data was provided as point data only and hence a 1 km buffer was used for all the aquatic ecosystems regardless of their actual extent.

Boundaries of mainland islands have been delineated based on best available data taking into account the range of factors list above. In some cases, there is a clear case for the assigned boundary e.g. national park or World Heritage Area boundaries. However, it should be acknowledged that in other cases where there are no clear cut boundaries, the delineation of islands may be somewhat arbitrary from a biodiversity conservation perspective. Furthermore, with the exception of physical boundaries such as pest-proof fences, vertebrate pests will not recognise island boundaries given their highly mobile nature.

Availability of datasets

The resources allocated to this project allowed only for the use of existing datasets and the definition workshop attendees resolved to focus on Australian Government held datasets. Several datasets would have been useful in refining the definition of mainland islands, and in particular addressing vertebrate pest issues within the definition. For example, areas where successful pest control is being undertaken could be considered to have very high conservation value in the context of this project, and some of these areas were identified by state agencies as additional mainland islands. Examples include the Operation Bounce Back Area (SA), Western Shield Program Area (WA) and the Southern Ark (Vic). Additionally, areas where pests are excluded could also be considered to have very high conservation value e.g. Arid Recovery Area (SA) and the Darling Downs-Moreton Rabbit Board Area (Qld). In addition to the examples listed here, there are many small-scale eradication and exclusion programs being undertaken across the country. However, as no nation-wide data is available for these programs they were not included in the definition of mainland islands.

3 Prioritisation Analysis

3.1 INTRODUCTION

DEWHA identified a need to gain a more detailed understanding of the mainland islands that have the highest biodiversity values, particularly those that are most threatened by vertebrate pest species. Therefore, it was necessary to develop a system by which to prioritise or rank the mainland islands identified above. Based on this system, information about the highest ranking islands was given precedence for analysis of management regimes.

3.2 METHODS

A three-step process was used to develop a prioritisation system for mainland islands. Firstly, islands were classified according to their conservation value. The islands were then assessed for the level of potential threat/risk, particularly with respect to vertebrate pests. Results were then evaluated in a decision matrix to determine an overall priority for each island and scores analysed mathematically to rank islands according to their total priority level.

This type of methodology is consistent with that outlined in PESTPLAN: A Guide to Setting Priorities and Developing a Management Plan for Pest Animals (Braysher and Saunders 2003).

3.2.1 Determining Conservation Value

Mainland islands have been defined as areas of high conservation value. Therefore, the data used to define and identify islands were the primary data used in identifying conservation value for the prioritisation analysis. Some additional data were used to further quantify and refine the conservation value of mainland islands.

Conservation value was based on the following:

- Mainland island definition score – averaged across the grid cells making up the islands
- Area to perimeter ratio – accounting for increased edge effects inside islands with large perimeters but small areas e.g. long and narrow islands.
- Adjacency – distance to nearest island
- Island uniqueness (see below)
- Island representativeness (see below)

Uniqueness is a measure of how rare the dominant vegetation type of each island is, relative to all other islands. A uniqueness score was calculated as follows:

- The predominant vegetation type of each island was determined (by area and using NVIS data).
- Each vegetation type was allocated a uniqueness number - calculated by determining how many islands had the same vegetation type and taking the inverse.
- All islands received the uniqueness score of their predominant vegetation type.

Representativeness is a measure of how many islands occur within each IBRA region, and was determined in a similar manner to uniqueness, as follows:

- The number of islands within each IBRA region was summed.
- The inverse of this number was allocated as the representativeness score of the bioregion.
- All islands received the representativeness score of the bioregion in which they were located.
- When islands crossed bioregion boundaries, they were counted as occurring in both i.e. islands could be counted more than once. In these instances, the highest score was taken for the prioritisation analysis.

All parameters contributing to the conservation value of islands were weighted as very high, high, medium or low (Table 4). Mainland island definition scores were weighted more heavily than other parameters. Heavier weighting of definition scores was considered appropriate as the scores were calculated from data on many separate conservation values.

The total conservation value score of all mainland islands was calculated by summing the individual parameter scores for each island. The highest possible conservation value score was 32.

3.2.2 Determining Threat Level

Threats related both to vertebrate pest impacts and other threatening processes were considered in the prioritisation analysis.

Threat level was based on the following:

- Density of pest species – averaged across all grid cells in the island
- Number of potential impacts from pest species on matters of NES (see below)
- Number of pest invasion fronts / range boundaries (defined as a 50km buffer around current pest distribution)
- Land use within the island
- Density of Weeds of National Significance (WoNS) within the mainland island
- Level of statutory protection (proportion of each island that is included in a reserve of IUCN categories 1-4; using CAPAD data)

The number of potential impacts from pest species on matters of NES was determined using a database compiled by ERIN (Assets Pressures and Mitigation Database[3]). The identity of all matters of NES and each pest species occurring in each island was determined from the spatial data layers provided by DEWHA. The Assets Pressures and Mitigation Database was then queried to determine which matters of NES were potentially affected by each pest species occurring within the island. The total number of impacts was tallied for each island.

[3] The Assets Pressures and Mitigation Database was compiled by ERIN based on information available about matters of NES e.g. listing information, management plans, recovery plans, threat abatement plans. The database compiles information about identified threats to matters of NES, including vertebrate pest species. ELA only considered the 20 pest species listed in Table 1 when assessing pest impacts.

All parameters contributing to the threat level of islands were weighted as very high, high, medium or low (see Table 5). Vertebrate pest density and impact levels were weighted more heavily than other threatening processes. Heavier weighting of pest factors was considered appropriate given the focus of this project.

The total threat score of all mainland islands was calculated by summing the individual parameter scores. The highest possible conservation value score was 33.

Table 4: Data and categories used to determine conservation value score

Data set	Conservation value level	Conservation value boundary	Conservation value score
Mainland island definition score (average across all grid cells within island)	Low	Low score	4
	Medium	Medium score	8
	High	High score	12
	Very high	Very high score	16
Area to perimeter ratio	Low	Small area relative to perimeter	1
	Medium	Moderate area relative to perimeter	2
	High	Large area relative to perimeter	3
	Very high	Very large area relative to perimeter	4
Adjacency	Low	Nearest island >250km away	1
	Medium	Nearest island within 250km, but no adjacent	2
	High	One adjacent island	3
	Very high	>1 adjacent island	4
Island uniqueness	Low	> 150 islands of same type	1
	Medium	106-150 islands of same type	2
	High	51-105 islands of same type	3
	Very high	<50 islands of same type	4
Island representativeness	Low	>66 islands within IBRA region	1
	Medium	33-65 islands within IBRA region	2
	High	13 – 32 islands within IBRA region	3
	Very high	<13 islands within IBRA region	4

Table 5: Data and categories used to determine threat score

Data set	Threat level	Threat level boundary	Threat score
Density of pests	Low	≤11 pest species	2
	Medium	12 pest species	4
	High	13 pest species	6
	Very high	>13 pest species	8
Pest impact level	Low	0-14 impacts	2
	Medium	15-19 impacts	4
	High	20-26 impacts	6
	Very high	>26 impacts	8
Number of invasion fronts/range boundaries within island	Low	0	1
	Medium	1-2	2
	High	3	3
	Very high	>3	4
Land use	Very Low	ACLUMP 1 & 6	1
	Low	ACLUMP 2	2
	Medium	ACLUMP 3	3
	High	ACLUMP 4	4
	Very high	ACLUMP 5	5
Weed density (WoNS, average across all grid cells within island)	Low	<2.5	1
	Medium	2.5-4	2
	High	4.1-5.5	3
	Very high	>5.5	4
Proportion of island without statutory protection	Low	>50% island area reserved	1
	Medium	6-50% island area reserved	2
	High	0-5% island area reserved	3
	Very high	0% island area reserved	4

ACLUMP 1 & 6: Conservation and natural environments, water

ACLUMP 2: Production from relatively natural environments e.g. forestry

ACLUMP 3: Production from dryland agriculture and plantations (e.g. dry cropping)

ACLUMP 4: Production from irrigated agriculture and plantations (e.g. irrigated cropping)

ACLUMP 5: Intensive uses (e.g. urban areas, mining)

3.2.3 Island Priority Level

Overall conservation value and threat levels were evaluated and assigned to categories according to the cut-offs outlined below (Table 6). These cut-offs represent the 0-25, 26-50, 51-75 and 76-100 percentiles of the priority scores dataset.

Table 6: Cut-offs for conservation and threat level categories

Category	Conservation value scores	Threat scores
Low	<16	<16
Medium	16-20	16-20
High	21-24	21-22
Very high	>24	>22

Priority was assigned based on the combination of conservation value and threat status according to the matrix below (Table 7). For example, an island with high conservation value under high threat received a high priority designation. All islands were evaluated according to the matrix below and were assigned a priority.

Table 7: Decision matrix for assigning priority from threat status and level of conservation value

		THREAT STATUS			
		VERY HIGH	**HIGH**	**MEDIUM**	**LOW**
CONSERVATION VALUE	**VERY HIGH**	Very high priority	Very high priority	Very high priority	High priority
	HIGH	Very high priority	High priority	High priority	Medium priority
	MEDIUM	High priority	Medium priority	Medium priority	Medium priority
	LOW	Low priority	Low priority	Low priority	Low priority

3.2.4 Ranking Islands

In order to rank islands according to priority, the conservation value scores were added to the threat level scores to give a total priority score.

Islands were then ranked according to the priority score. Many islands received the same priority score and in this case, were ranked within the same total priority score level according to conservation value score.

3.3 HIGH PRIORITIY MAINLAND ISLANDS

In total, 73 mainland islands were assigned a very high priority (Table 8). These are located primarily along the east coast of Australia. Consequently, the majority of the top 100 islands are also located in this area. Other top 100 islands located away from the east coast include Shark Bay and Stirling Range National Park (WA), Kakadu and the MacDonnell Ranges (NT), the Coorong (SA) and the Tasmanian Wilderness.

Maps are provided below of the priority level of all mainland islands (Figure 3), the top 100 ranked islands (Figure 4) and the overall distribution of conservation value and threat levels (Figure 5). Details of the top 100 islands are provided in Appendix A. Fact sheets have been prepared for the top 50 islands, and management arrangements have been analysed for the top 30 islands. Fact sheets including management analyses are available at Appendix B.

Table 8: Number of islands in each priority, conservation value and threat level category

Category	Overall Priority	Conservation Value	Threat Level
Very High	73	85	107
High	118	113	75
Medium	162	127	141
Low	118	146	148

Department of Defence Managed Sites

Several very high priority mainland islands included significant areas of land managed by the Department of Defence. These areas are:

- Holsworth Military Area (NSW)
- Puckapunyal Military Area (Vic)
- Shoalwater Bay Training Area (Qld)
- Wide Bay Training Area (Qld)

The prime purpose of Defence land is to maintain the capability of the Australian Defence Force and is managed accordingly. In terms of environmental management, Defence implemented the Australian Government's policy direction that all Commonwealth Agencies were to have a corporate EMS in place by December 2002, with at least one site certified by December 2003. Defence achieved these requirements through the corporate EMS being assessed as consistent with the international standard ISO 14001: 2004 Environmental Management Systems and Certification of RAAF Base Townsville's EMS and subsequent certification of Puckapunyal Military Area. Defence continues to progressively roll-out its EMS approach through higher risk Groups and Services activities and at its key Defence sites, where activities and the stewardship of environmental values need to be managed on the ground (www.defence.gov.au/environment/).

As management of pests species will be incorporated into to above framework, two islands, covered entirely by Defence land have been removed from the top 100 list (Puckapunyal and Shoalwater), and have been replaced with the next ranked islands. Furthermore, Defence areas have been excluded

from other mainland island areas when the Defence area made up a portion of a larger mainland island (e.g. Holsworthy and Wide Bay).

State/Territory Identified Mainland Islands

The Northern Territory and South Australian agencies provided suggestions for additional areas to be considered as mainland islands. These areas were not picked up by the original analyses undertaken in this study, however, have been included in the prioritisation analysis in modified format.

All state/territory identified mainland islands were assigned a conservation status score of medium since they did not have sufficiently high conservation value scores to be included in the original definition of mainland islands. The threat level was then determined for each additional island based on the methodology outlined above in section 3.2.2.

All additional mainland islands had threat levels of medium or low. This resulted in an overall priority level of medium. Therefore, no additional mainland islands were included on the top 100 list, which consists entirely of very high and high priority islands.

Figure 3: Priority level of all mainland islands

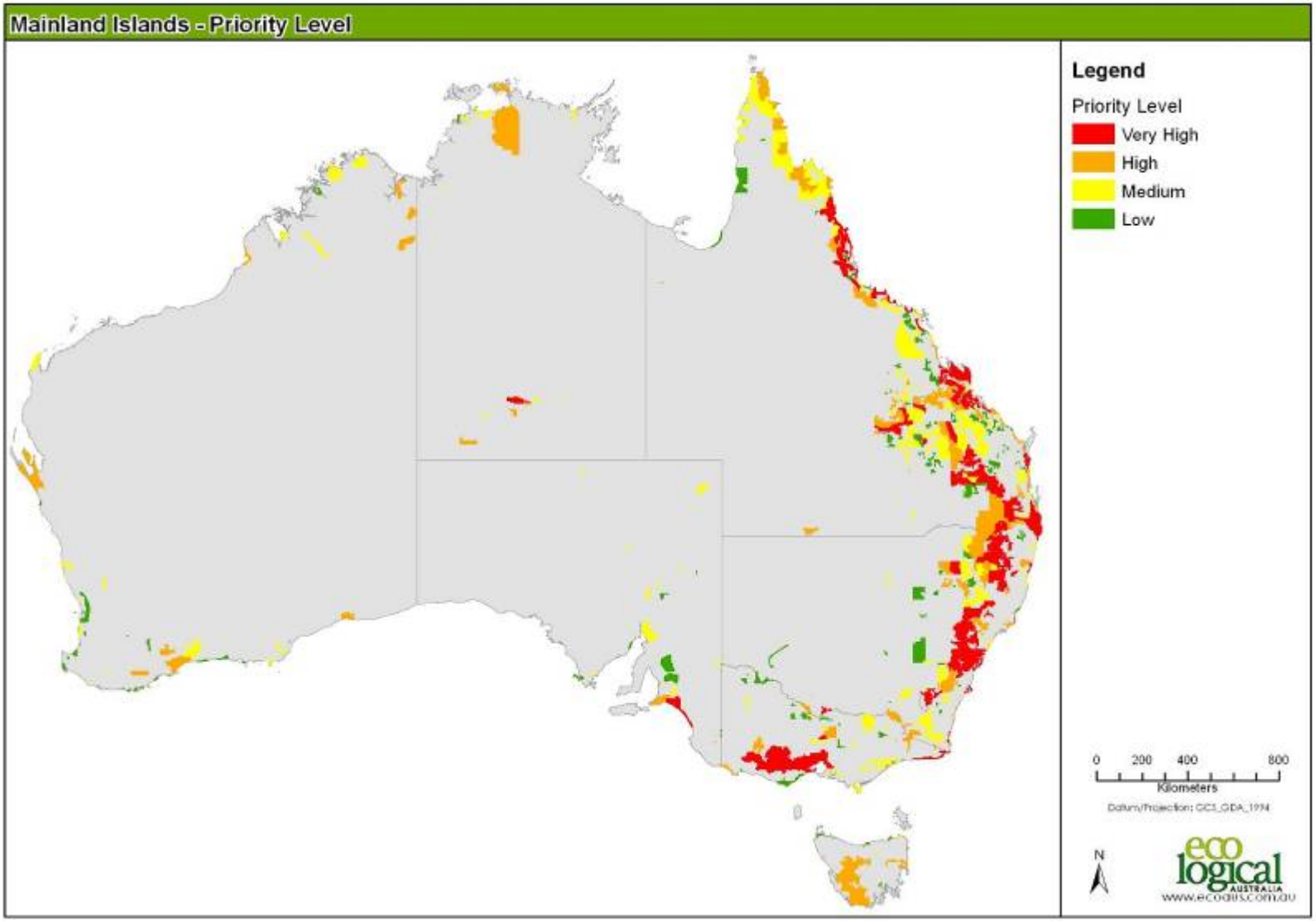


Figure 4: Top 100 ranked islands

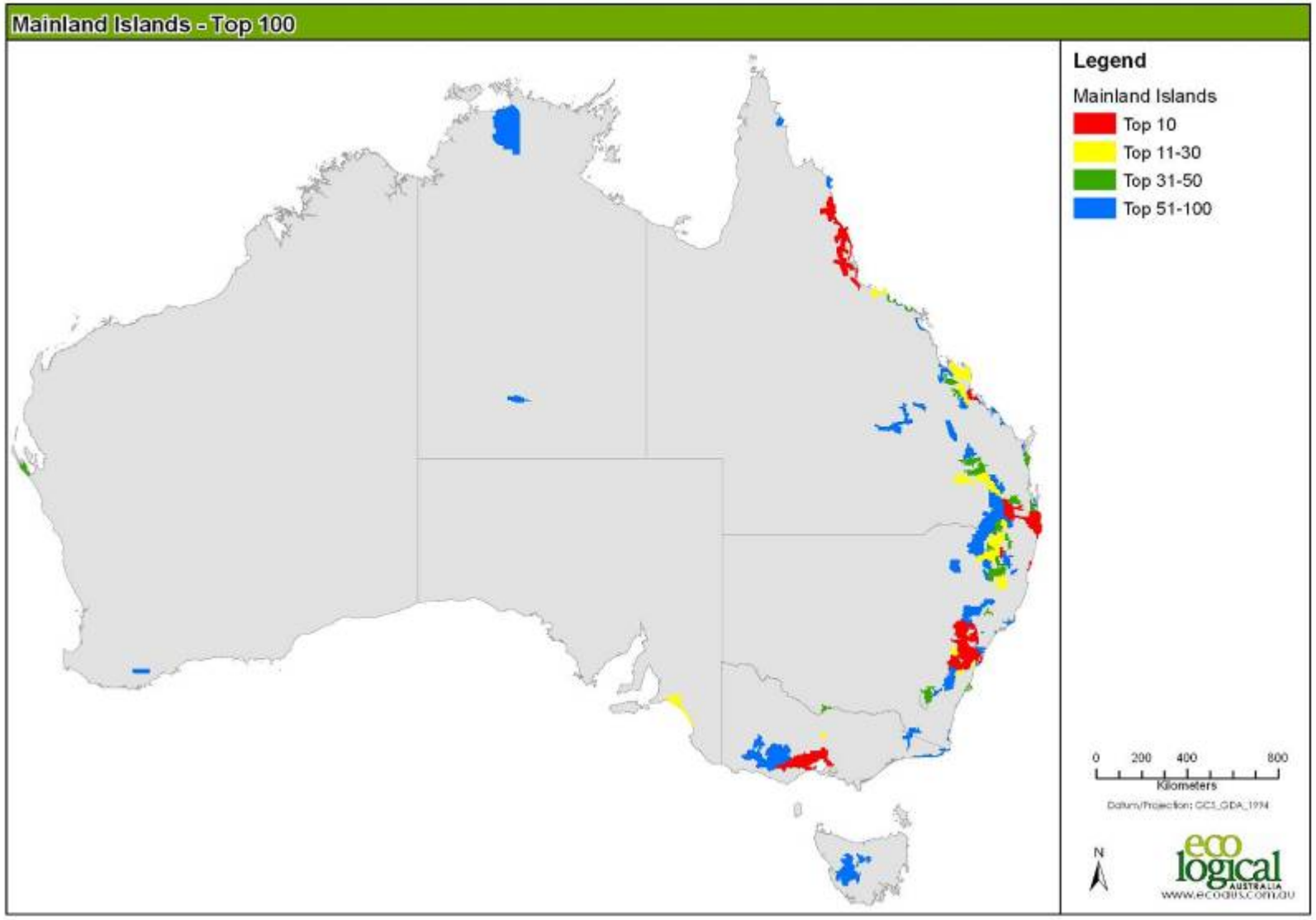
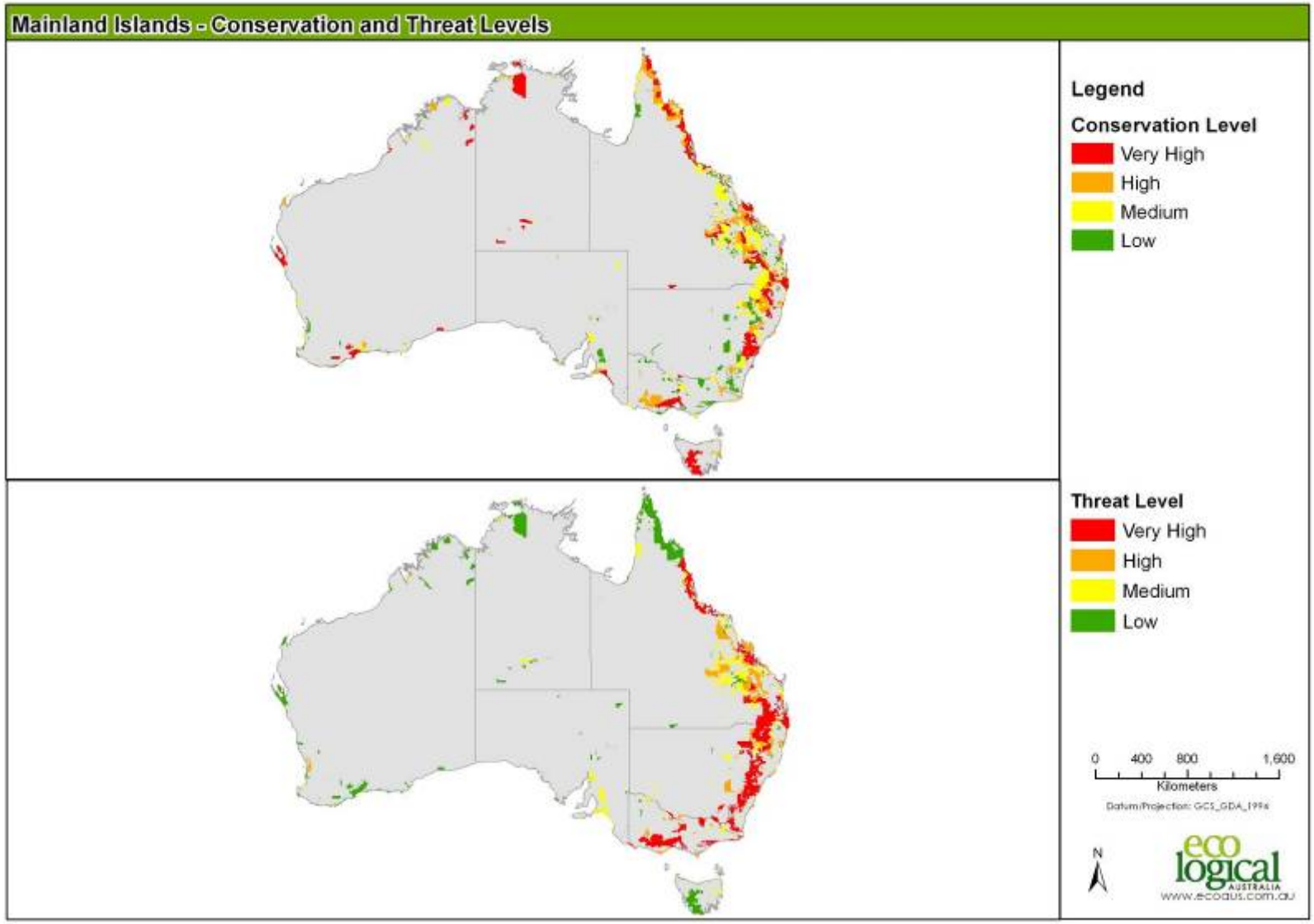


Figure 5: Conservation value and threat levels for all mainland islands



3.4 DISCUSSION

The prioritisation analysis ranked each island according to conservation value and threat. While high conservation value sites are distributed around the country, threats are concentrated along the east coast. Consequently, it is the high conservation value sites along the east coast that gain the highest rankings in the overall prioritisation analysis.

Two large urban areas were included in the top ranked mainland islands: Sydney and Melbourne. Both these areas have very high conservation values, associated with large numbers of threatened species and communities, migratory species and very high species richness and endemism. Both also contain World or Commonwealth Heritage Areas/Places and important wetlands. The pest threat in these urban environments is very high, with 15 of the 20 pest species considered in this study occurring within the two mainland islands. These pest species also had a large number of potential impacts on matters of NES. The current management arrangements for these mainland islands are outlined in the respective factsheets. However, it should be noted that pest management within these major urban areas will be a large challenge due to the landuse pressures and highly fragmented nature of the landscape.

3.4.1 Limitations of the analysis

Potential versus actual occurrence and impacts

Many data sets used in the prioritisation analysis are based on potential rather than actual species occurrences and impacts. For example, the presence of threatened species or vertebrate pests within a mainland island is predicted from the geographic range of the species. This means while the island is within the known distribution of the species, there is no guarantee that the plant/animal is actually found at the site. Similarly, pest impacts on matters of NES have been extracted from a variety of data sources and represent potential impacts only. Just because both the pest and the matter of NES are predicted within a mainland island, does not mean that the pest is impacting on the matter of NES on the ground.

In this analysis the magnitude of pest impacts has been determined by the total number of potential impacts of all pest species on all matters of NES found within a mainland island. Furthermore, pest impacts have been aggregated across all of the species included in the analysis. There is a risk associated with this approach. If there are few pest species at a site and they only impact on few matters of NES, the overall tally of impacts will be low. Thus it is assumed that the overall impact of pests at the site is minimal. However, in nature, a single pest species may have a devastating effect on one matter of NES (e.g. cane toad impacts on the northern quoll). While this represents only one impact (and this would be considered low in our analysis) the on-ground magnitude of that impact is worthy of attention and management.

The difference between potential and actual occurrences and impacts is an important consideration in terms of the end use of the prioritisation analysis. One of the key principles of pest management is to address actual rather than perceived problems i.e. it should not be assumed that a pest is causing significant, long-term damage just because it is present in an area. Therefore, before any decisions are made concerning pest management within any of the mainland islands, the actual impacts of pest species and the magnitude of these should be determined.

4 Analysis of management regimes

4.1 PEST MANAGEMENT IN AUSTRALIA

Management of vertebrate pests in Australia is undertaken by all levels of government as well as private land-holders and managers. Generally, government agencies prepare pest management policies, plans and guidelines, while on-ground pest control is the responsibility of landholders (both public and private).

To date, pest management in Australia has largely been reactive, with a strong reliance on government support to fund pest control programs. Past pest management has focused in the main part on lethal methods of control with a final aim of pest eradication. However, there is now an increasing acknowledgement that eradication of well-established vertebrate pests will not be possible and management objectives and techniques are changing to reflect this.

4.1.1 Pest management at a national level

At a national level, vertebrate pest management is primarily the undertaken by the Department of Agriculture, Fisheries and Forestry (DAFF) and the Department of the Environment, Water, Heritage and the Arts (DEWHA). These agencies prepare strategic documents to assist state and local government, industry and the wider community to manage pest species in coordinated and nationally consistent manner. Support for pest management is also available though Australian Government funding schemes such as Caring for our Country.

The Vertebrate Pests Committee (VPC) is an Australasia committee that provides coordinated policy and planning solutions to pest animal issues. Each state and territory and the Australian Government have membership on the VPC, and there are a number of technical experts who hold observer status on the committee. Recently, the VPC developed the Australian Pest Animal Strategy – A national strategy for the management of vertebrate pest animals in Australia (NRMMC 2007). The focus of this document is to address the negative impacts caused by vertebrate pest species currently established in Australia and to prevent the introduction and establishment of new pests.

At a species specific level, there are several nation-wide pest management directives. These include:

- Threat Abatement Plans (TAPs)[4] developed under the EPBC Act for feral cats, foxes, rabbits, goats, pigs and rodents on offshore islands.
- National pest management guidelines[5]
- A Strategic Approach to the Management of Ornamental Fish in Australia (NRMMC 2006)

[4] TAPs are listing in the References section of this report along with web links to individual documents

[5] Guidelines can be found at: http://www.daff.gov.au/brs/land/feral-animals/species

4.1.2 Pest management at a state/territory level

The pest management arrangements of each state and territory are summarised in the table below.

State / Territory	Management arrangements
Australian Capital Territory	Pest management is undertaken in accordance with the *Pest Plants and Animals Act 2005* and the ACT Vertebrate Pest Management Strategy. Key principles of pest management outlined in the Strategy are: • Management of vertebrate pests needs to be approached in a structured and consistent way if enduring and cost-effective outcomes are to be achieved. • A precautionary and pro-active approach to the management of species with pest potential will achieve significant environmental and economic benefits. • Pest animal management is most effective in terms of sustained implementation of management requirements when stakeholders are engaged early in the planning process and coordination is undertaken by a stable and representative group. • Increasing knowledge, awareness and understanding of pest issues is critical to effective management. • Monitoring the distribution and abundance of vertebrate pests or potential vertebrate pests, their impact on valued resources and the cost-effectiveness of related management programs provides information that is important to decision making about ecologically sustainable and economically sound land management. Responsibility for pest management in the ACT lies with the following organisations: Environment ACT has primary responsibility including: administering legislation, implementing policy, undertaking education and extension programs, and liaising and collaborating with other agencies and the community. ACT Parks and Conservation Service (within Environment ACT) is the major non-urban land manager in the ACT and as such undertake on-ground vertebrate pest management. On-going collaboration between ACT and NSW agencies is seen as an essential element of successful pest management. Namadgi National Park represents a significant area of the ACT. A vertebrate pest control program for the park address issues with horses, pigs, wild dogs, foxes, rabbits and goats.
New South Wales	Invasive species management is undertaken in accordance with the *NSW Invasive Species Plan 2008-2015*. The key principles of pest management outlined in this plan are: • Exclude: prevent establishment of new invasive species • Eradicate or contain: eliminate or prevent the spread of new invasive species • Effectively manage: reduce the impacts of widespread invasive species • Capacity: ensure NSW has the ability and commitment to manage

	invasive species Responsibility for pest management in NSW lies within the following hierarchy: Department of Primary Industries leads the implementation of the NSW Invasive Species Plan, manages significant areas of land and water, administers legislation, provides education, training and awareness raising. Department of Environment and Climate Change develops and implements pest management strategies for lands managed under the National Parks and Wildlife Act 1974, develops and implements initiatives to reduce the impacts of invasive species e.g. Threatened Species Priority Action Statement. Rural Lands Protection Board: participates in on-ground detection and control of vertebrate pests, including working collaborative with private landholders. Department of Lands develops and implements invasive species management strategies on land under its control and supports pest management activities undertaken by other stakeholders who manage land on the Department's behalf. Crown Land makes up approximately half of NSW. CMAs do not have a legislative role in managing invasive species, but provide a link and support for land mangers and the above agencies. Catchment Action Plans may contain targets for invasive species control. Local Government has obligations under the *Rural Land Protection Act 1998* and the *Companion Animals Act 1998* to manage pest animals on land they own, occupy or manage. Game Council NSW harnesses the efforts of accredited hunters in the reduction of some pest species including feral pigs, goats, foxes and rabbits. Other Public Land Managers are responsible for developing and implementing pest management strategies for land they manage.
Northern Territory	Pest management is undertaken in accordance with various legislative instruments and management plans. A key target for pest management in the Northern Territory is that by 2020, there is strategic containment of declared weeds, ecologically invasive plants and feral animals, sufficient to ensure that they have no significant impact on the conservation status of any Territory species or ecological community and to ensure that they have minimal impact on sustainable land use (DIPE 2005). The *Territory Parks and Wildlife Conservation Act 2000* allows for the declaration of feral animal control areas, in which feral animal control must be undertaken. To date, the Victoria River District is the only declared feral animal control area. Control in this area is focused on eradication of feral horses, donkeys and camels. The Northern Territory Parks and Conservation Masterplan (draft 2005) includes the following recommendations with respect to feral animals: • Develop a feral animal management strategy for the Northern Territory • As an adjunct to park plans of management, prepare weed control, feral animal control and fire management strategies and action plans for each park and reserve.

Queensland	Pest management is regulated under the *Land Protection (Pest and Stock Route Management) Act 2002*, and invasive species management is undertaken in accordance with the *Queensland Pest Animal Strategy*. The key principles of pest management contained in this strategy are: • Pest management is an integral part of managing natural resources and agricultural systems. • Public awareness and knowledge of pests must be raised to increase the capacity and willingness of individuals to manage pests. • Effective pest management requires a long-term commitment to pest management by the community, industry groups and government entities. • Consultation and partnership arrangements between local communities, industry groups, state government agencies and local governments must be established to achieve a collaborative approach to pest management. • Pest management planning must be consistent at local, regional, state and national levels to ensure resources target priorities for pest management identified at each level. • Preventative pest management is achieved by preventing the spread of pests, and viable parts of pests, especially by human activity and by early detection and intervention to control pests. • Pest management must be based on ecologically and socially responsible pest management practices that protect the environment and the productive capacity of natural resources. • Research about pests, and regular monitoring and evaluation of pest control activities is necessary to improve pest management practices. Responsibility for pest management in Qld lies within the following hierarchy: State Agency Pest Management Plans are required for those agencies responsible for managing land. Currently the following agencies have pest management plans, which are being implemented with regular review: Departments of Natural Resources, Main Roads, Primary Industries & Fisheries, Qld Parks & Wildlife Service, Forestry Plantations Qld, Qld Rail, Local Government Association of Qld, Land Protection Council. Regional Pest Management Plans are not a legislative requirement, however have been developed and implemented by some groups e.g. Capricorn Pest Management Group Regional Pest Management Strategy. Local Government Area Pest Management Plans are a legislative requirement for all LGAs in Qld. Property Pest Management Plans are not a legislative requirement for private land, however Qld has developed a training module to assist with developing property pest management plans. Pest management on state controlled property is undertaken in accordance with the relevant State Agency Pest Management Plan. Note: The Queensland Pest Animal Strategy is due for revision pending the finalisation of the Queensland Biosecurity Strategy (Frank Keenan, Biosecurity Qld, pers comm.).

South Australia	Pest management is regulated under the *Natural Resources Act 2006*. The Act intends for an integrated NRM system that prevents and controls the impacts of pest plants and animals (among other goals). Invasive species management strategies and milestones are outlined in Goal 4 of the SA *State Natural Resources Management Plan 2006*. Key aims of Goal 4 are: • To prevent new and emerging pests from having significant impacts on natural and productive systems – prevention, early detection and rapid response is the most cost-effective way to manage pest species. • To decrease the spread and adverse impacts of established pests on natural and productive systems. • To stress that pest management must be based on scientific assessments and management of direct, indirect and cumulative risks. Responsibility for pest management in South Australia lies with the following organisations: Regional NRM Boards have responsibility for developing and implementing regional NRM plans (which include pest management plans). They also have responsibility for coordinating control of pests on roadside verges. NRM Groups (groups falling under the relevant regional NRM Board) have operational responsibility for implementing and enforcing animal (and plant) control strategies. Landholders are responsible for controlling all declared pests that are present on their land and these must be controlled by, and at the expense of, the landholder. Local government does not have authority for pest control, however, plays a role through the *Local Government Act 1999* in allowing landholders to undertake pest management on roadsides. South Australia is currently developing a Biosecurity Strategy, which will address threats from aquatic and terrestrial vertebrate pests (among other threats, see PIRSA 2009).
Tasmania	Pests are generally managed on a species specific basis. Due to the reduced pest problem in Tasmania relative to the rest of Australia, pest management is focused heavily on preventing introductions and eradication. These activities are regulated under the *Nature Conservation Act 2002*, *Vermin Control Act 2000* and the *Inland Fisheries Act 1995***.** Pest species are divided into priority categories: • Highest priority: unwanted in the wild and to be eradicated from Tasmania, e.g. fox, gambusia, myna birds. • Second priority: unwanted in the wild but can only be feasibly/efficiently eradicated or controlled from specific areas around special values, e.g. cat, rabbit. • Third priority: wanted in the wild but within defined managed areas, e.g. deer, trout. The Fox Eradication Program (Department of Primary Industries and Water) is a $56 million program over 10 years. It aims to eradicate foxes from Tasmania by developing a coordinated strategic response.

	The World Wildlife Fund has produced a publication entitled Feral Animals of Tasmania (Pfennigwerth 2008). The aim of this document is to improve the community's knowledge and understanding of feral animals, and to encourage people to become involved in reporting and managing them.
Victoria	Pest management is regulated under the *Catchment and Land Protection Act 1994*, and invasive species management is undertaken in accordance with the Victorian Pest Management Framework (VPMF). The key principles of pest management outlined in this framework are: • Managers of land and water resources have a significant role in pest management • Effective pest management requires an integrated approach as part of the broader management of land and water resources • Prevention and early intervention provide the most cost-effective means of pest management • A duty of care operates for all land and water managers • Pest management activities must be in accordance with established standards of best practice • Pest management must occur within a risk framework Responsibility for pest management in Victoria lies within the following hierarchy: State Government (DSE, DPI) has state-wide legislative and policy responsibility for pest management, including implementation of the government's pest management programs. All state government agencies are responsible for pest management on land they manage. Catchment Management Authorities provide a regional focus to enable priorities for pest management activities to be developed within a catchment and landscape context. Local Government determines the appropriate use and development of land though local planning schemes. These must have regard for any strategies (e.g. pest management) that are developed under the Catchment and Land Protection Act. All land managers have a duty of care and are therefore expected to meet the cost of pest management on their land and ensure that pests do not impact on other land or waters. Note: The VPMF is being replaced with a new framework is due to be released in late 2009 (John Burley, Biosecurity Victoria, pers comm.).
Western Australia	There is no overall pest management strategy in place in WA and pests are generally managed on a species specific basis. The WA Department of Agriculture and Food aims to minimise the impact of vertebrate pests by: • Preventing the entry of new pest species • Eradicating small populations of pests • Minimising the impact of widespread pests • Raising awareness of the problem and solutions for managing vertebrate pests Western Shield is one of the largest pest management programs in Australia. It aims to minimise the impact of foxes and cats on native

	ecosystems and operates over 3.5 million hectares of state controlled land in WA (WA DEC 2009a). The draft *Cane Toad Strategy for Western Australia* (WA DEC 2009b) is currently on public exhibition. It outlines a 10-year management plan for cane toads and aims to provide an integrated response across the whole community to reduce the impact of the invasive species on biodiversity, social and economic values.

4.1.3 Vertebrate Pests as Key Threatening Processes

A threat can be declared a key threatening process (KTP) if it threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community. Threat abatement plans (TAPs) provide for the research, management, and any other actions necessary to reduce the impact of a listed KTP on native species and ecological communities. Implementation of the TAP should assist the long term survival in the wild of affected native species or ecological communities. There are several KTPs and TAPs that are relevant to vertebrate pest species at both the Australian Government and state level. These are listed below.

Australian Government KTPs associated with vertebrate pest species include:

- Competition and land degradation by rabbits (TAP)[6]
- Competition and land degradation by unmanaged goats (TAP)
- Predation by European red fox (TAP)
- Predation by exotic rats on Australian offshore islands of less than 1000 km^2 (100,000 ha) (Draft TAP)
- Predation by feral cats (TAP)
- Predation, habitat degradation, competition and disease transmission by feral pigs (TAP)
- The biological effects, including lethal toxic ingestion, caused by cane toads (*Bufo marinus*).

Tasmania has listed pests, weeds and diseases as a key threatening process under the *Threatened Species Protection Act 1995*. A threat abatement plan will be prepared.

NSW has declared several key threatening processes that are focused on vertebrate pest species. These are:

- Competition and grazing by the feral European rabbit
- Competition and habitat degradation by feral goats
- Herbivory and environmental degradation caused by feral deer
- Invasion and establishment of the cane toad
- Predation by feral cats
- Predation by the European red fox (TAP)
- Predation by the plague minnow (*Gambusia holbrooki*) (TAP)

[6] TAP indicates there is a Threat Abatement Plan in place for this KTP

- Predation by the ship rat (*Rattus rattus*) on Lord Howe Island
- Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)

Australian Government threat abatement plans, and in particular the associated background documents, outline the current species specific management arrangements.

The focus of threatening processes and threat abatement plans is on the pest species in question. However, vertebrate pests are also identified in many threatened species/community recovery/wildlife conservation plans as threats and specific actions are outlined in these plans to ameliorate pest impacts. For example, feral pest species have been identified as a threat to the reproductive success of seabirds in the National Recovery Plan for Albatrosses and Giant-petrels (Environment Australia, 2001).

4.2 BEST PRACTISE PEST MANAGEMENT PRINCIPLES

Pest management in Australia is moving away from traditional approaches of lethal control with the ultimate aim of complete eradication. It is recommended that efforts should now be focused on effectively managing pests where they are causing significant damage, limiting the spread of existing pests and preventing the introduction of new pests into Australia (Hart and Bomford 2006).

The following principles can be considered current best practise for vertebrate pest management in Australia (DAFF 2009, NRMMC 2007):

- Mange the actual rather than the perceived problem i.e. it should not be assumed that a pest is causing significant, long-term damage just because it is present in an area.
- Management objectives should focus on reducing pest impacts rather than pest numbers.
- Benefits of management should exceed the costs of implementing controls. This will be more easily quantified in agricultural settings than for biodiversity conservation aims.
- Where possible, develop commercial uses for pest species e.g. harvesting of feral pigs and goats for meat.
- Management should be strategic in terms of which species are targeted, where management should occur, timing, being proactive and using appropriate techniques. For example:
    - Target key areas with adequate resources rather than a more general, scattered approach.
    - Time management actions to fulfil objectives e.g. culling when pest numbers are naturally low if sustained suppression of numbers is the aim.
    - Implement long-term strategies rather than one-off control episodes.
    - Use a combination of control techniques.
- Continue to develop and implement more effective and humane pest animal management techniques.
- Focus on preventing future problems by increasing the emphasis on risk assessment, preventing the introduction of new pests and halting the spread of existing pests.
- Accept that no management may be the most appropriate solution in some circumstances e.g. the continued presence of the pest may be acceptable if key environmental values are not being significantly affected.

The Bureau of Rural Sciences has also prepared guidelines and information for the best practise management of various pest species[7].

4.3 SUMMARY OF PEST MANAGEMENT FOR MAINLAND ISLANDS

Management of vertebrate pests in Australia is undertaken by all levels of government as well as private land-holders and managers. Consequently, management of pests on mainland islands falls within a sometimes complicated hierarchy. Overall pest management on high priority mainland islands is best summarised by grouping the islands according to their primary management arrangements.

Islands covered entirely by one specific management arrangement.

These islands cover a discrete area such as World Heritage Areas or national parks. Overall management of these areas is undertaken in accordance with a site management plan, prepared by the responsible agency. In general, pest management is outlined in the overall management plan and is therefore integrated with other threat management activities. The degree of management attention and resources allocated to pest management varies depending on the level of pest problems relative to other environmental threats.

Pest management strategies / activities are, in general, aligned with broader level policies such as the Australian Vertebrate Pest Strategy and respective state/territory vertebrate pest plans.

Islands not covered by specific management arrangements.

Some mainland islands are not covered by any specific management plans. These are usually areas that are primarily private land holdings. While there are generally no site specific pest management arrangements, national, state and regional pest management strategies still apply. In Queensland, all local government areas are required to have pest management plans, and large land holders are also encouraged to develop property pest management plans. In other states (e.g. South Australia, Victoria) NRM organisations have regional pest management strategies and staff from these agencies work collaboratively with land holders to manage pests in a manner consistent with their regional priorities and directives.

Mainland islands without specific management arrangements may have small scale, locally targeted and organised pest control programs in place. Significant pest control efforts are undertaken by community groups such as Landcare and not-for-profit organisations such as the Foundation for Rabbit Free Australia (www.rabbitfreeaustralia.org.au). Furthermore, state government agencies provide grants for pest (and weed) control activities. The Good Neighbour Program in Victoria is an example of such an initiative. Through this program, the Victorian Government aims to cooperate with other landholders to control weeds and pests on the boundary between public and private land. Each year the program funds approximately 500 projects targeting control of animals such as rabbits, foxes, pigs, goats and wild dogs, as well as priority weed species (DSE 2009).

[7] Guidelines can be found at: http://www.daff.gov.au/brs/land/feral-animals/species

Islands covered by a combination of management arrangements.

These islands are made up of several sub-areas that have discrete management plans and may also contain areas that are not covered by any site specific management arrangements e.g. the Coffs Harbour mainland island includes Bongil Bongil National Park, Wedding Bells State Forest and areas of private land. In these instances, management of the areas with discrete management plans is undertaken according to those site-specific plans.

Integration of pest management for neighbouring areas with individual management plans is variable. State Forest pest management plans (Qld and NSW) specifically state that pest management will be undertaken in an integrated fashion with neighbouring properties and in consultation with the respective Rural Lands Protection Boards. However for other areas there appears to be little integration or regional pest management approach.

Additional but non-specific pest management strategies apply to areas without discrete management plans (see above).

Limitations of management analysis

The analysis of management regimes was based on publically available information and limited consultation with state agencies and members of the VPC. No consultation with site managers was undertaken.

Information gathered for many sites was based on management plans and strategies. Generally, these documents outline the need for pest management and actions to be undertaken. Often there is little information about the degree of implementation and success. Information about monitoring programs and their outcomes is also scarce. Furthermore, the information in some management plans and strategies is dated, with plans being written up to 10 years ago and several are due for revision or review.

In general, information about pest control programs in many areas is diffuse and at times difficult to access, particularly if these areas are not covered by site-specific management plans. Therefore, it is hard to gauge the degree to which pest management has occurred / is occurring at many sites around Australia. Lack of an overall view of pest management arrangements and activities increases the risk that pest management will not be undertaken in a coordinated manner, which may undermine the overall goal of reducing vertebrate pest impacts across Australia.

5 Summary of key findings

This study was a desktop assessment to identify mainland islands and prioritise them according to risk from a suite of vertebrate pests. The study was undertaken at a nation-wide scale, using pre-existing datasets with Australia-wide coverage. Associated with this type of analysis are some significant limitations. Therefore it is recommended that the outputs of this study be used as a strategic guide rather than a definitive list of areas requiring significant pest management.

The following summary of key findings highlights important outcomes of the data analyses and subsequent consideration of pest management regimes. Recommendations are provided in section 6.

- Mainland islands are primarily located along the east coast of Australia and this pattern is driven largely by the combination of high levels of species richness and endemism in the east.
- High conservation value islands were located across Australia, while threats were concentrated along the eastern seaboard.
- The top 100 highest priority islands are concentrated along the east coast of Australia. Other top 100 islands located away from the east coast include Shark Bay and Stirling Range National Park (WA), Kakadu and the MacDonnell Ranges (NT), the Coorong (SA) and the Tasmanian Wilderness.
- It should be noted that much of the data feeding into the prioritisation analysis relates to potential rather than actual species occurrences and threats. This highlights the need to determine the actual impacts of pest species and their magnitude before any decisions are made concerning pest management within any of the mainland islands.
- Management of vertebrate pests in Australia is undertaken by all levels of government as well as private land-holders and managers. Consequently, management of pests on mainland islands falls within a sometimes complicated array of tenures.
- Pest management on mainland islands can be categorised in one of three ways:
    - Islands covered entirely by one specific management arrangement
    - Islands not covered by specific management arrangements
    - Islands covered by a combination of management arrangements
- For islands covered entirely by one specific management arrangement, pest management is undertaken in accordance with a management plan, prepared by the responsible agency and is generally integrated with other threat management activities.
- Integration of pest management for islands covered by several management plans is variable, but generally well coordinated by Queensland and New South Wales State Forests.
- Information about pest control programs in areas that are not covered by site-specific management plans is diffuse and at times difficult to access. Consequently, it is hard to gauge the degree to which pest management has occurred / is occurring at many sites around Australia.

6 Recommendations

6.1 PEST MANAGEMENT

Several areas that are high priority mainland islands are well covered by existing management arrangements and funding regimes (e.g. World Heritage Areas for which Australia has international obligations in addition to requirements for management under the EPBC Act). Therefore, other areas on the top 100 list could be considered / investigated for allocation of funds and/or development of management strategies.

The prioritisation process does not consider need for pest management relative to other threatening processes. For some sites, consideration of management arrangements has highlighted that pests are not a major problem on the ground relative to other concerns (e.g. water availability issues in the Coorong Ramsar mainland island far outweigh vertebrate pest problems). Consequently, before any pest management actions are determined for mainland islands, an analysis of the need for these actions (in particular relative to other environmental management actions) should be undertaken.

The results of this study should be integrated with other pest management schemes e.g. Caring for Our Country Business Plan 2009-2010 Investment Priorities (there are specific cane toad, camel and rabbit objectives), BRS project of a nation-wide survey of the known impacts of rabbits on EPBC Act listed flora.

Any pest management activities undertaken on mainland islands should be performed in accordance with the best practices guidelines detailed in section 4.2.

Conduct a 'reality check' before any pest management activities are undertaken. Just because a mainland island is on the top 50 or top 100 list does not mean that pest management is either necessary or possible. The decision to undertake pest management should consider among other factors, long-term resourcing and potential non-target impacts e.g. on native species.

6.2 THIS AND FUTURE STUDIES

The level of analysis undertaken in this project is not sufficient to identify islands where action is required to eradicate or significantly reduce the abundance of specific invasive species and where eradication or reduction is technically feasible and cost effective. Instead, it should be used as a high level guide to target attention to high conservation value areas (islands) that are potentially facing significant threats from vertebrate pests. Before any management actions are proposed, an analysis of the actual threat from vertebrate pests is required, along with an assessment of whether the pests have a sufficient impact to warrant management action. This information will not be obtained without consultation with local land managers and potentially on-ground assessments.

The boundaries of mainland islands identified in this study should not be considered hard and fast. Boundaries were drawn based on the suite of information available, however, management of pests may be more feasible within a smaller or larger area. Ideally management units will be large enough to ensure the central (and highest conservation areas) are protected, but not so large that the resources needed to achieve the objectives are prohibitive. Furthermore, mainland islands were defined based on

an aggregate of 20 pest species and their impacts. It should be noted that an appropriate area of management for one species (e.g. small ranging rabbit) may not be appropriate for others (e.g. camels which roam up to 70 km per day).

The results of this study should be integrated with the outcomes of other pest and conservation prioritisation analyses. For example, Parks Victoria has completed a study entitled Prioritising Parks Victoria's Rabbit Control Programs (Long *et al.* 2003) which ranks national parks in Victoria with respect to rabbit control, and the Northern Territory government has identified areas of high conservation value. It should be noted that all but one of the Northern Territory mainland islands identified in this report correspond to areas identifies by the NT analysis as having high conservation value.

The results of this study could be refined with additional data. In particular information about areas that have been / are successfully managed for pests and about the magnitude of pest impacts (not just pest presence).

This study has aggregated analyses and results across twenty pest species with very different ecologies. Future studies / decision making should consider grouping pests according to their ecological requirements and behaviour e.g. aquatic versus terrestrial pests.

6.3 DATA AND RESOURCES

There are significant amounts of Australian Government held data and internal analyses (undertaken by ERIN, e.g. species specific pest pressure point analysis). These resources should be kept up to date and considered in pest management decision making.

State level data could be used to refine the analyses. Not all states participated in the consultation process, therefore opportunities to engage the states in future decision making should be sought. State agency input is likely to be especially valuable with respect to on-ground, local knowledge.

Compile data on areas of pest management (eradication/exclusion etc) so that there is a consistent national dataset that can be used to understand and coordinate pest management efforts.

In general, information about pest control programs in areas that are not covered by integrated management plans is diffuse and at times difficult to access and it is hard to gauge the degree to which pest management has occurred / is occurring at many sites around Australia. Recommendations for a national information system put forward by the National Land and Water Resources Audit and the Invasive Animal CRC (2008) should therefore be prioritised.

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Appendix A: Top 100 Ranked Islands

Note that islands are list alphabetically within their ranking category.

Rank	Name	Jurisdiction (State)	Area (ha)
Top10	Border Ranges	NSW/QLD	847945
Top10	Coffs Harbour	NSW	32810
Top10	Fitzroy River Mouth	QLD	104083
Top10	Mann River	NSW	55674
Top10	Melbourne	VIC	591353
Top10	Port Phillip Bay	VIC	96191
Top10	Sydney	NSW	382068
Top10	The Greater Blue Mountains Area	NSW	1181047
Top10	Western District Lakes	VIC	226171
Top10	Wet Tropics of Queensland	QLD	1513054
Top11-30	Beardy River Hills	NSW	19255
Top11-30	Binghi Plateau	NSW	39976
Top11-30	Bouldercombe	QLD	92465
Top11-30	Bowling Green Bay	QLD	149385
Top11-30	Bowral	NSW	45396
Top11-30	Chinchilla	QLD	225564
Top11-30	Deepwater Downs	NSW	94304
Top11-30	Dharawal	NSW	20731
Top11-30	Eastern Darling Downs	QLD	382803
Top11-30	Glen Innes-Guyra Basalts	NSW	225888
Top11-30	Lithgow	NSW	83458
Top11-30	Nandewar, Northern Complex, New South Wales	NSW	70828
Top11-30	Oxley Wild Rivers National Park	NSW	212764
Top11-30	Stanthorpe Plateau, New South Wales Part 1	NSW/QLD	82714
Top11-30	Tenterfield Plateau	NSW	125275
Top11-30	The Coorong	SA	259443
Top11-30	Tingha Plateau	NSW	75726
Top11-30	Upper Fitzroy River	QLD	84916
Top31-50	Armidale Plateau	NSW	273664
Top31-50	Barakula	QLD	183312
Top31-50	Barrington Tops National Park	NSW	43746

Top31-50	Beenleigh	QLD	77029
Top31-50	Canberra	ACT/NSW	196843
Top31-50	Central Murray	NSW/VIC	60319
Top31-50	Edgecumbe Bay	QLD	33824
Top31-50	Great Sandy National Park	QLD	73577
Top31-50	Jervis Bay	NSW	35788
Top31-50	Marlborough	QLD	132433
Top31-50	Monaro	ACT/NSW	52489
Top31-50	Moreton Basin	QLD	141989
Top31-50	Mount Morgan Ranges, North	QLD	85636
Top31-50	Nightcap	NSW	68894
Top31-50	Nudley State Forest	QLD	238361
Top31-50	Rocky River Gorge	NSW	39099
Top31-50	Severn River Volcanics	NSW	47489
Top31-50	Shark Bay	WA	99124
Top31-50	Stanthorpe Plateau, Queensland	QLD	123218
Top31-50	Toowoomba	QLD	457534
Top31-50	Upstart Bay	QLD	58285
Top31-50	Washpool National Park	NSW	50252
Top51-100	Abbot Bay	QLD	16790
Top51-100	Ashford	NSW	290427
Top51-100	Banana - Auburn Ranges	QLD	197961
Top51-100	Bournda National Park	NSW	11176
Top51-100	Broad Sound	QLD	195644
Top51-100	Broadwater	QLD	11166
Top51-100	Bungonia	NSW	307366
Top51-100	Carnarvon	QLD	436283
Top51-100	Cataract	NSW	69703
Top51-100	Cessnock	NSW	5116
Top51-100	Croajingolong National Park	VIC	131289
Top51-100	Don River	QLD	49859
Top51-100	Eden	NSW	10014
Top51-100	Eurimbula	QLD	54894
Top51-100	Fernlees	QLD	16588
Top51-100	Forster	NSW	10311
Top51-100	Galdstone	QLD	12273
Top51-100	Guy Fawkes River National Park	NSW	163126
Top51-100	Hawkesbury River Mouth	NSW	79435
Top51-100	Hope Vale Shire	QLD	101370
Top51-100	Inglewood	QLD	214100

Top51-100	Inverell Basalts	NSW	220578
Top51-100	Iron Range	QLD	103459
Top51-100	Kakadu	NT	2069316
Top51-100	Koorogang	NSW	5598
Top51-100	Kosciuszko	NSW/VIC	202938
Top51-100	Lake Glenbawn	NSW	245714
Top51-100	Laleham	QLD	87919
Top51-100	Littabella	QLD	20303
Top51-100	Macdonnell Ranges	NT	171825
Top51-100	Mary River Mouth	QLD	27116
Top51-100	Miles	QLD	154852
Top51-100	Moredun Volcanics	NSW	114034
Top51-100	Mount Kaputar National Park	NSW	191674
Top51-100	Mount Morgan Ranges	QLD	72455
Top51-100	Moura	QLD	208823
Top51-100	Myall Lakes	NSW	54365
Top51-100	Nandewar, Northern Complex, Queensland	QLD	615897
Top51-100	New England National Park	NSW	42073
Top51-100	Redland Bay	QLD	22840
Top51-100	Repulse Bay	QLD	62132
Top51-100	Royal National Park	NSW	12888
Top51-100	Scone	NSW	263217
Top51-100	South Burnett	QLD	198453
Top51-100	Stanthorpe Plateau, New South Wales Part 2	NSW	17760
Top51-100	Stirling Range National Park	WA	137922
Top51-100	Tasmanian Wilderness	TAS	776072
Top51-100	The Grampians	VIC	173260
Top51-100	Victorian Volcanic Plain	VIC	1122404
Top51-100	Yarrowyck-Kentucky Downs	NSW	61328

Appendix B: Mainland Island Fact Sheets

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