Reserves.xla

An Add-in for Microsoft Excel to implement reserve selection algorithms

Version 1.0

Institute of Biological Sciences, University of Wales Aberystwyth

E-mail: rob@aber.ac.uk

URL: http://users.aber.ac.uk/rob/reserves/

Purpose:

This add-in implements a series of reserve selection algorithms for choosing sites to be included in a reserve network. Full details of the algorithms and suggested usages are given in Briers RA (2002) Incorporating connectivity in reserve selection procedures. *Biological Conservation* 103: 77-83.

A summary of the selection rules implemented by the various algorithms is given in Appendix 1 of this document.

This program works on the GIGO principle (Garbage In Garbage Out). Certain tests are performed on the data that are entered into the program to check the validity of the input. However the program is essentially dumb i.e it will perform calculations on whatever data are given to it. If it is given inaccurate input, the output will also be wrong. It is up to the user to ensure that valid data are used in selection procedures. Full details of the required input are given below

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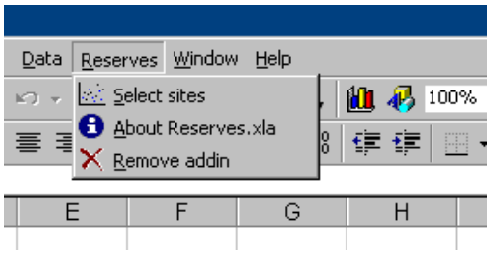
System requirements:

Reserves.xla is written in Visual Basic for Applications (VBA). It runs from within Microsoft Excel version 97 or 2000 and has been tested under Windows 95, 98, 2000 and NT4. If has not been tested on Windows/Excel XP, but I do not forsee any problems. It will NOT work under version 5 or 95 of Excel. Most of the VBA code was originally written in Excel 95, but due to changes in the Excel Object Model between 95 and 97 I have standardised the code to run under Excel 97+. If you require a version that runs under older releases of Excel please e-mail me (see above).

Running the program:

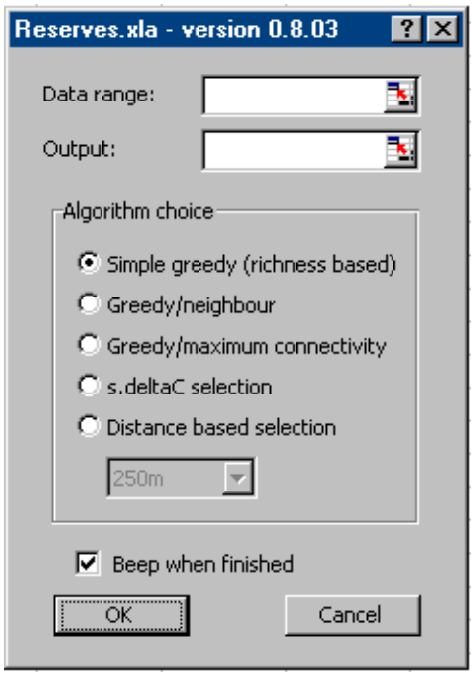
To use the add-in, start Excel, then select File..Open…, locate the directory in which the file was placed and double click on the filename **Reserves.xla**. It is recommended that the add-in is not permanently installed via Tools…Add-Ins… as this method uses up memory which could be used for other purposes.

Opening the file results in the creation of a new top level menu Reserves. Clicking on this menu gives you three choices:



Select sites

Clicking on this brings up the dialog pictured below, into which the details of the data and algorithm required are entered.



Data range:

Click on the box and then select the worksheet data which are to be used in the selection process using the mouse to click and drag over the required range. The format required for the program is indicated below.

	A	B	C	D
1	Sitenames	Site 1	Site 2	Site 3
2	X coordinates	333	234	232
3	Y coordinates	232	423	332
4	Species 1	1	0	0
5	Species 2	1	0	1
6	Species 3	0	1	1

Coordinate data are assumed to be in metres but different units can be used provided that they come from a Cartesian coordinate system.

Species presence or absence at a particular site should be indicated by a 1 (presence) or 0 (absence) in the appropriate place in the data matrix. The program performs basic checks on the validity of the data. When the program is run, if there are any non-numeric data in the species presence-absence matrix, or species are not present at any site, a warning will be given, the offending data highlighted in yellow and the selection procedure will be terminated.

Output range:

Click on the box and then select a single cell in a worksheet where the output will be placed. If more than one cell is selected, the top left cell is used as the starting point for the output. The size of the area required for output depends upon the number of sites selected. It is recommended that the output is placed in a blank worksheet due to the fact that any data in the way of the output will be overwritten. If this is going to occur, the user will be alerted, but the data will still be overwritten anyway.

Algorithm choice:

Click on the appropriate button to choose which algorithm is to be used. A brief summary of the algorithms is given below. For full details of the algorithms see Briers (2002) and Appendix 1 of this document.

Greedy – selects sites on the basis of site species richness i.e the site with the highest number of species that are not currently in the reserve is selected at each step.

Greedy/neighbour – as above only if sites have equal numbers of species, the site that is nearest to a site already included in the reserve network is chosen.

Greedy/max connectivity – as above only if there is a tie between sites the sites which maximizes mean connectivity of the reserve network is chosen. Connectivity, *C* is defined here as

$$\sum_{j>i} \exp^{-d_{ij}}$$

where d_{ij} is the distance between sites *i* and *j*. Mean connectivity is *C*/*n* where *n* is the number of sites included in the network.
Note that although distances between sites are assumed to be in metres, as a result of numerical limits on the size of values that can be stored in a double precision variable, distances are converted to kilometres for the calculation of *C*.

s.delta(Δ)*C* – for each candidate site, the number of species that would be added to the reserve by the site (*s*) is multiplied by the change in connectivity that would result from addition of the site (delta*C*). The site added has the maximum value of *s*.delta*C*.

Distance based selection – at each step, all the sites that are within a specified distance d_{max} of currently selected sites are located and the site which adds the maximum number of species added. If no sites can be located within d_{max} the selection process is terminated.

Beep when finished:

As the selection process can take some time, checking this box will cause the program to alert the user when the process has been completed.

Click on OK to start the selection process.

About Reserves.xla

This gives details of the program version and the URL of the website where the program is distributed and the author can be contacted.

Remove add-in

Clicking on this closes the add-in and removes the Reserves menu. Note: if the add-in has been installed using Tools…Add-Ins…, this will not un-install the add-in, but will simply remove the menu, which will re-appear next time Excel is started. The add-in will still remain in memory.

Output details:

The program will produce a list of sites included in the final reserve network, in the order in which they were selected. The X and Y coordinates of the sites are given, along with the number of species added to the reserve by each site and the cumulative number of species represented by the network.

Additionally a summary of the selection process is given, detailing the final connectivity of the reserve network (*C*), the number of sites selected (*n*), from which the mean connectivity can be calculated (*C*/*n*) (see Briers 2002), along with the number of times (if any) that random selection was invoked and the time taken to complete the selection process.

Important notes – *please read!*

Compatibility with other programs.

The algorithms implemented by **Reserves.xla** are fairly computationally intensive, particularly with large data sets, due to the number of calculations carried out in the selection process. The program will basically use as much of the CPU processing time and free memory as it can get hold of. Therefore it is not particularly friendly to a multitasking environment (i.e when multiple applications are running). Most of the time, if other applications are running this will simply increase the processing time. However printing at the same time as running the algorithms is NOT a good idea – the printer may freeze-up and the print job may be affected. This is not a bug, simply a result of the memory allocation to different processes running concurrently in Windows.

Time taken to complete selection.

The time taken to complete a selection depends on the size of the data set and the speed of the computer on which the program is being run. The examples given in Briers (2002) (131 sites and 256 species) took between 2 and 6 minutes to complete, depending on the algorithm used, on a 200Mhz Pentium II.

Random number generation

Several procedures are used by the algorithms to break ties between sites, but if there is still a choice eventually one site will be chosen at random from the candidate sites. **Reserves.xla** uses the Visual Basic **Rnd** function to generate random numbers – this pseudo-random number generator uses the linear-congruential method to generate the numbers. The **Rnd** function is not the best generator around in terms of the statistical properties of the random numbers produced, but for the purposes here it is likely to be sufficient. For more information on the method used by VB/VBA, see: http://support.microsoft.com/support/kb/articles/Q231/8/47.asp

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Acknowledgements:

Parts of the VBA code of **Reserves.xla** were adapted from macros written by Andy Brewer and Don Whittle to whom thanks are due for sharing code and ideas for this and other projects. The code for the menu was adapted from macros available at John Walkenbach's excellent Excel/VBA website (http://www.j-walk.com/ss/excel).

APPENDIX 1: Description of rules and algorithms used in reserve selection procedures.

A Description of rules used in algorithms

Rule	Description
Richness	Choose site containing the highest number of species not already represented in the network.
Representation	Choose site supporting species with the lowest total representation in the reserve network i.e. the number of times the species present at the site have been represented in the sites already selected.
Neighbour	Choose site which is nearest to a site already selected.
Maximum connectivity	Choose site which maximises the mean connectivity of the reserve network, $\overline{C}$.
Maximum sΔC	Choose site with the maximum value of sΔC i.e. the number of unrepresented species added by the site multiplied by the change in connectivity resulting from the addition of the site to the network.
Maximum s of neighbours	Find all sites within specified maximum distance, d_{max} of currently selected sites and select site with the highest number of unrepresented species.
Random	Choose site at random from sites available for addition to network.

B Algorithm descriptions

Algorithm 1 (Greedy)	*Richness*, ties broken by *Representation*, further ties by *Random*. Repeat until all species represented.
Algorithm 2 (Greedy/Neighbour)	*Richness*, ties broken by *Neighbour*, further ties by *Representation*, further ties by *Random*. Repeat until all species represented.
Algorithm 3 (Greedy/Maximum connectivity)	*Richness*, ties broken by *Maximum connectivity*, further ties by *Representation*, further ties by *Random*. Repeat until all species represented.
Algorithm 4 (*s*ΔC selection)	a) Select first site based on *Richness*. b) Subsequent sites selected by *Maximum s*ΔC, ties by *Representation*, further ties by *Random*. Repeat b) until all species represented.
Algorithm 5 (Distance based selection)	a) Select first site based on *Richness*. b) Subsequent sites selected by *Maximum s of neighbours*, ties by *Representation*, further ties by *Random*. Repeat b) until all species represented or no more sites are within specified d_{max}.

APPENDIX 2: End User Licence Agreement.

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In addition the user may publish texts that include or comment results obtained with the Software but only if these results or comments are accompanied by one of the following references:

Briers, R A (2002) Incorporating connectivity into reserve selection procedures. Biological Conservation 103: 77-83

Briers, R A (2001) Reserves.xla - An Add-in program for Microsoft Excel to implement reserve selection algorithms - Version 1.0

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