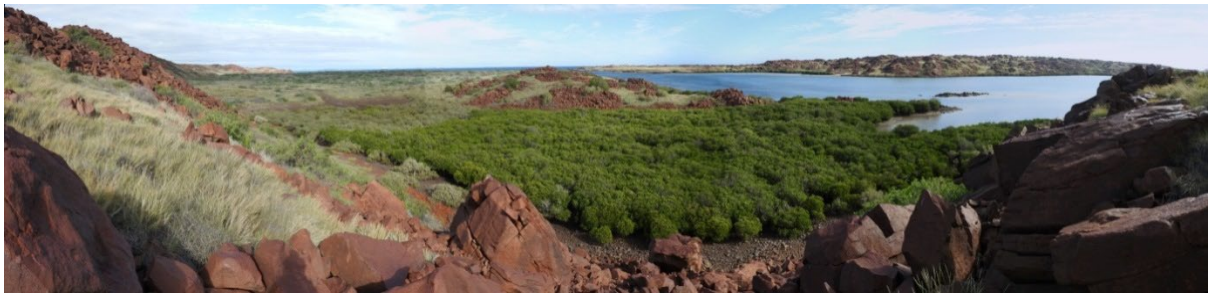
Island Management Decision Support Software – Version 1.0 User Manual



Cheryl A. Lohr [1], *Justin Osbaldiston*[2]
[1]Department of Biodiversity, Conservation and Attractions, Science and Conservation Division, Western Australia
[2]ARC Centre of Excellence for Coral Reef Studies, James Cook University

GOVERNMENT OF WESTERN AUSTRALIA

Department of **Biodiversity, Conservation and Attractions**

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Contents

Gorgon Barrow Island Net Conservation Benefits Fund

The Gorgon Barrow Island Net Conservation Benefits (NCB) Fund is an initiative of the Western Australian Government, through which funding is provided for conservation work at the leading edge of scientific knowledge. Gorgon Barrow Island NCBs are defined in the Barrow Island Act 2003 as "demonstrable and sustainable additions to or improvements in biodiversity conservation values of Western Australia targeting, where possible, the biodiversity conservation values affected or occurring in similar bioregions to Barrow Island". By agreement with Chevron Australia, which is developing the Gorgon liquefied natural gas project on Barrow Island, this $60 million Fund has been established to build a nature conservation legacy for future generations of Western Australians.

Front cover image

Image 1: North shore of Angel Island, Dampier Archipelago, Western Australia (Source: Jana Brotankova).

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Corresponding author and Institution: Cheryl Lohr, Department of Biodiversity, Conservation, and Attractions, Government of Western Australia, Cheryl.lohr@dbca.wa.gov.au.

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Introduction

Invasive non-indigenous species are among the most powerful drivers of biotic extinction, particularly on islands. While controlling invasive species can provide significant conservation benefits, planning control or eradication actions across several islands and threatening species offers hundreds, if not thousands of alternative management action combinations. This makes it difficult to plan actions efficiently – to have the most benefit for a given investment – across groups of islands.

The Islands Decision-Support System (DSS) is a new piece of decision-support software, designed to prioritise the myriad of possible actions we could take to protect island species from invasive non-indigenous species and other threats. The Islands DSS uses data drawn from user-friendly spreadsheets, spatially and temporally dynamic models of ecosystems (Lohr et al 2017a), and models of the efficacy and cost of management actions (Wenger et al 2017). The Islands DSS incorporates the newest advances in systematic conservation planning, but was designed for practical applications. The software is interactive and participatory, and is intended for day-to-day use to refine and support decisions related to island management that can be implemented over both short and long time-frames.

Several mathematical models have been incorporated into the software's coding. Details of the software's prioritisation algorithm, ecological community model, and method of estimating the cost of management may be found in Lohr et al (2017b). We strongly recommend that new users of the Islands DSS become familiar with these models prior to using the software.

Introduction to the GUI

The GUI (Graphical User Interface) is a program created to assist the user in entering and searching through the data, and reviewing the results of the prioritisation solver. Prior to running the prioritisation solver, the user can use the GUI to visualise, and spatially explore various sets of ecological data without having a trawl through spreadsheets and maps. The user can search for specific species and sites to view data such as abundance and/or density of a species, and habitats available on sites. If connected to the internet, the GUI uses the latest Google Map of the region to spatially arrange the data. The GUI also provides the portal for entering parameters into the prioritisation algorithm and viewing the decision recommendations. The user must be connected to the internet for the prioritisation algorithm to run. After the prioritisation solver has been run, the user can also review projected species population dynamics on selected islands for the given time frame.

The data used in the GUI and solver is drawn from a series of spreadsheets (.xlsx). The user can edit the spreadsheets to add, remove or change the data being used without engaging the GUI or solver. This makes the software very flexible in regards to the user's data storage and management systems. The GUI and solver can use any set of spreadsheets, providing they are in the correct format as described in this manual.

System requirements

Internet Connection
Windows 7/8/10
1.5GB Disk Space
2GB RAM (minimum), 4GB (recommended)

Definitions

GUI: Graphical user interface that displays data and results.

Label: alphanumeric name for a species, location, or management action.

ID number: Unique positive integer identifying a species or location.

Feature: Any species or site-specific characteristic that may be negatively impacted by a listed threat.

Threat: Any species, disturbance or environmental variable that negatively impacts one or more of the listed features and whose impacts can be mitigated by one or more of the listed action packages.

Action package: Whole collection of tasks or sub-actions involved in managing a threat. An action package may use one or more unique management techniques or tools. Implementing one technique in the field may require several smaller tasks or sub-actions be completed.

Sub-action: One of the tasks included in an action package. A sub-action may be the implementation of a unique field technique, or any other significant field or office based tasks required to support the implementation of the field technique.

Management unit: Unique user-defined area that will receive a consistent application of an action package.

Centre matrix: Cells that connect row headings to column headings.

Specification: User may specify whether an action package is designed to control a threat or eradicate it.

Control: Temporary suppression of the abundance of a threat over one or more years.

Eradication: Extirpation or complete removal of a threat from a management unit.

Consumer: Species whose resources are contained within the boundary of a given management unit.

Space-limited species: Species that are either primary producers or species that only consume a management units space plus resources from outside a given management unit (e.g., marine turtles, seabirds nest on islands and consume marine resources, plants).

Transport: Any type of vehicle used to move personnel or equipment to and from a management unit. Each type of transport must have a unique spreadsheet describing the area of land that can be treated given the machine's capabilities (see section on *Transport*).

Access location: The agency office, baseyard, or home port that houses personnel and equipment when it is not in use in the field.

Prey: Any species that is being consumed or negatively influenced (through competition) by another species.

Predator: Any species that is consuming or negatively influencing (through competition) another species.

Data input spreadsheets

General rules for data input spreadsheets

All labels and species or location identification (ID) numbers need to be consistent throughout the spreadsheets.

Labels are case-sensitive.

The temporal unit for the software is one year. The software does not distinguish among smaller units of time (i.e., months or days).

The area unit used is hectares.

Both sites and species have a numerical identification number in the spreadsheets. Spreadsheets should always be saved with the sites and species in numerical order, whether they be listed as row headings or column headings.

List of user-maintained spreadsheets

Action Efficiencies
Action Packages
Carrying Capacity and Habitat
Constants
Consumables Cost per Ha
Equipment Costs
Transports (e.g. Fixed Wing, Helicopter Boat Dropoff, Camping, Charter Vessel)

Sites
Species Interactions
Species Population In Site
Species

Action Efficiencies

Column A contains names of the sub-actions, starting from cell 3. This list must only include all unique sub-actions listed in the Action Packages spreadsheet.

Rows 1 and 2 are the Latin names and corresponding species ID numbers of threats, starting from cell B. These rows must only include all unique threats listed in the *Action Packages* spreadsheet under column A Threat ID.

The centre matrix states the efficiency of the corresponding sub-action for the corresponding threat, starting at cell 3B. The efficiencies must all be non-negative numbers that quantify the proportion (values between 0 and 1) of the threat population that will be removed through one application of the sub-action. If a listed sub-action does not affect a listed threat, enter 0 in the cell. Ultimately, if an action package is used to control a species (see *Action Packages* spreadsheet) then the Islands DSS code will multiply the efficiencies across the number of treatments within one year ($efficiency^{\#\ of\ treatments}$) and sum the efficiencies across all the sub-actions included in an individual action package. The maximum total efficiency of an action package will be rounded down to one, which is equal to 100% of the threat is removed and hence eradicated. If an action package is designed to eradicate a species then the Islands DSS will assume that upon complete implementation of the package that 100% of the species will have been removed regardless of the design of the package. If an action package is designed to control a threat then the Islands DSS will use the sum of the efficiencies across the sub-actions and eradication will only be assumed when more than 99% of the species has been removed within a single year. Users of the Islands DSS should carefully code eradication packages in the *Action Packages* spreadsheet as the design of the package will influence the estimated cost of the package, not its efficacy.

The value of efficiency entered into the Action Efficiencies spreadsheet should be equal to the expected reduction in the species given a single application of the action. For example, when aerial baiting with rodenticides for eradication, it is standard practice to completely cover a management unit (i.e. island) with 20 to 30 kg of bait per hectare, delivered in two (12kg/ha + 8 kg/ha = 20 kg/ha) or three (15 kg/ha + 8 kg/ha + 7 kg/ha = 30 kg/ha) batches. If only a single application of bait was made we might expect an 80-90% drop in the abundance of rodents (i.e. 0.8-0.9). Multiple applications of the rodenticide will exceed 100% reduction in the abundance of rodents. Conversely, ground baiting with Ovocontrol is a long-term strategy requiring bimonthly applications of bait for the duration of each breeding season (approx. 24 per annum) to prevent the development of approximately 59% of pigeon eggs (Avery et al 2008). Each application of the bait will reduce the pigeon abundance by approximately 2.46% (59/24=2.46).

Action Efficiencies

	A	B	C	D	E	F
1	Latin	Acetosa vesicaria	Aerva javanica	Bos taurus	Canis familiaris	Cenchrus ciliaris
2	Action/Species_ID	2378	964	829	713	961
3	aerial baiting	0	0	0	0.65	0
4	aerial shooting	0	0	0.7	0	0
5	bait transportation	0	0	0	0	0
6	ground baiting	0	0	0	0.68	0
7	ground shooting	0	0	0.18	0.28	0
8	hand spraying	0.85	0.85	0	0	0.8
9	manual removal	0	0	0	0	0
10	post-eradication monitoring	0.1	0.1	0.1	0.1	0.1
11	pre-eradication field plannin	0.1	0.1	0.1	0.1	0.1
12	pre-eradication office planni	0	0	0	0	0
13	revegetation	0.1	0.1	0	0	0.2
14	revegetation office planning	0	0	0	0	0
15	trapping	0	0	0.16	0.018	0
16						

Action Packages

An action package should contain several rows with 1 row per sub-action.

Column A contains the ID numbers of the threats, starting from cell 2. This must be a non-negative integer, and must have corresponding records in the *Species*, *Action Efficiencies*, *Carrying Capacity and Habitat*, *Consumables Cost per Ha*, *Equipment Costs*, *Species Population in Site* and *Species Interactions* spreadsheets.

Column B contains the names of the action packages, starting from cell 2. Each threat may be mitigated through one or more action packages; therefore each action package must have a unique name.

Column C is the specification for the action package, starting from cell 2. All specifications within each action package must be the same. This must be 1 for control or 2 for eradication. Ultimately, if an action package is used to control a species then the Islands DSS code will multiply the efficiencies (See *Action Efficiencies* spreadsheet) across the number of treatments and sum the efficiencies across all the sub-actions included in an individual action package. If an action package is designed to eradicate a species then the Islands DSS will assume that upon complete implementation of the package that 100% of the species will have been removed regardless of the design of the package. Users of the Islands DSS should carefully code eradication packages in the *Action Packages* spreadsheet as the design of the package will influence the estimated cost of the package, not its efficacy.

Column D is the name for the sub-action, starting from cell 2. Each sub-action within an action package must have a unique name. Names for sub-actions are case sensitive and must have corresponding records in the *Action Efficiencies*, *Consumables Cost per Ha*, and *Equipment Costs* spreadsheets.

Column E is the number of times the sub-action is required to be repeated each year, starting from cell 2. This must be a non-negative integer. Within each action package, the sum of Column E equals the total number of trips personnel will make to the management unit within one year. If multiple sub-actions are implemented within one trip to a management unit then we recommend that you divide the total number of field trips by the number of field based sub-actions and round up to the nearest integer.

Column F is the number of days on site the sub-action will require. This can be 1 (for aircraft, as aircraft use distance from hangar to the island to calculate time, see *Transport*), a percentage of FTE expressed as a decimal followed by a space and "FTE", or a multiplication of pre-defined values separated by a "*" sign with no spaces. Pre-defined values are "terrain penalty", "person days per ha", "site size", "infestation size", "person days per ha at density level" or any positive integer (eg "terrain penalty*site size*3").

Column G is the number of personnel required for that sub-action, starting from cell 2. This must be a non-negative integer.

Column H is the minimum number of years that sub-action will take to implement, starting from cell 2. This must be a non-negative integer.

Column I is the year (relative to the action package) when that sub-action will start, starting from cell 2. This must be a non-negative integer. For action packages that take less than 1 year to implement, all sub-actions will start in year 1.

Column J is the type of transport this sub-action uses, starting from cell 2. If the sub-action does not use a transport, then enter "none". For all the transports, there must be a unique corresponding *Transport* spreadsheet. The name of the transport spreadsheet and the name of the transport listed in Column J must use the same characters, but it is not case-sensitive.

Action Packages

	A	B	C	D	E	F	G	H	I	J
1	Threat ID	Action package	Specification	Sub-actions	Number of trips required per year	Days required per trip (not including time in transit)	Personnel required	Years committed	Start year	Transport
28	712	Felis catus control	2	aerial baiting	1	1	1	1	1	fixed wing
29	712	Felis catus control	2	bait transportation	1	1	1	1	1	none
30	710	Rattus rattus control	2	aerial baiting	1	1	1	1	1	helicopter
31	710	Rattus rattus eradication 1	2	pre-eradication field planning	1	terrain penalty*person days per ha*island size	4	1	1	charter vessel
32	710	Rattus rattus eradication 1	2	pre-eradication office planning	0	0.3 FTE	1	1	1	none
33	710	Rattus rattus eradication 1	2	aerial baiting	2	1	2	1	1	helicopter
34	710	Rattus rattus eradication 1	2	post-eradication monitoring	1	terrain penalty*person days per ha*island size	4	2	2	charter vessel
35	710	Rattus rattus eradication 2	2	pre-eradication field planning	1	terrain penalty*person days per ha*island size	4	1	1	charter vessel
36	710	Rattus rattus eradication 2	2	pre-eradication office planning	0	0.3 FTE	1	1	1	none
37	710	Rattus rattus eradication 2	2	ground baiting	3	terrain penalty*person days per ha*island size*3	2	1	1	charter vessel
38	710	Rattus rattus eradication 2	2	post-eradication monitoring	1	terrain penalty*person days per ha*island size	4	2	2	charter vessel

Carrying Capacity and Habitat

Column A is the Latin name of the species, starting from cell 2

Column B is the common name of the species, starting from cell 2

Column C contains the species ID number for the species, starting from cell 2. This must be a positive integer, and must have corresponding records in the *Species*, *Species population in site* and *Species interactions* spreadsheets.

Column D contains the carrying capacity of the species, starting from cell 2. This must be a positive number that describes the maximum number of consumers that could occupy one hectare of habitat, or the maximum proportion of a hectare that could be covered by a plant or other space-limited species.

Columns E onwards are the Habitats, with one column for each habitat type. The values for these must be 0 if the species does not use the habitat, 0.5 if the habitat is sub-optimal for the species, and 1 if the habitat type is optimal for the species. Any habitats that do not provide all the necessary resources (food, water, and shelter) for a species should be considered sub-optimal. These habitat names must be exactly the same as the habitats in the *Sites* sheet.

Carrying Capacity and Habitat

	A	B	C	D	E	F	G	H
1	Latin	Common	Species_ID	K	Red rock	Tussock grassland	Mudflat	Dune vegetation
2	Acacia coriacea	Wirewood	963	0.7	1	0.5	0	1
3	Acetosa vesicaria	Ruby dock	2378	1	0	1	0	0.5
4	Aerva javanica	Kapok	964	0.9	0	1	0	0.5
5	Bettongia lesueur	Boodie	7	1.17	0	1	0	1
6	Bos taurus	Feral Cattle	829	0.3	0	1	0	0
7	Calidris ruficollis	Red-necked Stint	238	8000	0	0	1	0.5
8	Calidris tenuirostris	Great Knot	239	8000	0	0	1	0
9	Canis familiaris	Dog	713	0.005	0	1	0.5	1

Constants

The constants are used in equations that extrapolate the cost of implementing a sub-action from one hectare – as described in *Consumables Cost per Ha* spreadsheet - to each entire management unit. Only sub-actions that use boat and the phrase 'person days per ha' in the *Action Packages* spreadsheet should have a value included in this file. If the phrase 'person days per ha at density level' is used then do not include an associated value in the *Constants* spreadsheet. This phrase will automatically use an equation [person days per hectare = (0.0193 * density of the weed) + 0.07] to calculate the required *Constant*. Aerial sub-actions are parameterised in other transport files (see *Aircraft*). Do not list any sub-actions that do not use any transport in this file. There should be one entry in the *Constants* spreadsheet if the sub-action is applied across a management unit at the same rate for all species: or if the application rate varies among species then there should be one row per species listed in the *Action Packages* spreadsheet an individual value for each species that has person days per ha in their equation

Row 1 contains the hourly salary rate used to calculate the cost of wages. This must be a positive number. The software calculates the relative cost-effectiveness of available management actions across all of the management units. We do not recommend entering an hourly salary rate of $0 to describe the use of volunteers unless the software user can reasonably assume that volunteer workers are available for use in all of the management units. The cost-effectiveness of volunteers and or specialist workers on some sites should be given due consideration by decision-makers concurrent to use of the results of the Island Management Decision-Support Software.

In subsequent rows, the values (column B) should describe the number of person days per ha required to perform the sub-action listed in the label (column A). The names must be the name of a sub-action, followed by a space, then the ID number of the species that the sub-action is targeting in brackets. If the targeted threat does not influence the value of the constant then, there may be only 1 row with the name of the sub-action. The software will assume that all values for that sub-action are the same regardless of species. If both the name and ID number are specified, that specific value will be used for cases where the listed sub-action can be performed on the listed threat. There must be at least one row per sub-action. Labels for sub-actions are case sensitive and must have corresponding records in the *Action Efficiencies*, *Consumables Cost per Ha*, and *Equipment Costs* spreadsheets. The values must be non-negative numbers.

Constants

	A	B
1	Hourly Salary	63.18
2	Person days per ha	
3	aerial baiting (712)	0
4	aerial shooting (830)	0.004
5	bait transportation	0
6	ground baiting (712)	0.03
7	ground shooting (711)	0.02
8	ground shooting (716)	0.02
9	hand spraying (961)	0.07
10	hand spraying (1461)	0.07
11	manual removal (1432)	2.8
12	post-eradication monitoring (711)	0.07
13	pre-eradication field planning (961)	0.07
14	pre-eradication field planning (712)	0.07
15	pre-eradication field planning (2353)	0.07
16	revegetation (2353)	2.8
17	revegetation (1649)	2.8
18	trapping (716)	0.07
19	trapping (710)	0.07
20		

or

Constants.xlsx

	A	B
1	Hourly Salary Rate	63.18
2	Hours per Working Day	8
3	Person days per ha	
4	ground shooting	0.02
5	manual removal	2.8
6	post-eradication monitoring	0.07
7	pre-eradication field planning	0.07
8	revegetation	2.8

Consumables Cost Per Ha

Consumables are defined as any tools or materials that will only be used once (e.g., herbicides, weed-matting, bait).

Column A contains names of sub-actions, starting from cell 3. This list must only include all unique sub-actions listed in the *Action Packages* spreadsheet. The names for sub-actions are case sensitive.

Rows 1 and 2 contain the Latin names and corresponding species ID numbers for threats, starting from cell B. These must only include all unique threats listed in the *Action Packages* spreadsheet.

The centre matrix is the consumable costs per hectare for the corresponding sub-action and threat, starting at cell 3B. These values must all be non-negative numbers. If a species does not have any consumable costs for the corresponding sub-action, enter 0 in the cell.

Consumables Cost per Ha

	A	B	C	D	E	F
1	Latin	Acetosa vesicaria	Aerva javanica	Bos taurus	Canis familiaris	Cenchrus ciliaris
2	Action Name/Species_ID	2378	964	829	713	961
3	aerial baiting	0	0	0	0.045	0
4	aerial shooting	0	0	0.2	0	0
5	bait transportation	0	0	0	0.012	0
6	ground baiting	0	0	0	0.045	0
7	ground shooting	0	0	0.2	0.2	0
8	hand spraying	0.01	0.5	0	0	1.12
9	manual removal	0	0	0	0	0
10	post-eradication monitoring	0.2	0.2	0.2	0.2	0.2
11	pre-eradication field plannin	0.2	0.2	0.2	0.2	0.2
12	pre-eradication office planni	0	0	0	0	0
13	revegetation	50000	50000	0	0	50000
14	revegetation office planning	0	0	0	0	0
15	trapping	0	0	0.2	0.5	0

Equipment Costs

Equipment is defined as any tools or materials that may be used for more than one field trip or project. Keep in mind that many projects will need to replace or supplement pre-existing equipment, especially for eradication programs. Equipment costs are not calculated on a per hectare basis; they are calculated on a per management unit or project basis. For example, one aerial bait spreader will be used regardless of the size of the management unit.

Column A contains names of sub-actions, starting from cell 3. This list must only include all unique sub-actions listed in the *Action Packages* spreadsheet.

Rows 1 and 2 contain the Latin names and corresponding species ID numbers for threats, starting from cell B. These must only include all unique threats listed in the *Action Packages* spreadsheet.

The centre matrix is the total equipment costs for the corresponding sub-action and threat, starting at cell 3. These values must all be non-negative numbers. If a species does not have any equipment costs for the corresponding sub-action, enter 0 in the cell.

Equipment Costs

	A	B	C	D	E	F
1	Latin	Acetosa vesicaria	Aerva javanica	Bos taurus	Canis familiaris	Cenchrus ciliaris
2	Action/Species_ID	2378	964	829	713	961
3	aerial baiting	0	0	0	0	0
4	aerial shooting	0	0	0	0	0
5	bait transportation	0	0	0	1000	0
6	ground baiting	0	0	0	50	0
7	ground shooting	0	0	5000	5000	0
8	hand spraying	1000	1000	0	0	1000
9	manual removal	0	0	0	0	0
10	post-eradication monitoring	0	0	0	0	0
11	pre-eradication field planning	1000	1000	0	80000	1000
12	pre-eradication office planning	2000	2000	2000	2000	2000
13	revegetation	0	1000	0	0	1000
14	revegetation office planning	2000	2000	2000	2000	2000
15	trapping	0	0	5000	10000	0
16						

Sites

The Sites spreadsheet describes the management units as defined by the software user.

Column A is the Site ID number, starting in row 2. These must all be unique positive integers.

Column B is the name of the site, starting in row 2. These labels are used to display data and results in the GUI and should be individually recognisable.

Column C is the Area of the site in hectares, starting in row 2. These must all be positive numbers.

Column D is the terrain penalty rate (refer to section on *Terrain penalty*), starting in row 2. These must all be positive numbers.

Column E is the name of the access location for the site, starting in row 2.

Column F is the distance from the site to the access location in kilometres, starting in row 2. These must all be positive numbers.

Column G states if the site is accessible by land or not, starting in row 2. This must be 0 if false and 1 if true

Columns H across describe the quantity (in hectares) of each habitat types on each site. Row 1 contains the habitat labels and must have corresponding labels in the *Carrying capacity and Habitat* spreadsheet.

Sites

	A	B	C	D	E	F	G	H	I
1	Site_ID	Site	Area Ha	Terrain penalty rate	Access Location	Distance To Access Location	Accesssible Via Land	Red rock	Red rock vegetate
2	1	Bedout	41.26	1.01603391	Port Hedland	97.66021327	0	0	0
3	2	North Turtle	65.983	1.003306892	Port Hedland	58.25525473	0	0	0
4	3	Cohen	12.033	1.021293491	Dampier	33.51382504	0	0	0.404
5	4	Keast	51.306	1.004611789	Dampier	34.25267383	0	0	0.006
6	5	Collier Rocks 5	36.012	1.008149293	Dampier	34.08444944	0	0	6.561
7	6	Collier Rocks 6	28.06	1.010023326	Dampier	33.50606336	0	0.843	3.845
8	7	North Gidley	67.351	1.006307367	Dampier	31.32932483	0	3.06	11.353
9	8	Middle Gidley	232.153	1.007920721	Dampier	30.31293655	0	9.77	45.572
10	9	Hauy	108.901	1.011408766	Dampier	38.5701895	0	0.006	0.872

Species Interactions

Species may compete for resources or consume one another. The influence of these interactions on the total population of the 'prey' species is captured in the *Species Interactions* value (see *Community ecology model*). All species in the *Species* spreadsheet must be listed as a row heading and as a column heading.

Column A contains the Latin names of species, starting at row 3.

Column B contains the ID numbers of the species listed in Column A, starting at row 3. These numbers must be positive integers and must correspond to the species ID number listed in the *Species* spreadsheet.

Row 1 contains the Latin names of species, starting at column C.

Row 2 contains the ID numbers of the species listed in row 1, starting at column C. These must be positive integers and must correspond to the species ID number in the *Species* spreadsheet.

The centre matrix, starting at C3, is the interaction coefficient. These can be a non-negative number or "B" or "C". "B" describes a competitive coexistence relationship between two space-limited species. "C" describes a competitive exclusion relationship between two space-limited species. Do not use a "B" or "C" in any rows whose row heading describes a consumer. Any numbers entered into the centre matrix should reflect the proportional reduction of the total population of the prey species listed in the column

heading by each individual in the predator species listed in the corresponding row heading (see *Community ecology model*).

Species Interactions

	A	B	C	D	E	F	G
1	Predator(down)/prey (right)	Latin	Acacia coriacea	Acetosa vesicaria	Aerva javanica	Anous stolidus	Ardenna pacifica
2	Latin	Species_ID	963	2378	964	9	43
12	Calidris tenuirostris	239	0	0	0	B	B
13	Canis familiaris	713	0	0	0	0.06	0.06
14	Capparis umbonata	1136	0	0	0	0	0
15	Carpobrotus sp. Theve	1137	0	0	0	0	0
16	Cenchrus ciliaris	961	C	C	C	0	0
17	Cenchrus echinatus	1649	0	0	0	C	C

Species Population in Site

This spreadsheet describes the presence and/or abundance of each species in each management unit.

Column A contains the names of sites, starting at row 3.

Column B contains the ID numbers of the sites in Column A, starting at row 3. These must be positive integers and must correspond to the site ID number in the *Sites* spreadsheet.

Row 1 contains the Latin names of species, starting at column C.

Row 2 is the ID numbers of the species in row 1, starting at column C. These must be positive integers and must correspond to the species ID number in the *Species* spreadsheet.

The centre matrix, starting from cell A3, contains data describing the presence and/or abundance of each species in each management unit. The cell must be blank if the species does not exist on the site. For a plant, enter the area in hectares the plant covers, then a space, then the average density of that plant in brackets. If the area is unknown, enter -99, followed by a space and the density in brackets. A density value must be entered. For an animal, enter the abundance of the species for that site. If the species is known to occur on the site but the abundance is unknown, enter -99.

Species Population In Site

	A	B	C	D	E	F	G	H
1		Species (Latin) ->	Acacia co	Acetosa v	Aerva jav	Anous sto	Ardenna p	Arenaria i
2	Site	Zone_ID\Species_ID	963	2378	964	9	43	222
3	Bedout	1			20 (10)	5000		-99
4	North Turtle	2						-99
5	Cohen	3					25	-99
6	Keast	4						-99
7	Collier Rocks	5						

Species

This spreadsheet describes the demographic attributes of each species, their Taxonomic Kingdom, and trophic level (i.e., space-limited species or consumer), plus the decision-makers management objectives and weights.

Column A contains the Latin name of the species, starting in row 2. Names in this column are used to create the labels seen in the GUI and hence should be concise but recognisable.

Column B contains the common name of the species, starting in row 2.

Column C contains the ID number of the species, starting in row 2. These must be positive integers and correspond to the species ID numbers in the *Species Population In Site*, *Species Interactions*, *Action Efficiencies*, *Action Packages*, *Carrying Capacity and Habitat*, *Consumables Cost per Ha*, and *Equipment Costs* spreadsheets.

Column D contains the continuous maximum rate of population growth (r_{max}) for the species, starting in row 2. These must be non-negative numbers.

Column E contains the confidence interval (CI) for the growth rate of the species, starting in row 2. These values are not essential to run the solver and primarily advise the user on the quality of the data in column D.

Column F contains the age of first reproduction for the species (in years), starting in row 2. These values are not essential to run the solver and primarily provide the user with a method of estimating the continuous maximum rate of population growth (column D) for lesser studied species of conservation concern (see *Community ecology model*).

$$R_{max} = age\ first\ reproduction$$

Column G contains the lifespan of an animal or the longevity of the seedbank of a species, starting in row 2. These values are not essential to run the solver and primarily advise the user on the minimum number of years that a sub-action should occur to ensure a plant species is eradicated (see *Action Packages*, column H).

Column H contains the taxonomic Kingdom of the species, starting in row 2. These must be 1 if the species is a plant or 2 if the species is an animal.

Column I lists the species group, starting in row 2. These must be 1 if the species is a space-limited species or 2 if the species is a consumer. A consumer must have a food source available in the *Species Interactions* spreadsheet otherwise the community ecology model coded into the software will cause the consumer to become extinct regardless of the presence of introduced threats. Species that consume marine resources, detritus, or insectivores should be listed as space-limited species unless the species they consume are listed in the spreadsheets.

Column J describes the status of the species, starting in row 2. These must be 1 if the species is a protected or native feature that you want to conserve; or 2 if the species is a threat that you want to control or eradicate.

Species

	A	B	C	D	E	F	G	H	I	J
1	Latin	Common	Species_ID	Growth_Rate	CI_Growth_Rate	Age_Reproduction	Lifespan_Seedbank	Taxa	Species_Group	Status
12	Canis familiaris	Dog	713	0.34	0.24	1.75	23.56	2	2	2
13	Capparis umbonata	Wild orange	1136	0.02	0.01	4.00	10.00	1	1	1
14	Carpobrotus sp. Theve	Carpobrotus s	1137	0.05	0.04	1.00	2.00	1	1	1

Column K is the mass in kilograms of the species, starting in row 2. If the species is a plant enter 0. These values are not essential to run the solver and primarily provide the user with a method of estimating the MJ provided as prey and MJ required per annum for each species (column L and M).

Column L is the megajoules (MJ) provided by the species when it is consumed, starting in row 2 (see *Community ecology model*). These must be non-negative numbers. When W equals the bodyweight or mass of the species as listed in Column K then MJ provided may be calculated as:

$$MJ\ provided\ when\ prey = 0.27W^{0.75}$$

Column M is the megajoules (MJ) required annually by individuals of the species to live and reproduce, starting in row 2 (see *Community ecology model*). These must be non-negative numbers. If the species is a plant enter 0. When W equals the bodyweight or mass of the species as listed in Column K then MJ required may be calculated as:

Herbivores: $Annual\ MJ\ required = 365\left(\frac{1.5*0.27W^{0.75}}{0.50}\right)$

Carnivores/Omnivores: $Annual\ MJ\ required = 365\left(\frac{1.5*0.27W^{0.75}}{0.75}\right)$

Column N is the species weighting (see *Weighting features*), starting in row 2. These must be positive numbers between 0 and 1.

Column O, the *Regional_objective* is the management objective for the species over the whole system. This must be a non-negative number that describes the minimum acceptable abundance for features across the whole system (number of individuals for animals and number of hectares for plants).

Species.xlsx

	A	B	K	L	M	N	O	P
1	Latin	Common	Mass_KG	MJ_Provided	MJ_Required	Weight	Regional_Objective	
2	Pelecanus conspicillatus	Australian Pelican	5.37	119.54	1042.94	0.42	3420	
3	Esacus magnirostris	Beach Stone-curlew	1	22.26	197.10	0.53	160	
4	Onychoprion anaethetus	Bridled Tern	0.12	2.56	38.92	0.53	57000	
5	Sula leucogaster	Brown Booby	1.07	23.82	207.36	0.57	6000	
6	Bettongia lesueur	Boodie	1.21	26.99	227.74	0.62	3500	
7	Hydroprogne caspia	Caspian Tern	0.65	14.47	214.02	0.42	800	
8	Anous stolidus	Common Noddy	0.22	4.95	63.85	0.53	1800	
9	Macropus robustus	Euro	17.26	384.13	1668.80	0.41	35000	
10	Hydromys chrysogaster	Common water rat	0.63	13.93	138.71	0.42	140	

Transport

Any type of vehicle used to move personnel or equipment to and from a management unit must have a unique spreadsheet describing the area of land that can be treated given the machine's capabilities. The name of each transport spreadsheet must match the label under column "Transport" in spreadsheet *Action Packages*. The contents of Cell 1A are used to define whether the spreadsheet refer to transport via aircraft or boat.

Aircraft

Cell 1A is used to define the spreadsheet as an aircraft. This must be "Maximum flying time before refuel (hours)".

Cell 1B is the maximum flight time of the aircraft in hours. This must be a positive integer.

Cell 2B is the hourly cost of the aircraft. This must be a positive number.

Cell 3B is the travelling flight speed of the aircraft in km/h. This must be a positive number.

Cell 4B is the working speed of the aircraft in km/h. This must be a positive number.

Cells 5B down describe the distance between transects (km) for each threat listed in the *Action Packages* spreadsheet. The value must be a positive number. The names are in the format "Transect interval per km (species ID number)". For each aerial sub-action that uses transect intervals (e.g., baiting), enter a row. If the sub-action is aerial but doesn't use transect intervals (e.g., shooting), don't enter anything, the solver will assume the aircraft is used to its maximum capability. The rows entered should only be for sub-actions that require transect intervals.

From the transect intervals down is the distances from the aircraft hangar to the access location (km). This access location is the one defined in the *Sites* spreadsheet in the access location column. There must be one entry for each unique access location. The values must be positive numbers. The names are in the format "Distance from base to

ACCESS LOCATION NAME HERE (km)". If a temporary baseyard or helicopter pad (Access location) is set up on a remote field site then list it as an Access location in the *Sites* spreadsheet. Transporting aircraft to a temporary airport by boat may be listed as a sub-action.

Fixed Wing

	A	B
1	Maximum flying time before refuel (hours)	4
2	Hourly rate	1280
3	Flight speed (km/h)	300
4	Baiting speed (km/h)	170
5	Transect interval per km (710)	0
6	Transect interval per km (712)	1
7	Distance from base to Port Hedland (km)	42
8	Distance from base to Port Walcott (km)	25

Boat

Cell 1A is used to define the spreadsheet as a boat. This must be "speed (km/h)".
Cell 1B is the travelling speed of the boat. This value must be a positive integer.
Cell 2A must be 'used in land actions.
Cell 2B states whether this transport can be used in land actions, 0=yes, 1=no
Cell 3A must be 'capacity (down)/days (right)
Row 3, starting at column B, is the list of available trip lengths (in days) for the boat. These must be positive integers. One column must list the cost of using a boat for one day.
Column A, starting at row 4, lists the number of passengers the boat can carry (excluding boat operation crew). These must be positive integers.
The centre matrix, starting at B4, is the cost to use a boat for the corresponding amount of time and people on board. If that combination is not available for the boat, leave that cell blank.

charter vessel.xlsx

	A	B	C	D	E	F	G
1	speed (km/h)	25					
2	used in land actions	1					
3	capacity (down)/days (right)	2	4	5	7	8	14
4	6	4750	4500		4250		
5	12	6500		6250		6000	5750

Camping or other on-site accommodation

Some action packages, particularly packages that require a considerable amount of time to implement, may require that staff camp on the island rather than live aboard a boat or commute from a supply depot. The amount of time spent camping depends on the duration of the action package. Therefore, we have included camping in the Islands DSS as a sub-action.

The number of applications required per year for camping should be equal to the number of sub-actions that require staff to camp on the island and the number of trips per application should equal one. In the example below, staff are required to camp during ground baiting, ground shooting, pre-eradication field planning, trapping and post-eradication monitoring. Therefore, the number of

applications per year for camping is 5. Under the days required per trip, users should enter 'length of average sub-action'.

Action packages that involve camping should also include 'boat dropoff' as the method of transport for any sub-actions that require staff to camp. For sub-actions with boat dropoff the 'days required per trip' are the number of days required for the boat to travel to and from the island; whereas the number of trips per year depends on the duration of the sub-action. We have assumed that staff camping on an island long-term will need to be supplied with consumable goods (e.g., food) on a regular basis. In Western Australia, staff will rotate and be resupplied with goods once every two weeks (1/14=0.07). Hence, the number of trips required in the example below is 'terrain penalty*person days per ha*site size*0.07'. Every two weeks, the boat will use 1 day to travel to and from the island to resupply staff that are camping, until the relevant sub-actions are complete.

A	B	C	D	E	F	G	H	I	J	K
Threat ID	Action package	Specificati	Sub-actions	Number of applications required per year	Number of trips required per application	Days required per trip (not including time in transit)	Personnel required	Years committed	Start year	Transport
711	Vulpes vulpes eradication 4	2	ground baiting	1	terrain penalty*person days per ha*site size*0.07	1	4	1	1	boat dropoff
711	Vulpes vulpes eradication 4	2	ground shooting	1	terrain penalty*person days per ha*site size*0.07	1	4	1	1	boat dropoff
711	Vulpes vulpes eradication 4	2	post-eradication monitoring	1	terrain penalty*person days per ha*site size*0.07	1	2	2	2	boat dropoff
711	Vulpes vulpes eradication 4	2	pre-eradication field planning	1	terrain penalty*person days per ha*site size*0.07	1	2	1	1	boat dropoff
711	Vulpes vulpes eradication 4	2	trapping	1	terrain penalty*person days per ha*site size*0.07	1	4	2	1	boat dropoff
711	Vulpes vulpes eradication 4	2	camping	5	1	length of average sub-action	4	3	1	camping
711	Vulpes vulpes eradication 4	2	bait transportation	1	1	1	1	1	1	none
711	Vulpes vulpes eradication 4	2	pre-eradication office planning	1	0	0.3 FTE	1	1	1	none

The cost of using a boat to dropoff staff camping on an island should be entered into the *Boat Dropoff* spreadsheet, which has the same format as the *Charter Vessel* spreadsheet but should include a cost of using the vessel for one day.

Boat Dropoff.xlsx

	A	B
1	speed (km/h)	25
2	capacity (down)/days (rig	1
3	6	4750
4	12	6500

Additionally, users of the software should enter the cost of camping equipment in the *Equipment costs* spreadsheet. The daily cost of camping (e.g., food, overheads, field allowance) should be entered into the *Camping* spreadsheet, which has the same format as the *Charter vessel* spreadsheet. Do not enter the daily cost of camping into the *Consumables cost per ha* spreadsheet, otherwise the daily cost of camping will be multiplied by the total size of the island.

Camping.xlsx

	A	B
1	speed (km/h)	25
2	capacity (down)/days (right)	1
3	1	80

Step by step

1) Download James-cook-university.zip
2) Extract James-cook-university
3) Double click Islands DSS.exe
4) In Data setup select each requested spreadsheet, please 'Validate', fix noted errors.
5) Press 'Continue' to load spreadsheets.

6) When map interface opens navigate to ‘Options’, ‘Set Solver Inputs’
7) Select number of years and budget.
8) Add in any commitments and exclusions.
9) Press Continue
10) Get a cup of coffee this could take a few minutes.
11) Click Explore-Sites-All or selected sites
12) Click Explore-Introduced-All or selected threats
13) Click Actions to see all recommended actions
14) Copy paste results from GUI into a document if you want to review the results later. New runs of the software will override pre-existing results
15) Click Explore-Options-Open Solver log file to look for any errors

Want to try some new decision parameters?
1) Click Explore-Options-Set solver inputs
2) Change inputs
3) Click Continue
4) Get another cup of coffee this could take a few minutes.
5) Repeat steps above from Step 11.

You need to update the data in the input file?
1) Click Explore-Options-Set initial inputs
2) Repeats steps above from step 4.
3) If the data won’t update, turn off the software, and turn it on again.

Interpreting results

Common errors

1) Error: Species is detected on an island but abundance is zero.
   The Islands DSS rounds down all number less than 1 to zero. The calculations should still occur in the background, but the summary results may appear to be zero.
2) Error: There are no actions available for this species
   If an introduced species does not interact with any native species (cross-reference *Species populations in site* spreadsheet with *Species Interactions* spreadsheet) then there is no ecological benefit to be gained from removing the introduced species, so the software code filters out actions against the introduced species and returns the error.
   Alternatively, if the threat reproduces very rapidly, especially if it reproduces faster than they are removed by the available action packages then the solver will not recommend taking any action because you are just wasting money. Try adding a more intensive action package.

Assumptions

1) All cost estimates are rounded and may be subject to rounding errors.
2) The cost estimates for equipment are very high. We assume that the cost of equipment (e.g., machinery, computers, remote sensing cameras) is not subject to the size of the island. Whereas, the cost of consumables per ha is subject to the size of the island. This version of the Islands DSS does not include a ‘travelling salesman’ algorithm that allows people to travel directly from one island to another without first going back to the mainland. Therefore, it is assumed that a new set of equipment must be purchased for each action. If the software recommends you aerial bait for rodents on two different islands, then the cost estimates will reflect the need to buy two aerial bait buckets at $20,000 each. If an agency already owns the necessary equipment, then we recommend removing the cost of purchasing that equipment from the *Equipment costs* spreadsheet.

3) The solver will ignore species that do not live on a site, and sites without any species living on them.
    a. If there is no suitable habitat available then a species cannot reside on a management unit. The software will ignore species presence/abundance data if no suitable habitat is available on the management unit as we assume the species must be a vagrant or migratory and not permanently reside on the management unit. The error log will report the ID numbers of ignored species-management unit combinations.
4) Islands that do not host a feature we want to conserve are unlikely to be prioritised for management action regardless of the presence of threats.
    a. The goal of the software is to efficiently conserve native or protected features. We assume that managers will not waste funds controlling or eradicating a threat if the action will not improve the condition of a feature we want to conserve. Action against a threat that does not interact with any features may be recommended if there are no other more cost-effective actions to take.
5) All actions that occur within one year occur simultaneously.
    a. The software does not schedule actions within a year. If it is recommended that one particular *Action Package* occur on multiple management units within the same year; then the cost of purchasing equipment that may be used on multiple sites may be duplicated. The software assumes that all actions that occur within one year occur simultaneously.
6) Include temporary baseyards as Access locations in the *Sites* spreadsheet.
    a. The travelling distance to a management unit is measured from the Access location to the entry site for the management unit. The solver allows aircraft to make as many trips as necessary from an Access location to a site. Some specialised equipment such as aircraft may not be stored at the Access location. There is an additional cost of using specialised equipment. The cost calculations sum the distance from aircraft hangar to the access location and the access location to the island. If specialised equipment like aircraft is transported by boat to a temporary baseyard and several management actions may then occur out of the temporary baseyard; list the temporary baseyard as an Access location.
7) The software does not directly predict the impact of management actions on non-target species.
    a. The abundance of features may respond to management actions if their threat is mitigated (e.g., less rats may equal more seabirds). The software cannot predict the impact of management actions on non-target species (e.g., death of scavenging features due to the consumption of poisoned rodents) unless the user creates an *Action Package* for each non-target species with relevant *Action efficiencies*, *Cost of consumables per ha* (=0) and *Equipment costs* (=0).
8) If plant or animal abundance is ≤ 1% of the abundance of the previous year, then it is considered eradicated and the abundance is set to 0.
    a. We assume that such a dramatic and rapid drop in a species abundance is due to deliberate actions and highly likely to result in the extirpation of a species from a management unit. Any management technique entered into the *Action Packages* spreadsheet that is ≥ 99% effective is assumed to result in successful eradication. It is the responsibility of the software user to ensure that the sum of *Action efficiencies* for any given *Action Package* reflect reality.

Managing other threats (not invasive species)

The software developers have not tested the following ideas and recommend careful interpretation of the results if the software is used to prioritise the management of threats that are not invasive species. Users should have a thorough understanding of the *Community ecology model* the software uses to predict the impact threats may have on features.

Human disturbance as a threat

Human disturbance is a common threat preventing the normal social or reproductive behaviours of some species. Human disturbance is typically mitigated through closing access to sites at particular times of the year or education. These actions can be added to Action Packages, if the user can define the efficiency and cost of applying these actions in the relevant spreadsheets. The growth rate of human disturbance (*Species* spreadsheet) should be zero if there is no expected increase in the number of visitors to a site; or it may reflect an expected increase in the number of visitors per year (i.e. Growth rate = 0.05 equals 5% increase in the number of visitors per year).

Conserving ecosystems

In some cases managers may want to conserve distinct ecosystem types rather than a single species. A user may enter an ecosystem type as a feature (row) in the *Species* spreadsheet: but the growth rate (column D) should describe the rate of expansion of the whole ecosystem type; other rows in the *Species* spreadsheet should contain competing ecosystem types; the *Species Interactions* spreadsheet should describe the proportional reduction in the ecosystem type per individual in the threat population and is likely to be a very small number; and the habitat types listed in the *Sites* spreadsheet should not include the ecosystem type to be conserved, but rather soil subtrates.

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