Invasive species

TITLE | ASSESSING THE IMPACT OF
PRIORITY INVASIVE SPECIES

AUTHORS | Sean Brindle: Invasive Species Analyst
Industry & Investment NSW, PO Box 129, COWRA NSW 2794

Rob Williamson: Leader – Invasive Species Strategy & Planning
Industry & Investment NSW, Locked Bag 21, ORANGE NSW 2800

Monitoring, evaluation & reporting program

Technical report series

NATIVE VEGETATION
NATIVE FAUNA
THREATENED SPECIES
INVASIVE SPECIES
RIVERINE ECOSYSTEMS
GROUNDWATER
MARINE WATERS
WETLANDS
ESTUARIES AND COASTAL LAKES
SOIL CONDITION
LAND MANAGED WITHIN CAPABILITY
ECONOMIC SUSTAINABILITY AND SOCIAL WELLBEING
CAPACITY OF NATURAL RESOURCE MANAGERS

APRIL 2010

NSW
GOVERNMENT

Assessing the impact of priority invasive species

Technical guidelines 2010

Sean Brindle

Invasive Species Analyst

Industry & Investment NSW

PO Box 129, Cowra NSW 2794

Rob Williamson

Leader – Invasive Species Strategy & Planning

Industry & Investment NSW

Locked bag 21, Orange 2800

Disclaimer
The information contained in this publication is based on knowledge and understanding at the time of writing (April 2010). However, because of advances in knowledge, users are reminded of the need to ensure that information on which they rely is up to date and to check the currency of the information with the appropriate officer of Industry & Investment NSW or the user's independent advisor.

CONTENTS

INTRODUCTION

Industry and Investment NSW (I&I NSW) is the lead agency for invasive species monitoring, evaluation and reporting (MER) in NSW. I&I NSW has co-ordinated the collection of data on the presence, distribution and impact of priority invasive species from local government, livestock health and pest authorities, I&I NSW Primary Industries and the NSW Department of Environment Climate Change and Water (DECCW). The Department collected data on priority invasive species to report on invasive species impact at both the catchment and State scales.

This document describes the methods used to collect and evaluate the invasive species data for catchment and State-wide reporting. These guidelines are for anyone who wishes to replicate the data collection and reporting methods used.

The data collection process used to survey local government and livestock health and pest authorities on weeds and pest animals is outlined in detail in sections 1.2 and 2.2, respectively. The method used is designed to capture distribution and abundance information from a large number of individual staff located in different organisations and geographic areas of NSW.

The National Land & Water Resources Audit developed a method to map emerging pest animal and weeds distributions and abundance by the use of defined grid cells[1] This method focuses on the observations made by on ground weed and pest animal managers. A map of NSW was overlaid with a grid cell layer and weed and pest animal management officers reported a distribution and abundance score for grid cells in their own jurisdictions.

Some datasets described in the guidelines relate to widespread invasive species and are not linked to any particular control program. Datasets such as freshwater fish data and the wild dog stock losses data are datasets that I&I NSW are contracted to report on as part of the NSW Natural Resources MER Strategy[2]. Not all species are monitored in NSW. State-wide monitoring relies on existing on-ground networks such as local government weed officers and livestock health and pest authority rangers. Where networks or state wide research programs make data available for evaluation and reporting the impact of invasive species, this information has been incorporated into state datasets. There are gaps in our knowledge of the impact of some important widespread invasive species such as goats, pigs, and rabbits. This document doesn't address the issues relating to these gaps but focuses on what data is available.

The management of invasive species in NSW is carried out under the framework of the NSW Invasive Species Plan. Invasive species MER activities in NSW are currently aligned with goals 1-3 of the Plan. The NSW Invasive Species Plan can be accessed via the I&I NSW website[3].

---

[1]www.nlwra.gov.au/national-land-and-water-resources-audit/weeds

[2]www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/296649/MER-Strategy.pdf

[3]www.dpi.nsw.gov.au/agriculture/pests-weeds/nsw-invasive-species-plan

INDICATORS

In Australia there are a large number of invasive species that can be grouped in the following classifications; weeds, pest animals, aquatic pests, and invertebrate pests. These pests impact on production, natural ecosystems and human health to varying degrees. The management approach to controlling the impact of invasive species in NSW is targeted at 4 key areas.

1. to exclude invasive species not presently in NSW

2. to eliminate or contain newly established invasive species

3. controlling widespread invasive species at priority sites

4. enhancing the capacity of NSW invasive species stakeholders to manage invasive species in NSW

The first 3 management approaches relate to new, emerging and widespread invasive species. Indicators for these 3 approaches have been developed to measure the progress NSW is making to reduce the impact of priority invasive species. The NSW Natural Resources Commission's (NRC) indicators for invasive species for this project are:

1. Number of new invasive species established (all new species whose impacts are likely to be significant).

2. Distribution and abundance of emerging invasive species **(selected species only)**.

3. Success of control programs for widespread invasive species **(selected species only)** as measured by: (i) a reduction in biodiversity impacts; and (ii) a reduction in other impacts (e.g. socio-economic, impacts on land and water).

The data collected in this program is used to report against the NRC indicators and is the basis for the Catchment Report Cards series for NSW. The report cards indicate a region's progress towards the 13 state natural resource management targets, as outlined in the 2006 State Plan.

WEEDS DATA

1.1 WEED LEGISLATION OVERVIEW

The *Noxious Weeds Act (1993)* requires landholders to control weed species for which weed control orders are in effect. Local Control Authorities (LCA's) employ noxious weed officers to inspect public and private land to enforce the Act. If a weed species is assessed to be likely to have significant impacts on production, the environment or human health then the species is eligible to be declared a noxious weed. If absent from the state or a region the weed species can be classed as a control class 1 or 2 weed, respectively. If the species' distribution is over a larger area it will fall into the control class 3 or 4 categories. Once the weed's spread is demonstrated to be so widespread that a control order is not likely to contain the weed then there are grounds for its declaration to be repealed. Control class 5 relates to weeds that can not be either sold or transported in NSW.

1.2 LOCAL GOVERNMENT (LOCAL CONTROL AUTHORITY) WEEDS SURVEY

The 134 priority weed species included in the local government survey were selected from the following categories:

1. Noxious weed control classes 1,2,3,5.
2. Weeds of National Significance (WoNS), Alert WoNS.
3. Emerging weed species suggested by regions i.e., nominated in Regional Weed Strategies/Plans and by Local Government Regional Weed Committees.

The full list of species surveyed is located in Appendix 1.

The survey asked Local Control Authority weed officers to assign a score for density against cells in a mapped grid layer. For an explanation of the density classes, see Table 1 and Figures 1.1 & 1.2.

Table 1. Invasive species presence, distribution and abundance scoring system

DENSITY CLASSES	SCORE	DENSITY
Present-occurrence unknown	1	?
Occasional & localised	1	<1%
Occasional & widespread	2	1% to 10%
Common & localised	3	11% to 50%
Common & widespread	4	11% to 50%
Abundant & localised	5	>50 %
Abundant & widespread	6	>50 %

Table 6 – Density classes and equivalent QLD Annual Pest Distribution Survey classes

WONS density classes	Equivalent QLD APDS density class (weed occurrence denoted by ♠)
2. less than 1%	Occasional and localised — confined to a specific extent of the defined area and infestations are of a low density
3. 1% to 10%	Occasional and widespread — present in most or all of the survey area and infestations generally of a low or scattered density

21

Figure 1.1 Weed density classes as taken from the publication *Field manual for surveying and mapping nationally significant weeds***. Bureau of Rural Sciences**

Table 6 – Density classes and equivalent QLD Annual Pest Distribution Survey classes
(*continued from previous page*)
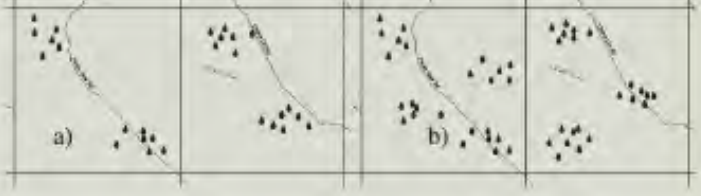
WONS density classes	Equivalent QLD APDS density class (weed occurrence denoted by ▲)
4. 11% to 50%	 a) Common and localised — confined to specific parts of the survey area and the infestations are generally of medium density b) Common and widespread — present in most or all of the survey area and infestations are generally of a medium density
5. > 50%	 a) Abundant and localised — confined to specific parts of the survey area and infestations generally of a high density b) Abundant and widespread — present in most of or all of the survey area and infestations generally of a high density

Figure 1.2 Weed density classes as taken from the publication *Field manual for surveying and mapping nationally significant weeds*. Bureau of Rural Sciences

METHOD FOR DATA COLLECTION

Due to the large number of weed species the project collected data on, the process to survey local government weeds officers was split into two parts. Part one required local government to report presence information against each of the priority weeds. Weed officers reported a species as present, absent or presence unknown in their LCA. See Figure 1.3 below.

Botanical Name	Common name	Present in LCA	Absent from LCA	Unknown
	For further information on this survey contact: Sean Brindle NSW Department of Primary Industries 02 6391 3889 sean.brindle@dpi.nsw.gov.au	PLEASE ENTER NUMBER '1' IN ONLY ONE OF THE GREEN CELLS FOR EACH WEED SPECIES		
Acacia catechu	cutch tree/catechu			
Acacia karroo	karoo thorn			
Acacia nilotica*	prickly acacia			
Acetosa sagittata	rambling dock/turkey rhubarb			
Acroptilon repens	creeping knapweed/hardhead thistle			
Ailanthus altissima	tree-of-heaven			
Alhagi maurorum	camel thorn			
Alternanthera philoxeroides*	alligator weed			
Annona glabra*	pond apple			
Araujia sericifera	moth plant/moth vine			
Arundinaria spp.	simon bamboo/arundinaria reed			
Arundo donax	giant reed/elephant grass			
Asparagus asparagoides*	bridal creeper			
Asphodelus fistulosus	onion weed			
Asystasia gangetica ssp micrantha	Chinese violet			
Baccharis halimifolia	groundsel bush			
Barleria prionitis	barleria or porcupine flower			
Bassia scoparia except ssp tricophylla	kochia/summer cypress			
Bryophyllum spp. and hybrids	mother-of-millions			
Cabomba caroliniana*	cabomba			
Caesalpinia decapetala	mysore thorn			
Calluna vulgaris	heather/Scots heather			
Cardiospermum grandiflorum	balloon vine			
Carduus nutans	nodding thistle			
Celtis sinensis	Chinese celtis			
Centaurea calcitrapa	star thistle			
Centaurea maculosa	spotted knapweed			
Centaurea nigra	black knapweed			
Cestrum parqui	green poisonberry/green cestrum			
Chromolaena odorata	Siam weed			
Chrysanthemoides monilifera*	bitou bush/boneseed			
Conium maculatum	hemlock			
Conyza sp.	fleabane			
Cortaderia spp.	pampas grass			
Cotoneaster spp.	cotoneaster			
Crataegus monogyna	hawthorn/English hawthorn			

Figure 1.3 LCA weeds survey, Part 1

The template used in part 1 is a MS-Excel file that was emailed to the weed officers with a letter explaining the purpose of the survey. Where possible the survey was sent to the LCAs via a representative of each Regional Weeds Advisory Committee, usually the committee coordinator or project officer. If an LCA was not part of a committee the LCA was sent the survey directly.

The returned part 1 surveys contained a list of the weeds reported as present in each LCA. Using this information a second survey template was constructed, again in MS-Excel, to capture distribution and abundance data for each weed reported as present in the LCA.

For the purposes of the survey a series of ArcGIS layer files (*.shp) were created by the NSW Department of Industry and Investment's spatial information unit. These layer grids divided NSW into grid cells of varying sizes; 0.05, 0.1, 0.25 and 0.5 degrees. See Figure 1.4 below.
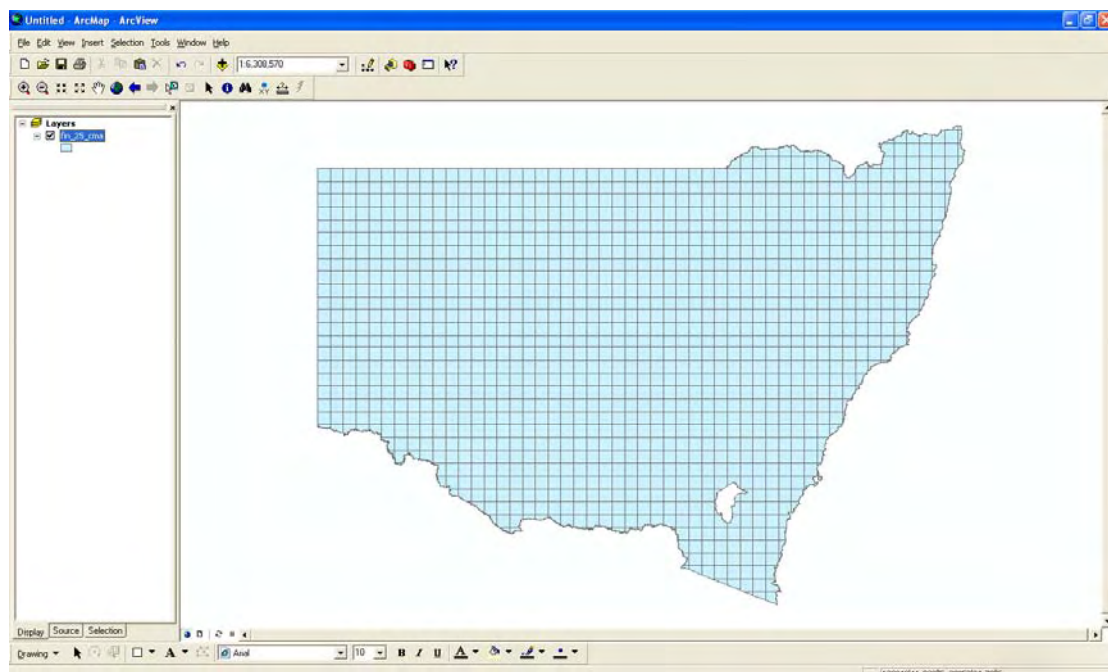
Figure 1.4 ArcGIS 0.25 degree grid layer

As this was the first time a task of this type was required of local government in NSW, the survey was designed to gain the maximum amount of information with the least amount of time and effort expended by local government weed officers. With this in mind the maximum number of grid cells needed to be filled out by an individual LCA was capped at 30 (except for some of the larger western LCAs). This was made possible by allocating different grid sizes for different sized LCAs. The following figure (Figure 1.5) lists the grid scale assigned to each LCA.

	LCA	SCALE		LCA	SCALE
1	Albury	0.05	23	Castlereagh Macquarie County Council	0.50
2	Ashfield	0.05	24	Central Darling	0.50
3	Auburn	0.05	25	Central Murray County Council	0.25
4	Balranald	0.50	26	Cessnock	0.10
5	Bankstown	0.05	27	Clarence Valley	0.25
6	Bega Valley	0.25	28	Cobar	0.50
7	Bellingen	0.10	29	Coffs Harbour	0.10
8	Bland	0.25	30	Coolamon	0.10
9	Blue Mountains	0.10	31	Cooma-Monaro	0.25
10	Bogan	0.25	32	Cootamundra	0.10
11	Bombala	0.25	33	Corowa	0.10
12	Botany	0.05	34	Cowra	0.10
13	Bourke	0.50	35	Dubbo	0.25
14	Brewarrina	0.50	36	Dungog	0.10
15	Broken Hill	0.05	37	Eurobodalla	0.25
16	Burwood	0.05	38	Fairfield	0.05
17	Cabonne	0.25	39	Far North Coast County Council	0.25
18	Camden	0.05	40	Forbes	0.25
19	Campbelltown	0.05	41	Glen Innes Severn	0.25
20	Canada Bay	0.05	42	Gloucester	0.25
21	Canterbury	0.05	43	Gosford	0.10
22	Carrathool	0.50			

44	Goulburn Mulwaree	0.25	86	New England Tablelands	
45	Great Lakes	0.25		County Council	0.50
46	Greater Hume	0.25	87	Newcastle	0.05
47	Greater Queanbeyan	0.05	88	North Sydney	0.05
48	Greater Taree	0.25	89	Orange	0.05
49	Griffith	0.10	90	Palerang	0.25
50	Gundagai	0.10	91	Parkes	0.25
51	Gunnedah	0.25	92	Parramatta	0.05
52	Gwydir	0.25	93	Pittwater	0.05
53	Hawkesbury River		94	Port Macquarie-Hastings	0.25
	County Council	0.25	95	Port Stephens	0.10
54	Hay	0.25	96	Randwick	0.05
55	Holroyd	0.05	97	Rockdale	0.05
56	Hornsby	0.05	98	Ryde	0.05
57	Hunters Hill	0.05	99	Shoalhaven	0.25
58	Hurstville	0.05	100	Snowy River	0.25
59	Illawarra District Noxious		101	Southern Slopes	
	Weeds Authority	0.10		County Council	0.25
60	Inverell	0.25	102	Strathfield	0.05
61	Jerilderie	0.25	103	Sutherland	0.05
62	Junee	0.10	104	Sydney	0.05
63	Kempsey	0.25	105	Tamworth Regional	0.25
64	Kogarah	0.05	106	Temora	0.10
65	Ku-ring-gai	0.05	107	Tenterfield	0.25
66	Lachlan	0.25	108	Tumbarumba	0.25
67	Lake Macquarie	0.05	109	Tumut	0.25
68	Lane Cove	0.05	110	Unincorporated Western	
69	Leeton	0.10		Lands Commission	0.50
70	Leichhardt	0.05	111	Upper Hunter County Council	0.25
71	Liverpool	0.05	112	Upper Lachlan	0.25
72	Liverpool Plains	0.25	113	Upper Macquarie	
73	Lockhart	0.25		County Council	0.25
74	Lord Howe Island	n/a	114	Urana	0.25
75	Maitland	0.05	115	Wagga Wagga	0.25
76	Manly	0.05	116	Wakool	0.25
77	Marrickville	0.05	117	Warringah	0.05
78	Mid-Western Regional	0.25	118	Waverley	0.05
79	Moree Plains	0.25	119	Weddin	0.25
80	Mosman	0.05	120	Wellington	0.25
81	Murrumbidgee	0.25	121	Wentworth	0.50
82	Nambucca	0.10	122	Willoughby	0.05
83	Narrabri	0.25	123	Wingecarribee	0.10
84	Narrandera	0.25	124	Wollondilly	0.10
85	Narromine	0.25	125	Woollahra	0.05
			126	Wyong	0.10

Figure 1.5 Grid cell scales per LCA

Each LCA reported the density classes itemised in Table 1 above for each grid cell for each weed species reported as present in part 1 of the survey. An example of the form in which an LCA entered data into is illustrated in Figure1.6.
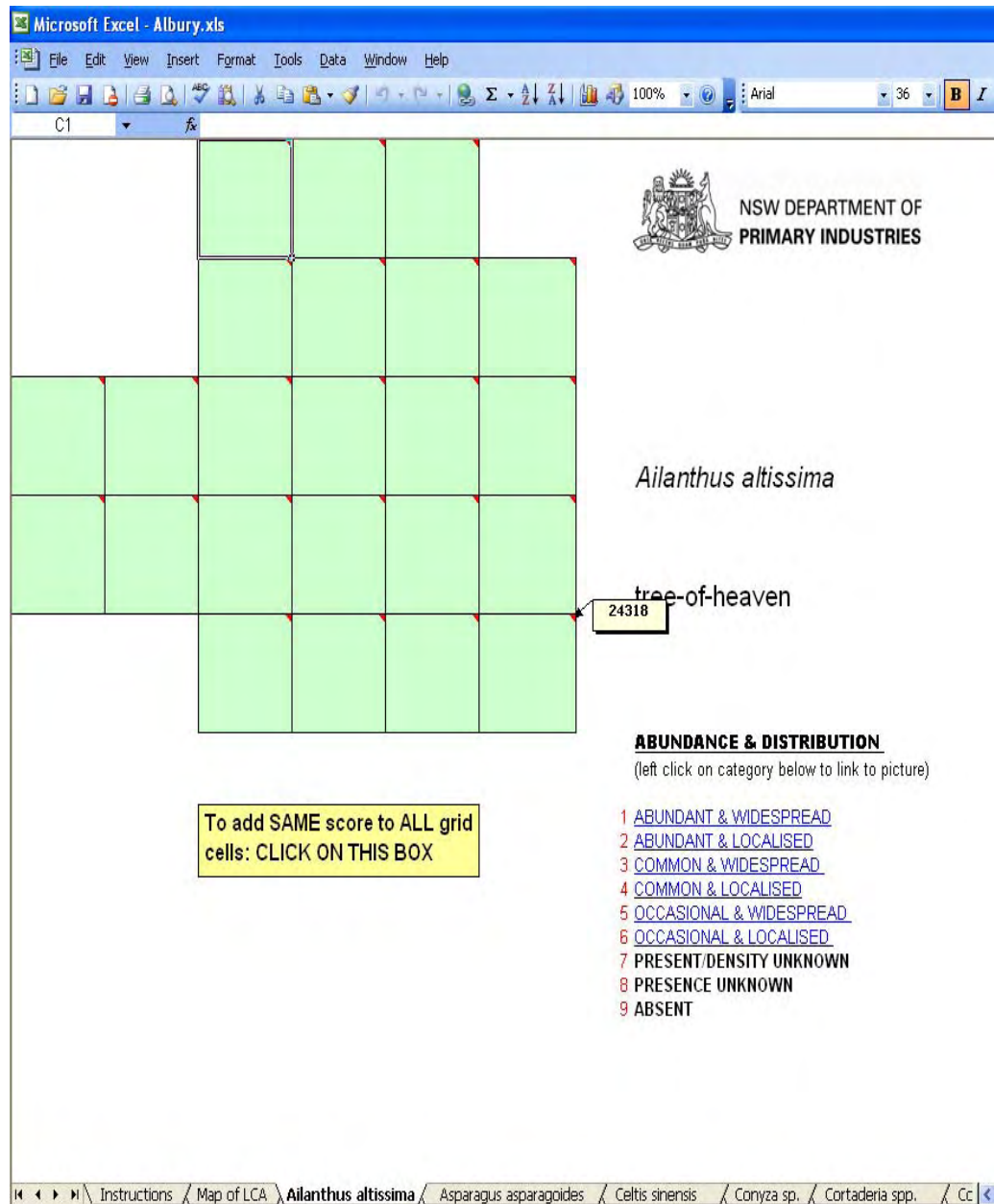
Figure 1.6 An illustration of part 2 of the survey

At the same time the email containing the above survey forms was sent to the LCA a topographical map of the LCA with a grid cell matrix overlaid was sent to provide the weed officer with a spatial reference to enter weed distribution and abundance scores against (see Figure 1.7 below).
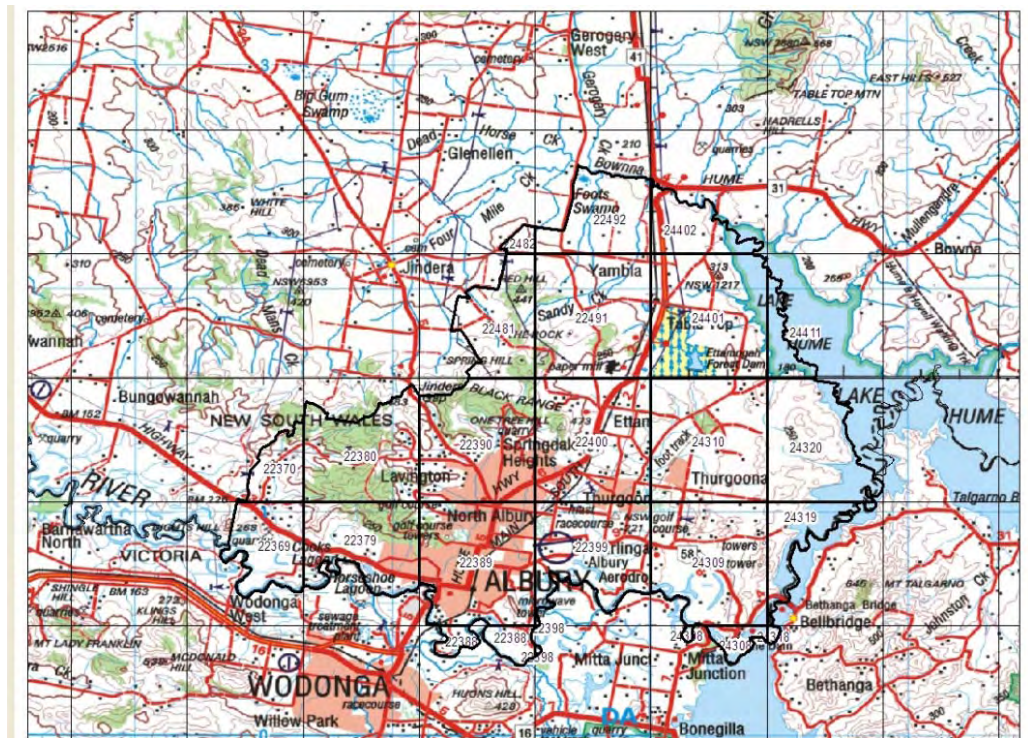
Figure 1.7 Map of the Albury LCA with a grid cell overlay. This map allows weed officers to record weed distribution and abundance scores to a specific location indexed by a unique grid cell number.

The data entered in the individual worksheets (Figure 1.6) relate to specific weed species. Once the data is entered it is automatically transferred to a locked data worksheet located in the same file. See Figure 1.8 below.

The number in yellow cells relates to the unique weed species ID number. The orange cells contain the grid cell ID. The white cells in column 'C' contain the LCA identifier number.

The data collected from the LCA's was collected at four different scales across NSW. To report this information at the state level the data needed to initially be collated from the 125 LCA survey forms into a single spreadsheet, then updated to four state-wide data sets for each scale i.e., 0.5, 0.25, 0.1 and 0.05 degree grids, for each weed species. Finally the data needed to be aggregated to the 0.25 degree grid size for NSW and 0.1 degree grid size for the Sydney Metro Catchment for each weed species.

The above steps are detailed in the following two tables; Table 3 contains the steps used to transform the raw data into four state-wide datasets of different scales for each weed and Table 4 details the steps required to aggregate this data into 0.25 degree grids that are able to be mapped using ArcGIS (ArcMap).

Figure 1.8 Data worksheet that holds the distribution and abundance scores (green cells)

Table 2 Steps taken in process to align scores across all 4 scales in readiness to aggregate

Files	Worksheet(s)	Macro	Actions
LCA_summary.xls "LCA"_part_2.xls e.g. Albury_part_2.xls	data2	absent_ unknown_create	Update "data2" worksheet in "LCA_part_2.xls" with unknown and absent scores from part 1 of the survey.
"LCA"_part_2.xls e.g. Albury_part_2.xls All_data_split_into_sca les.xls	data 0.5(a),0.5(b),0.25(a),0. 25(b), 0.1(a),0.1(b),0.05(a),0. 05(b).	load_data_1	Load raw presence data from "data" worksheet in "LCA"_part_2.xls into All_data_split_into_scales.xls
"LCA"_part_2.xls (e.g. Albury_part_2.xls) All_data_split_into_sca les.xls	data2 0.5(a),0.5(b),0.25(a),0. 25(b), 0.1(a),0.1(b),0.05(a),0. 05(b).	load_data_2	Load raw absent and unknown data from "data2" worksheet in "LCA"_part_2.xls into All_data_split_into_scales.xls. The worksheet is related to the scale.
All_data_split_into_sca les.xls (weed)(weed#)_(scale) .xls	0.5(a),0.5(b),0.25(a),0. 25(b), 0.1(a),0.1(b),0.05(a),0. 05(b). data	load_data_3	Macro run for every weed in every worksheet in All_data_split_into_scales.xls. The process loads each weeds data into 4 scale files named (weed)(weed#)_(scale).xls in the "data" worksheet.
(weed)(weed#)_(scale) .xls	data, sean_(scale)area	update_ind_ scale_sets	Updates data from the 'data' worksheet into the state-wide sheet ('sean_(scale)sheet')
(weed)(weed#)_(scale) .xls	sean_(scale)area	proportional_ mean[1]	Calculates the mean of each grid cell based on the proportional size of each part cell. Some cells contain more than one LCA.
(weed)(weed#)_(scale) .xls	sean_(scale)area	filter_multiply_ records	The maximum number of grid cells is 52K. This is true for the 0.05 grid. This macro multiplies the scores dependant on the scale so each scale dataset totals 52K rows.
(weed)(weed#)_(scale) .xls final(weed#).xls	sean_(scale)area all_grid_summary	copy into 52K	This macro copies the 52K datasets into a single file. The final file contains all 4 scale datasets aligned by row.

[1] – proportional_mean macro code is located in Appendix 2.

Table 3 Steps taken in process to aggregate data from 4 scales to one (0.25 degree grid)

Files	Worksheet(s)	Macro	Actions
final(weed#).xls	all_grid_summary	sort_select	Selects the column to sort the table on. 52K rows are too large to do manually
final(weed#).xls	all_grid_summary	none	Excel command (sort) sorts the table based on the scale of choice. The scale chosen is the scale to which the data is to be aggregated.
final(weed#).xls	all_grid_summary	aggregate_25[2]	Uses a set of aggregation rules to aggregate the data into a 52k dataset for the 0.25 scale.
final(weed#).xls	all_grid_summary	last_filter	Takes every 25th row and saves it into a dataset of 2080 records that can be saved as a text file and joined to a 0.25 grid cell shape file. Now data can be mapped.

[2] The rules for the logic employed are based on the guidelines set out in the paper – *National guideline for data aggregation.* This publication is the result of a workshop run by the National Land and Water Resources Audit and led by Professor Kim Lowell (CRC for Spatial Information). The macro code for the 'aggregate_25' macro is found in Appendix 3.

A summary of the conversion rules are:

- Data is collected per grid cell per LCA jurisdiction based on the density classes in Table 1.

- Where 100% of the grid cell is inside the boundaries of an LCA, the score is not changed.

- Where more than one LCA is located in a grid cell, a proportional mean distribution and abundance score is calculated. The rules detailed in the paper *National guideline for data aggregation* were used when applicable; for example if more than 25% of the grid cell area is reported as 'unknown distribution', the whole grid cell is reported as unknown distribution. The guidelines can be accessed at: http://www.feral.org.au/feral_documents/West2008_Appen_Gloss_refs.pdf

- In calculating the proportional mean the raw score reported by an LCA is broken down into its 2 components; distribution (localised or widespread) and abundance (occasional, common, abundant). The process calculates a proportional mean for the distribution as well as the abundance. The means are combined to create a new distribution and abundance score.

The final data sets for each of the priority weed species are incorporated into a grid cell shape file (*.shp) and produce a NSW distribution and abundance map as below (Figure 1.9)
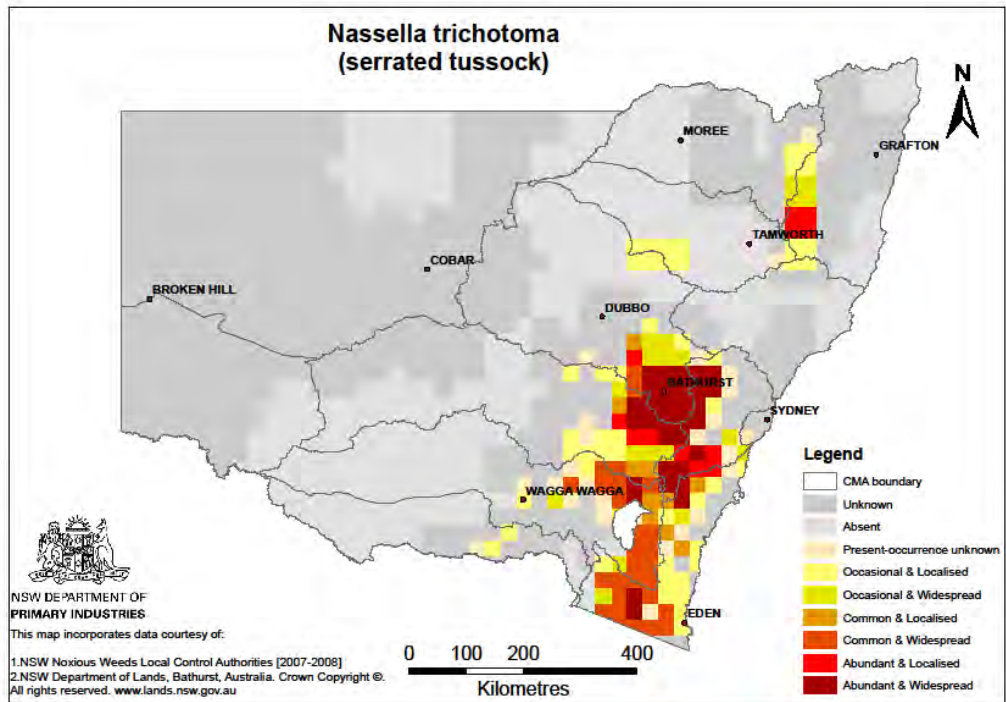
Figure 1.9 State wide dataset for Serrated Tussock. Aggregated to 0.25 degree grid

PEST ANIMAL DATA

2.1 PEST ANIMAL LEGISLATION OVERVIEW

Under the *Rural Lands Protection Act (1998)* landholders are obligated to control feral pigs, wild dogs and wild rabbits through pest control orders. Livestock Health and Pest Authorities are charged with enforcing the orders. Authority rangers were considered to have the best knowledge of the distribution and abundance of these and other vertebrate pests. Rangers also deal frequently with other pest animals that impact on production, for example, foxes, goats and wild deer.

2.2 EMERGING PEST ANIMAL SURVEY OF LIVESTOCK HEALTH AND PEST AUTHORITIES

In 2008 I&I NSW surveyed 47 Rural Lands Protection Boards (RLPBs) were amalgamated in January 2009 to become Livestock Health and Pest Authorities) to gain information on the distribution and abundance of five **emerging** pest animal species. The emerging pest animals surveyed were camels, horses, donkeys, deer and cane toads. The grid cell format was the same as for the local government weeds survey i.e., data collected against grid squares.

Wanaaring RLPB in the state's far north west was the only board not to supply data.

The results show that the new and emerging pest animals surveyed are scattered across the state. Deer are the pest animal with the widest distribution (present in 408 of the 2080 grids in NSW). Horses were present in 67 grids followed by cane toads, 22 (far north east NSW, reported as far south as Kempsey/Port Macquarie), and donkeys 11 (only reported in the far west of NSW – Milparinka, Broken Hill, Wentworth and Wilcannia RLPBs). No feral camels were reported as present in NSW.

METHOD FOR DATA COLLECTION

The method for collecting pest animal distribution and abundance data was similar to the methods used to collect the weeds distribution and abundance data collected from local government. The main difference is the collection of pest animal data is at one scale only (0.25 degree). Also the data was entered into a datasheet by the LHPA rangers and faxed back to I&I NSW. The data was then entered into the state wide data sheet for the given pest animal species.

The raw data was then processed to give a proportional mean for those cells that contained more than one LHPA jurisdiction, using the same logic as employed by the LCA weeds survey.

Table 4 Process taken to update raw data to produce 0.25 degree grid of NSW

Files	Worksheet(s)	Macro	Actions
(pest animal).xls	sheet 1	PA_proportional_mean[1]	Some cells contain more than one RLPB (LHPA). Calculates the mean of each grid cell based on the proportional size of each part cell. Updates a state wide dataset for 0.25 degree grid (2080 records).

[1] PA_proportional_mean macro code is located in Appendix 4.

A summary of the conversion rules are:

• Data is collected per grid cell per LHPA jurisdiction based on the density classes in Table 1.

• Where 100% of the grid cell is inside the boundaries of a LHPA, the score is not changed.

• Where more than one LHPA is located in a grid cell, a proportional mean distribution and abundance score is calculated. The rules detailed in the paper *National guideline for data aggregation* were used when applicable; for example if more than 25% of the grid cell area is reported as 'unknown distribution', the whole grid cell is reported as unknown distribution. The guidelines can be accessed at: http://www.feral.org.au/feral_documents/West2008_Appen_Gloss_refs.pdf

• In calculating the proportional mean the raw score reported by a LHPA is broken down into its 2 components; distribution (localised or widespread) and abundance (occasional, common, abundant). The process calculates a proportional mean for the distribution as well as the abundance. The means are combined to create a new distribution and abundance score.
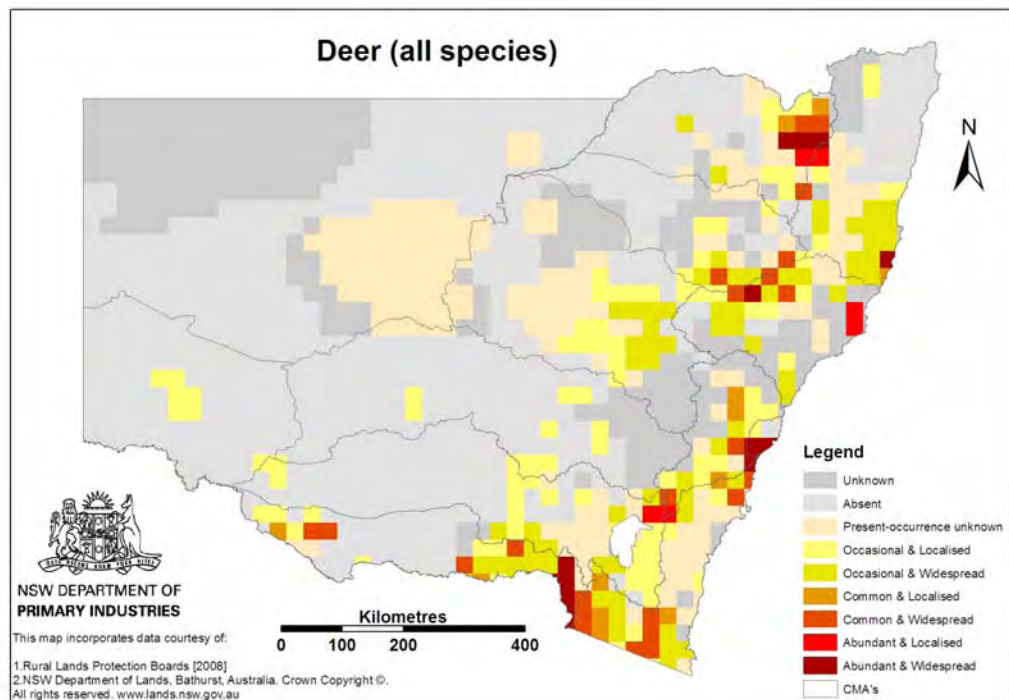
Figure 2.1 State wide dataset for Deer. Data collected to 0.25 degree grid

The final data sets for each of the 5 pest animal species are incorporated into a grid cell shape file (*.shp) to produce a NSW distribution and abundance map as below (Figure 2.1)

2.3 WILD DOG STOCK LOSSES

Industry & Investment NSW has been collecting data on wild dog stock losses since 2004. This data is forwarded to I&I NSW from Livestock Health and Pest Authority (LHPA) rangers who have filled out reports based on information given to them by landholders.

The data is a simple measure of numbers of stock lost attributed to wild dogs. The raw data sent to I&I NSW by the LHPAs is located in Appendix 5 of this document.

2.4 FOX THREAT ABATEMENT PLAN

The *NSW Threat Abatement Plan for Predation by the Red Fox* (Fox TAP) establishes priorities for fox control for the conservation of biodiversity across New South Wales. The Fox TAP is coordinated by the NSW Department of the Environment Climate Change and Water (DECCW). In particular, the plan identifies which threatened species are most likely to be impacted by fox predation and the sites at which these impacts are predicted to be most critical. The plan includes monitoring programmes to measure the response of priority threatened species to fox control at these sites.

The priorities the DECCW have used to target sites for fox control are listed at:

www.threatenedspecies.environment.nsw.gov.au/tsprofile/threat_profile.aspx?id=20015

AQUATIC PEST DATA

3.1 AQUATIC PEST LEGISLATION OVERVIEW

The *Fisheries Management Act (1994)* lists species that are not able to be imported into NSW.. These species pose a significant threat to wildlife, ecosystems, human health or the aquaculture industry.

The list is comprised of two classes:

1. Noxious fish species that pose such a significant threat to the environment or production that they have destruction orders (Table 5);

2. Other species that have restrictions in place that only allow importation into NSW with a permit (Tables 6a and 6b).

Table 5. Noxious fish species

Mozambique mouthbrooder	*Oreochromis mossambicus*
Redbelly tilapia	*Tilapia zilii*
Black mangrove cichlid	*Tilapia mariae*
Carp	*Cyprinus carpio*
Mosquitofish/ Plague minnow	*Gambusia holbrooki*
Speckled mosquito fish	*Phalloceros caudimaculatus*
Banded grunter	*Amniataba percoides*
Pacific oysters	*Crassostrea gigas*
Black-striped mussel	all species of the genus *Mytilopsis*

Table 6a. Other aquatic species (marine & freshwater) requiring permits to import into NSW

Piranha	*Serrasalmus* spp., *Pygocentrus* spp.
Airbreathing/walking catfish	All species in the Family *Clariidae*
Grass carp	*Ctenopharyngodon idella*
Roach	*Rutilus rutilus*
Tench	*Tinca tinca*
Electric eels	All species in the Family *Gymnotidae*
Snakeheads	*Channa* spp., *Parachanna* spp.
Bluegills	*Lepomis* spp.
Largemouth bass	*Micropterus* spp.
African tigerfish	*Hydrocynus* spp.
South American tigerfish or trahira	*Erythrinus, Hoplerythrinus* and *Hoplias* spp.
Parasitic (or candiru or pencil) catfish	All species in the Family *Trichomycteridae*
Nile perch (live)	*Lates niloticus*
Pike cichlid	*Crenicichla* spp.
Tiger catfish	*Pseudoplatystoma fasciatum*
Electric catfish	All species in the Family *Malapteruridae*
African lung fish	*Protopterus annectens*
Channel catfish	*Ictalurus punctatus*
Freshwater stingrays	*Himantura* spp.
Pikes	All species in the Family *Esocidae*
Freshwater Garfish	All species in the Family *Lepisosteidae*
Sticklebacks	All species in the Family *Gasterosteidae*
Bichirs	All species in the Family *Polypteridae*
Schilbe catfishes	*Schilbe* spp.
Redfin perch	*Perca fluviatilis*
Barcoo Grunter	*Scortum barcoo*
Welchs Grunter	*Bidyanus welchi*
Sooty Grunter	*Hephaestus fuliginosus*
Sleepy cod	*Oxyeleotris lineolatus*

Table 6b. Other aquatic species (marine & freshwater) requiring permits to import into NSW.

Any hybrid between species in the Family *Terapontidae* including Barcoo Grunter, Welchs Grunter, Silver Perch, Banded Grunter, Sooty Grunter or Spangled Perch.

Atlantic salmon	*Salmo salar*
Brook trout	*Salvelinus fontinalis*
Brown trout	*Salmo trutta*
Rainbow trout	*Oncorhynchus mykiss*
Barramundi	*Lates calcarifer*
Marron	*Cherax tenuimanus*
Redclaw	*Cherax quadricarinatus*
Abalone	*Haliotis* spp

3.2 FRESHWATER PEST MONITORING BY I&I NSW FISHERIES

I&I NSW Fisheries, in conjunction with the Murray Darling Basin Sustainable Rivers Audit has nearly completed the collection of baseline data from approximately 470 state wide sampling sites. The survey supplies data against all three indicators for this project i.e.; new, emerging and widespread alien (non native) freshwater fish species.

The Platy (*Xipophorus maculatus*), a fish species native to Mexico, was found in the Hunter Central Rivers region. This species is the only new alien fish species recorded in NSW.

The percentage of alien fish present (Table 7) at each of the sampling sites provides an indicator for the distribution of that alien species. This data is used for the emerging species indicator for freshwater fish. While we have no data to indicate when the alien species first arrived at a site, we can report the current extent of an alien species across a region or the state. Changes in the distribution of an alien fish species can be measured when the second cycle of sampling is completed.

Table 7. Percentage of Alien fish present at sites in NSW

Alien Fish Species (Non-native)	Percentage of sites present in NSW
Common carp	56.52604%
Mosquitofish	47.94265%
Goldfish	33.70284%
Rainbow trout	10.84836%
Redfin perch	9.446741%
Brown trout	8.290357%
Eel tailed catfish (translocated native)	3.284471%
Oriental weatherloach	1.525097%
Climbing galaxias (translocated native)	0.333333%
Platy	0.169492%

The third indicator, a measure of the impact of widespread alien fish, is calculated by comparing the percentage of alien fish recorded versus the total fish recorded. This is done for each site. The average percentage of alien fish to total fish across the 411 sites sampled so far in NSW is 40.06% (Figure 3.1).
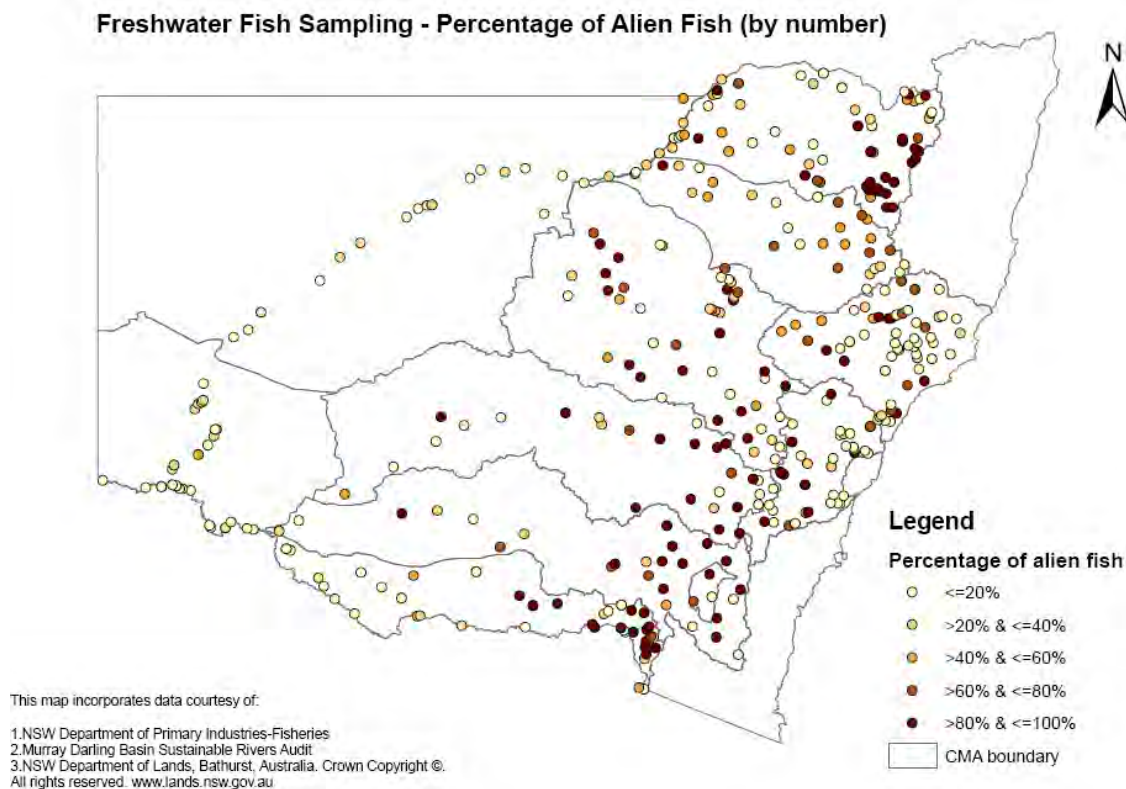
Figure 3.1 Alien fish as a percentage of total fish at freshwater sampling sites

The data collection report – *Fish Theme Summary of Pilot Audit Technical Report* – can be accessed at :

www.mdbc.gov.au/__data/page/64/Web_Summary_Fish_Theme.pdf

3.3 *CAULERPA TAXIFOLIA* – AN EMERGING MARINE WEED

Caulerpa taxifolia is an important marine weed found in estuaries in NSW. It can be reported that the number of locations infested has increased since 2006. To date *Caulerpa* infests 12 locations in NSW, namely:

Brisbane Water	Lake Conjola
Pittwater	Narrawallee Inlet
Port Jackson	Burrill Lake
Botany Bay	Durras Lake
Port Hacking	Batemans Bay
St Georges Basin	Wallagoot Lake

I&I NSW Fisheries no longer map infestations but are changing their sampling to a more standardised and less labour-intensive protocol that will enable relative comparisons of area infested over time.

3.4 OTHER MARINE PESTS

We have received data from I&I NSW Fisheries on several other marine pests, but it should be noted this data is not collected as part of routine surveillance of estuaries in NSW; rather it is an accumulation of data from independent projects.

Six marine pests have been recorded in NSW coastal waters by I&I NSW Fisheries (Table 8).

Table 8. Marine pests detected in NSW estuaries and coastal lakes

Common Name	Scientific Name	No. of estuaries/lakes present
Broccoli Weed	*Codium fragile tomentosoides*	15
European Shore Crab	*Carcinus maenas*	10
Cameleon Goby	*Tridentiger trigonocephalus*	4
Yellowfin Goby	*Acanthogobius flavimanus*	3
New Zealand Screw Shell	*Maoricolpus roseus*	1
European Fan Worm	*Sabella spallanzanii*	1

CONCLUSION

To date the collection of data has established dataset baselines. It follows that we cannot infer any trends yet. Data for each indicator, where available, will be collected on differing timescales. Indicator one (new invasive species) will be reported on annually. Indicator two (emerging invasive species) will be reported on a 3-year cycle and indicator three (success of control programs of widespread species) will be reported on every 5–10 years. Note this reporting cycle is the same as that nominated in the NSW Invasive Species Plan.

DEFINITIONS OF NEW, EMERGING AND WIDESPREAD INVASIVE SPECIES

New Invasive Species:

Any introduced species that has not been recorded in NSW previously and whose impacts are likely to be significant or a species previously recorded in NSW that has since exhibited invasiveness.

Emerging Invasive Species:

A newly established species whose distribution and abundance is expanding but has the potential to be contained or eliminated.

Widespread Invasive Species:

A species widely distributed in NSW with the management focus being the reduction of their impacts through control at priority sites.

REFERENCES

1. 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*, NSW Department of Primary Industries, Orange.

2. McNaught,I., Thackway, R., Brown, L. and Parsons, M. (2006). *A field manual for surveying and mapping nationally significant weeds*. Bureau of Rural Sciences, Canberra, available on the web; http://affashop.gov.au/product.asp?prodid=13948

3. National Land and Water Resources Audit (2007), *Weeds – Ecologically significant invasive species*, available on the web: www.nlwra.gov.au/national-land-and-water-resources-audit/weeds

4. Murray-Darling Basin Commission (2003), *Fish Theme Pilot Audit Technical Report - Sustainable Rivers Audit*, available on the web: www.mdbc.gov.au/__data/page/64/Web_Summary_Fish_Theme.pdf

5. National Land and Water Resources Audit (2007), *Vertebrate Pests – Ecologically significant invasive species*, available on the web: www.nlwra.gov.au/national-land-and-water-resources-audit/vertebrate-pests

6. Natural Resources Commission (2005), *Recommendations, state-wide standards and targets*, available on the web; www.nrc.nsw.gov.au/content/documents/Recommendations%20-%20State-wide%20standard%20and%20targets%20May%202005.pdf

7. National Land and Water Resources Audit (2006), *National guideline for data aggregation*, Output of workshop held in 2006.

APPENDIX 1 – 134 PRIORITY WEEDS SURVEYED IN THE 2007–08 LOCAL GOVERNMENT SURVEY

	Botanical Name	Common Name
1	Acacia catechu	cutch tree/catechu
2	Acacia karroo	karoo thorn
3	Acacia nilotica	prickly acacia
4	Acetosa sagittata	rambling dock/turkey rhubarb
5	Acroptilon repens	creeping knapweed/ hardhead thistle
6	Ailanthus altissima	tree-of-heaven
7	Alhagi maurorum	camel thorn
8	Alternanthera philoxeroides	alligator weed
9	Annona glabra	pond apple
10	Araujia sericifera	moth plant/moth vine
11	Arundinaria spp.	simon bamboo/arundinaria reed
12	Arundo donax	giant reed/elephant grass
13	Asparagus asparagoides	bridal creeper
14	Asphodelus fistulosus	onion weed
15	Asystasia gangetica ssp micrantha	Chinese violet
16	Baccharis halimifolia	groundsel bush
17	Barleria prionitis	barleria or porcupine flower
18	Bassia scoparia except ssp tricophylla	kochia/summer cypress
19	Bryophyllum spp. and hybrids	mother-of-millions
20	Cabomba caroliniana	cabomba
21	Caesalpinia decapetala	mysore thorn
22	Calluna vulgaris	heather/Scots heather
23	Cardiospermum grandiflorum	balloon vine
24	Carduus nutans	nodding thistle
25	Celtis sinensis	Chinese celtis
26	Centaurea calcitrapa	star thistle
27	Centaurea maculosa	spotted knapweed
28	Centaurea nigra	black knapweed
29	Cestrum parqui	green poisonberry/green cestrum
30	Chromolaena odorata	Siam weed
31	Chrysanthemoides monilifera	bitou bush(1)/boneseed(2)
32	Conium maculatum	hemlock

	Botanical Name	Common Name
33	*Conyza* sp.	fleabane
34	*Cortaderia* spp.	pampas grass
35	*Cotoneaster* spp.	cotoneaster
36	*Crataegus monogyna*	hawthorn/English hawthorn
37	*Cryptostegia grandiflora*	rubber vine
38	*Cylindropuntia rosea*	hudson pear
39	*Cynoglossum creticum*	blue hound's tongue
40	*Cyperus teneristolon*	cyperus teneristolon
41	*Cytisus multiflorus*	white Spanish broom
42	*Cytisus scoparius*	Scotch,English & Spanish broom
43	*Dipogon lignosus*	dipogon
44	*Dittrichia viscosa*	false yellowhead
45	*Eichhornia azurea*	anchored water hyacinth
46	*Eichhornia crassipes*	water hyacinth
47	*Equisetum* spp.	horsetail spp.
48	*Genista monspessulana*	montpellier broom/cape broom
49	*Gleditsia triacanthos*	honey locust
50	*Gloriosa superba*	glory lily
51	*Gymnocoronis spilanthoides*	temple plant/Senegal tea plant
52	*Harrisia* spp.	harrisia cactus/apple cactus
53	*Heliotropium amplexicaule*	blue heliotrope
54	*Heteranthera reniformis*	kidneyleaf mudplantain
55	*Hieracium* spp.	hawkweed/orange hawkeweed
56	*Hygrophila costata*	yerba de hicotea/hygrophila
57	*Hygrophila polysperma*	East Indian hygrophila
58	*Hymenachne amplexicaulis*	olive hymenachne/hymenachne
59	*Hyparrhenia hirta*	coolatai grass
60	*Hypericum perforatum*	St. John's wort
61	*Ipomea alba*	moonflower
62	*Ipomea indica*	morning glory (purple)
63	*Koelreuteria elegans* subsp *formosana*	Chinese rain tree/golden rain tree.
64	*Lachenalia reflexa*	yellow soldier
65	*Lagarosiphon major*	lagarosiphon
66	*Lantana camara*	lantana

	Botanical Name	Common Name
67	*Lantana montevidensis*	lantana (creeping)
68	*Limnocharis flava*	yellow burrhead
69	*Lonicera japonica*	Japanese honeysuckle
70	*Ludwigia longifolia*	long-leaf willow primrose
71	*Ludwigia peruviana*	ludwigia
72	*Ludwigia repens*	red ludwigia
73	*Miconia* spp.	miconia
74	*Mimosa pigra*	mimosa
75	*Moraea* spp.	cape tulips
76	*Myriophyllum spicatum*	Eurasian water milfoil
77	*Nassella charruana*	lobed needle grass
78	*Nassella hyalina*	cane needle grass
79	*Nassella neesiana*	Chilean needle grass
80	*Nassella tenuissima*	Mexican feather grass
81	*Nassella trichotoma*	serrated tussock
82	*Olea europaea* ssp *europaea*	feral olive
83	*Orobanche* spp. except *O.minor* & native *O.cernua* var. *australiana*	broomrapes
84	*Parietaria judaica*	pellitory
85	*Parkinsonia aculeata*	Parkinsonia
86	*Parthenium hysterophorus*	parthenium weed
87	*Paspalum quadrifarium*	tussock paspalum
88	*Pelargonium alchemilloides*	garden geranium
89	*Pennisetum setaceum*	fountain grass
90	*Pennisetum villosum*	long-style feather grass
91	*Pereskia aculeata*	leaf cactus
92	*Phyla* spp.	lippia
93	*Phyllostachys* spp.	rhizomatous bamboo
94	*Physalis virginiana*	perennial ground cherry
95	*Physalis viscosa*	prairie ground cherry
96	*Piptochaetium montevidense*	Uruguayan rice grass
97	*Pistia stratiotes*	water lettuce
98	*Pittosporum undulatum*	sweet pittosporum
99	*Praxelis clematidea*	praxelis
100	*Prosopis* spp.	mesquite

	Botanical Name	**Common Name**
101	*Psidium cattleianum*	cherry guava
102	*Pueraria lobata*	kudzu
103	*Pyracantha* sp.	firethorn
104	*Retama raetam*	white weeping broom
105	*Ricinus communis*	castor oil plant
106	*Rubus fruticosus* (spp. agg.)	blackberry
107	*Sagittaria platyphylla*	sagittaria
108	*Salix* spp. except *S.babylonica, S.X calodendron*, *S.X reichardtii*	willows (not weeping and two pussy willows)
109	*Salpichroa origanifolia*	pampas lily of the valley
110	*Salvinia molesta*	salvinia
111	*Schinus* species other than *S. terebnthifolius*	peppercorn
112	*Schinus terebinthifolius*	broad-leaf pepper tree
113	*Scolymus maculatus*	spotted golden thistle
114	*Senecio glastifolius*	holly leaved senecio
115	*Solanum elaeagnifolium*	silver-leaf nightshade
116	*Solanum seaforthianum*	Brazilian nightshade
117	*Sorghum halepense*	Johnson grass
118	*Sorghum* sp. hybrid cultivar	silk forage sorghum
119	*Sorghum x almum*	Columbus grass
120	*Sporobolus fertilis* (*S.indicus*)	giant Parramatta grass
121	*Sporobolus pyramidalis* (*S.natalensis*)	giant rat's tail grass
122	*Stratiotes aloides*	water soldier
123	*Striga* spp. except native *S.parviflora*	witchweeds
124	*Tamarix* spp	athel pine
125	*Tanacetum vulgare*	common tansy
126	Tecoma stans	yellow bells
127	Thunbergia laurifolia	laurel clock vine
128	Tipuana tipu	rosewood or tipuana tree
129	Toxicodendron succedaneum	rhus tree
130	*Trapa* spp.	water caltrop
131	*Triadica sebifera*	Chinese tallow tree
132	*Trianoptiles solitaria*	subterranean cape sedge
133	*Ulex europaeus*	gorse
134	*Vachellia farnesiana*	mimosa bush

APPENDIX 2 – WEEDS, *PROPORTIONAL_MEAN* MACRO CODE

<mark>Highlighted code</mark> refers to logical steps used to calculate proportional mean.

```
Sub proportional_mean()
Dim curr_lca As String
Dim last_rec As Long


'initialise variables
IsEmpty (curr_cell_ref)
IsEmpty (curr_lca)
IsEmpty (curr_score)
IsEmpty (next_cell_ref)
IsEmpty (rec_num)
IsEmpty (next_rec_num)
IsEmpty (counter)
IsEmpty (dist_temp)
IsEmpty (curr_perc)
IsEmpty (un_perc)
IsEmpty (abun_temp)
IsEmpty (tot_perc)
IsEmpty (tot_abun)
IsEmpty (abun)
IsEmpty (dist_temp_2)
IsEmpty (dist_tot)
IsEmpty (new_score)
'IsEmpty (last_rec)


Application.ScreenUpdating = False
scale_temp = InputBox("enter scale - (0.05,0.1,0.25,0.5)")
If scale_temp = 0.05 Then last_rec = 57700
If scale_temp = 0.1 Then last_rec = 16000
If scale_temp = 0.25 Then last_rec = 3200
If scale_temp = 0.5 Then last_rec = 1200
rec_num = 1
Do Until rec_num > last_rec 'Or curr_cell_ref > 55000
  stop_loop = False

  Do Until stop_loop = True Or rec_num > last_rec
  rec_num = rec_num + 1
  ActiveSheet.Cells(rec_num, 1).Select
  curr_lca = Selection
    If curr_lca <> "" Then
    stop_loop = True
    End If
```

```vba
Loop
'initialise variables, counters & totals
    break_loop = True
    counter = 0
    tot_perc = 0
    abun_tot = 0
    abun = 0
    dist_temp_2 = 0
    dist_tot = 0
    un_perc = 0
    curr_perc = 0
    dist_temp = 0
    abun_temp = 0
    seven_ctr = 0
    da_ctr = 0
    nine_perc = 0
    If rec_num > last_rec Then GoTo finish:


    single_ctr = 0
    pres_ctr = 0
    no_print = True


        Do Until break_loop = False
        single_ctr = single_ctr + 1
        ActiveSheet.Cells(rec_num, 3).Select
        curr_cell_ref = Selection
        ActiveCell.Offset(0, 1).Select
        curr_perc = Selection
        ActiveCell.Offset(0, 1).Select
        curr_score = Selection
        next_rec_num = rec_num + 1
        ActiveSheet.Cells(next_rec_num, 3).Select
        next_cell_ref = Selection
        counter = counter + 1
        If next_cell_ref <> curr_cell_ref Then
        break_loop = False
        End If
        If single_ctr = 1 And next_cell_ref <> curr_cell_ref And curr_score > 0 Then
        ActiveSheet.Cells(rec_num, 6).Select
        Selection = curr_score
        End If
        If break_loop = True Then
        rec_num = rec_num + 1
        End If


        If rec_num > last_rec Then GoTo finish:
```

```
If curr_score = 1 Or curr_score = 3 Or curr_score = 5 Then
dist_temp = 2
da_ctr = da_ctr + 1
no_print = False
ElseIf curr_score = 2 Or curr_score = 4 Or curr_score = 6 Then
dist_temp = 1
da_ctr = da_ctr + 1
no_print = False
ElseIf curr_score = 9 Then
nine_perc = nine_perc + curr_perc
no_print = False
ElseIf curr_score = 7 Then
seven_ctr = seven_ctr + 1
un_perc = un_perc + curr_perc
no_print = False
ElseIf curr_score = 8 Then
un_perc = un_perc + curr_perc
no_print = False
End If


If curr_score = 1 Or curr_score = 2 Then
abun_temp = 3
ElseIf curr_score = 3 Or curr_score = 4 Then
 abun_temp = 2
 ElseIf curr_score = 5 Or curr_score = 6 Then
  abun_temp = 1
 Else: abun_temp = 0
   End If


tot_perc = tot_perc + curr_perc
If abun_temp = 3 Or abun_temp = 2 Or abun_temp = 1 Or abun_temp = 0 Then
abun_temp_2 = abun_temp * (curr_perc / 100)
abun_tot = abun_tot + abun_temp_2
End If
If dist_temp = 1 Or dist_temp = 2 Or dist_temp = 0 Then
dist_temp_2 = dist_temp * (curr_perc / 100)
dist_tot = dist_tot + dist_temp_2
End If
If break_loop = False Then Exit Do


Loop
```

```
final_calc:
    dist = 0
    abun = 0



    If un_perc < 25 And da_ctr > 0 And nine_perc <> tot_perc Then
     dist = dist_tot * (100 / tot_perc)
     abun = abun_tot * (100 / tot_perc)
    End If
     If dist > 0 And dist < 1.5 Then dist = 1
     If dist >= 1.5 And dist <= 2 Then dist = 2



    If abun >= 0 And abun < 1.5 Then abun = 1



    If abun >= 1.5 And abun < 2.5 Then abun = 2



    If abun >= 2.5 And abun < 3.5 Then abun = 3



     If abun = 3 And dist = 2 Then
     new_score = 1
     End If
      If abun = 3 And dist = 1 Then
      new_score = 2
      End If
       If abun = 2 And dist = 2 Then
       new_score = 3
       End If
        If abun = 2 And dist = 1 Then
        new_score = 4
        End If
         If abun = 1 And dist = 2 Then
         new_score = 5
         End If
          If abun = 1 And dist = 1 Then
          new_score = 6
          End If
```

```vba
If un_perc < 25 And da_ctr = 0 And seven_ctr > 0 And nine_perc <> tot_perc Then
new_score = 7
End If
If un_perc >= 25 And da_ctr > 0 And seven_ctr > 0 And nine_perc <> tot_perc Then
new_score = 7
End If
If un_perc >= 25 And da_ctr = 0 And seven_ctr > 0 And nine_perc <> tot_perc Then
new_score = 7
End If
If un_perc >= 25 And da_ctr > 0 And seven_ctr = 0 And nine_perc <> tot_perc Then
new_score = 7
End If
If un_perc >= 25 And da_ctr = 0 And seven_ctr = 0 And nine_perc <> tot_perc Then
new_score = 8
End If
If un_perc < 25 And da_ctr = 0 And seven_ctr = 0 And nine_perc <> tot_perc Then
new_score = 8
End If
If un_perc < 25 And da_ctr = 0 And seven_ctr = 0 And nine_perc = tot_perc Then
new_score = 9
End If


    If no_print = True Then GoTo miss_paste:


    ctr_less_1 = counter – 1
    ActiveSheet.Cells(rec_num, 6).Select
    If ctr_less_1 <> 0 Then
    Selection = new_score
    End If
    For i = 1 To ctr_less_1
    ActiveCell.Offset(-1, 0).Select
    Selection = new_score


    Next i
miss_paste:

Loop

finish:

End Sub
```

APPENDIX 3 – WEEDS, *AGGREGATE_25* MACRO CODE

<mark>Highlighted code</mark> refers to logical steps used to aggregate data to 0.25 scale.

```
Sub aggregate_25()
Dim curr_lca As String
Dim last_rec As Integer


'initialise variables
IsEmpty (curr_cell_ref)
IsEmpty (curr_lca)
IsEmpty (curr_score)
IsEmpty (rec_num)
IsEmpty (dist)
IsEmpty (dist_temp)
IsEmpty (un_perc_ctr)
IsEmpty (abun_temp)
IsEmpty (abun)
IsEmpty (last_rec)


Application.ScreenUpdating = False
'last_rec = InputBox("enter last record number plus one")
rec_num = 1
Do Until rec_num > 52001
ctr = 0
un_perc_ctr = 0
dist_temp_tot = 0
abun_temp_tot = 0
new_score = 0
dist_temp = 0
'IsEmpty (score_subtot)
'IsEmpty (dist_temp)
un_perc = 0
  seven_ctr = 0
  eight_ctr = 0
  nine_ctr = 0
  eight_5_ctr = 0
  ctr_5 = 0
  eight_25_ctr = 0
```

```
' For i = 1 To 25
  'ctr_5 = rec_num + 1
 'ActiveSheet.Cells(ctr_5, 3).Select
 'If Selection = 8 Then eight_5_ctr = eight_5_ctr + 1
 'ActiveCell.Offset(0, 2).Select
 'If Selection = 8 Then eight_25_ctr = eight_25_ctr + 1
 'Next i


 For i = 1 To 25


 dist_temp = 0
 abun_temp = 0
 rec_num = rec_num + 1
 ActiveSheet.Cells(rec_num, 3).Select
 'GoSub separate_and_total
 ActiveCell.Offset(0, 2).Select
 GoSub separate_and_total:
 ActiveCell.Offset(0, 2).Select
 GoSub separate_and_total:
 ActiveCell.Offset(0, 2).Select
 GoSub separate_and_total:
 Next i


 GoSub final_calc:


Loop

separate_and_total:
 If Selection <> "" And (Selection = 1 Or Selection = 3 Or Selection = 5) Then
     dist_temp = 2
     dist_temp_tot = dist_temp_tot + dist_temp
     ctr = ctr + 1
 ElseIf Selection <> "" And (Selection = 2 Or Selection = 4 Or Selection = 6) Then
     dist_temp = 1
     dist_temp_tot = dist_temp_tot + dist_temp
     ctr = ctr + 1
 ElseIf Selection <> "" And (Selection = 9) Then
     dist_temp = 0
     nine_ctr = nine_ctr + 1
 ElseIf Selection <> "" And Selection = 8 Then
     un_perc_ctr = un_perc_ctr + 1
     eight_ctr = eight_ctr + 1
 ElseIf Selection <> "" And Selection = 7 Then
     un_perc_ctr = un_perc_ctr + 1
     seven_ctr = seven_ctr + 1
```

```
        End If


    If Selection <> "" And (Selection = 1 Or Selection = 2) Then
        abun_temp = 3
        abun_temp_tot = abun_temp_tot + abun_temp
    ElseIf Selection <> "" And (Selection = 3 Or Selection = 4) Then
        abun_temp = 2
        abun_temp_tot = abun_temp_tot + abun_temp
    ElseIf Selection <> "" And (Selection = 5 Or Selection = 6) Then
        abun_temp = 1
        abun_temp_tot = abun_temp_tot + abun_temp
    Else
        abun_temp = 0
    End If
    Return


final_calc:


    If ctr > 0 Then
    dist = dist_temp_tot / ctr
    abun = abun_temp_tot / ctr
    End If
    If seven_ctr = 0 And ctr = 0 And eight_ctr = 0 And nine_ctr = 0 Then
    GoTo no_paste:
    End If
    If seven_ctr = 0 And ctr = 0 And eight_ctr = 0 And nine_ctr > 24 Then
    dist = 0
    End If
    If seven_ctr = 0 And ctr = 0 And eight_ctr > 0 And nine_ctr > 24 Then
    dist = 0
    End If
    If seven_ctr = 0 And ctr = 0 And eight_ctr = 0 And nine_ctr > 0 And nine_ctr < 25
then
    dist = 8
    End If
    If un_perc_ctr >= 19 And seven_ctr > 0 And ctr > 0 Then
    dist = 7
    End If
    If un_perc_ctr >= 19 And seven_ctr = 0 And ctr > 0 Then
    dist = 7
    End If
    If un_perc_ctr >= 19 And seven_ctr > 0 And ctr = 0 Then
    dist = 7
    End If
```

```
If un_perc_ctr >= 19 And seven_ctr = 0 And ctr = 0 And nine_ctr < 25 Then
    dist = 8
End If


If abun >= 0 And abun < 1.5 Then
    abun = 1
Else
    If abun >= 1.5 And abun < 2.5 Then
    abun = 2
    Else
        If abun >= 2.5 And abun < 3.5 Then
        abun = 3
        End If
    End If
End If


If dist > 0 And dist < 1.5 Then
    dist = 1
Else
    If dist >= 1.5 And dist <= 2 Then
    dist = 2
    End If
End If


If abun = 3 And dist = 2 Then
new_score = 1
Else
    If abun = 3 And dist = 1 Then
    new_score = 2
    Else
        If abun = 2 And dist = 2 Then
        new_score = 3
        Else
            If abun = 2 And dist = 1 Then
            new_score = 4
            Else
                If abun = 1 And dist = 2 Then
                new_score = 5
                Else
                    If abun = 1 And dist = 1 Then
                    new_score = 6
                    Else
                        If dist = 7 Then
                        new_score = 7
                        Else
                            If dist = 8 Then
                            new_score = 8
```

```
            Else
            If dist = 0 Then
            new_score = 9
          End If
         End If
        End If
       End If
      End If
     End If
    End If
   End If
   rec_num_plus_one = rec_num + 1
   ActiveSheet.Cells(rec_num_plus_one, 10).Select
   For i = 1 To 25
   ActiveCell.Offset(-1, 0).Select
   Selection = new_score
   Next i
no_paste:
   Return


End Sub
```

APPENDIX 4 – PEST ANIMALS, *PA_PROPORTIONAL_MEAN* MACRO CODE

Highlighted code refers to logical steps used to calculate proportional mean.

```
Sub PA_proportional_mean()
Dim curr_lca As String
Dim last_rec As Long


'initialise variables
IsEmpty (curr_cell_ref)
IsEmpty (curr_lca)
IsEmpty (curr_score)
IsEmpty (next_cell_ref)
IsEmpty (rec_num)
IsEmpty (next_rec_num)
IsEmpty (counter)
IsEmpty (dist_temp)
IsEmpty (curr_perc)
IsEmpty (un_perc)
IsEmpty (abun_temp)
IsEmpty (tot_perc)
IsEmpty (tot_abun)
IsEmpty (abun)
IsEmpty (dist_temp_2)
IsEmpty (dist_tot)
IsEmpty (new_score)
'IsEmpty (last_rec)


Application.ScreenUpdating = False
pest_name = InputBox("enter pest animal name")


  last_rec = 3200


rec_num = 1


copy_book_macro_1 = pest_name & ".xls"
Workbooks(copy_book_macro_1).Activate


Sheets(1).Activate
Do Until rec_num > last_rec
  stop_loop = False

    Do Until stop_loop = True Or rec_num > last_rec
```

```
rec_num = rec_num + 1
ActiveSheet.Cells(rec_num, 1).Select
curr_lca = Selection
    If curr_lca <> "" Then
    stop_loop = True
    End If


Loop
 'initialise variables, counters & totals
    break_loop = True
    counter = 0
    tot_perc = 0
    abun_tot = 0
    abun = 0
    dist_temp_2 = 0
    dist_tot = 0
    un_perc = 0
    curr_perc = 0
    dist_temp = 0
    abun_temp = 0
    seven_ctr = 0
    da_ctr = 0
    nine_perc = 0
    If rec_num > last_rec Then GoTo finish:


    single_ctr = 0
    pres_ctr = 0
    no_print = True
        Do Until break_loop = False
        single_ctr = single_ctr + 1
        ActiveSheet.Cells(rec_num, 3).Select
        curr_cell_ref = Selection
        ActiveCell.Offset(0, 1).Select
        curr_perc = Selection
        ActiveCell.Offset(0, 1).Select
        curr_score = Selection
        next_rec_num = rec_num + 1
        If curr_score = 0 Then curr_perc = 0


        ActiveSheet.Cells(next_rec_num, 3).Select
        next_cell_ref = Selection
        counter = counter + 1
        If next_cell_ref <> curr_cell_ref Then
        break_loop = False
        End If

        If single_ctr = 1 And next_cell_ref <> curr_cell_ref And curr_score > 0 Then
```

```vba
ActiveSheet.Cells(rec_num, 6).Select
Selection = curr_score
End If
If break_loop = True Then
rec_num = rec_num + 1
End If


If rec_num > last_rec Then GoTo finish:


If curr_score = 1 Or curr_score = 3 Or curr_score = 5 Then
dist_temp = 2
da_ctr = da_ctr + 1
no_print = False
ElseIf curr_score = 2 Or curr_score = 4 Or curr_score = 6 Then
dist_temp = 1
da_ctr = da_ctr + 1
no_print = False
ElseIf curr_score = 9 Then
nine_perc = nine_perc + curr_perc
no_print = False
ElseIf curr_score = 7 Then
seven_ctr = seven_ctr + 1
un_perc = un_perc + curr_perc
no_print = False
ElseIf curr_score = 8 Then
un_perc = un_perc + curr_perc
no_print = False
End If


If curr_score = 1 Or curr_score = 2 Then
abun_temp = 3
ElseIf curr_score = 3 Or curr_score = 4 Then
 abun_temp = 2
 ElseIf curr_score = 5 Or curr_score = 6 Then
  abun_temp = 1
  Else: abun_temp = 0
    End If


tot_perc = tot_perc + curr_perc
If abun_temp = 3 Or abun_temp = 2 Or abun_temp = 1 Or abun_temp = 0 Then
abun_temp_2 = abun_temp * (curr_perc / 100)
abun_tot = abun_tot + abun_temp_2
End If
If dist_temp = 1 Or dist_temp = 2 Or dist_temp = 0 Then
dist_temp_2 = dist_temp * (curr_perc / 100)
dist_tot = dist_tot + dist_temp_2
```

```
        End If
        If break_loop = False Then Exit Do


    Loop


final_calc:
    dist = 0
    abun = 0


    If un_perc < 25 And da_ctr > 0 And nine_perc <> tot_perc Then
     dist = dist_tot * (100 / tot_perc)
     abun = abun_tot * (100 / tot_perc)
    End If
    If dist > 0 And dist < 1.5 Then dist = 1
    If dist >= 1.5 And dist <= 2 Then dist =


    If abun > 0 And abun < 1.5 Then abun = 1


    If abun >= 1.5 And abun < 2.5 Then abun = 2


    If abun >= 2.5 And abun < 3.5 Then abun = 3


    If abun = 3 And dist = 2 Then
     new_score = 1
     End If
     If abun = 3 And dist = 1 Then
     new_score = 2
     End If
     If abun = 2 And dist = 2 Then
     new_score = 3
     End If
      If abun = 2 And dist = 1 Then
      new_score = 4
      End If
       If abun = 1 And dist = 2 Then
       new_score = 5
       End If
        If abun = 1 And dist = 1 Then
        new_score = 6
        End If
    If un_perc < 25 And da_ctr = 0 And seven_ctr > 0 And nine_perc <> tot_perc Then
    new_score = 7
    End If
    If un_perc >= 25 And da_ctr > 0 And seven_ctr > 0 And nine_perc <> tot_perc Then
```

```vba
        new_score = 7
        End If
If un_perc >= 25 And da_ctr = 0 And seven_ctr > 0 And nine_perc <> tot_perc Then
        new_score = 7
        End If
        If un_perc >= 25 And da_ctr > 0 And seven_ctr = 0 And nine_perc <> tot_perc Then
        new_score = 7
        End If
        If un_perc > 0 And da_ctr = 0 And seven_ctr = 0 And nine_perc > 0 Then
        new_score = 8
        End If
        If un_perc = 0 And da_ctr = 0 And seven_ctr = 0 And nine_perc > 0 Then
        new_score = 9
        End If
        If un_perc > 0 And da_ctr = 0 And seven_ctr = 0 And nine_perc = 0 Then
        new_score = 8
        End If


        If no_print = True Then GoTo miss_paste:


        ctr_less_1 = counter – 1
        ActiveSheet.Cells(rec_num, 6).Select
        If ctr_less_1 <> 0 Then
        Selection = new_score
        End If
        For i = 1 To ctr_less_1
        ActiveCell.Offset(-1, 0).Select
        Selection = new_score


        Next i
miss_paste:


Loop


finish:


Dim loop_run As Boolean
ctr = 0
rec_num = 1
write_ctr = 1
last_rec_num = 0
ctr = 1
Application.ScreenUpdating = False

loop_run = True
```

```
Do While loop_run = True


If write_ctr = 2081 Then
 loop_run = False
 GoTo next_rec:
 End If
 rec_num = rec_num + 1
 ActiveSheet.Cells(rec_num, 3).Select
 curr_cell_ref = Selection
 ActiveCell.Offset(1, 0).Select
 next_cell_ref = Selection


 If curr_cell_ref <> next_cell_ref Then
 GoTo move_data:
Re_turn:


 Else
 If curr_cell_ref = next_cell_ref Then
 GoTo next_rec:
 End If
 End If


next_rec:


Loop
GoTo end_sub_one:
move_data:


For i = 1 To ctr
write_ctr = write_ctr + 1


ActiveSheet.Cells(rec_num, 6).Select
curr_score = Selection
ActiveSheet.Cells(write_ctr, 8).Select
Selection = curr_score

Next i

GoTo Re_turn:

end_sub_one:

End Sub
```

APPENDIX 5 – WILD DOG DATA

RLPB	2004				
	Total Stock Losses	Sheep	Cattle	Goats	Other
Armidale	889	871	2	16	0
Bombala	0				
Braidwood	145	145			
Cooma	699	513	1	185	0
Gloucester	146	50	96		
Goulburn	96	95	1	0	0
Grafton	272	56	148	0	68
Gundagai	106	104	2	0	0
Hume	318	318			
Hunter	260	156	19	83	2
Kempsey	1287	134	760	54	339
Maitland	0				
Moss Vale	0				
Mudgee-Merriwa	0				
Northern New England	69	30	13	23	3
Northern Slopes	0				
Tamworth	322	306	4	12	
Yass	80	79	0	1	0
ACT	44	44			
Coonabarabran	8	8			
	4741				

2005				
RLPB	Total Stock Losses	Sheep	Cattle	Goats	Other
Armidale	35	35			
Bombala	0				
Braidwood	159	128	1	30	0
Cooma	0				
Gloucester	0				
Goulburn	0				
Grafton	34	23	11		
Gundagai	200	200			
Hume	444	444			
Hunter	21	5	13	0	3
Kempsey	0				
Maitland	0				
Moss Vale	0				
Mudgee-Merriwa	260	258		2	
Northern New England	0				
Northern Slopes	0				
Tamworth	0				
Yass	216	62	0	154	0
ACT	0				
Coonabarabran	0				
	1369				

	2006				
RLPB	**Total Stock Losses**	**Sheep**	**Cattle**	**Goats**	**Other**
Armidale	1301	1298	2		1
Bombala	134	134			
Braidwood	114	114			
Cooma	47				47
Gloucester	310	134	176		
Goulburn	0				
Grafton	242	49	164	2	27
Gundagai	170	160		4	6
Hume	345	344		1	
Hunter	497	348	54	54	41
Kempsey	1676	249	934	78	415
Maitland	50	15	35		
Moss Vale	30	30			
Mudgee-Merriwa	361	357			4
Northern New England	468	438	7	3	20
Northern Slopes	0				
Tamworth	470	466	2	0	2
Yass	242				242
ACT	0				
Coonabarabran	0				
	6457				

2007					
RLPB	Total Stock Losses	Sheep	Cattle	Goats	Other
Armidale	318	318			
Bombala	33	32			1
Braidwood	58	53		5	
Cooma	591	588		3	
Gloucester	0				
Goulburn	0				
Grafton	166	61	74	3	28
Gundagai	112	112			
Hume	0				
Hunter	362	228	45	32	57
Kempsey	2211	169	934	389	719
Maitland	0				
Moss Vale	0				
Mudgee-Merriwa	914	879		35	
Northern New England	5	5			
Northern Slopes	7	7			
Tamworth	141	140	1		
Yass	0				
ACT	0				
Coonabarabran	0				
	4918				