Agenda Day 2

February 4, 2015 – National Conservation Training Center

9:00 – 9:45	Talk IV - How does Marxan find good solutions?
9:45 – 10:15	Talk V - Zonae Cogito and Simulated Annealing demonstration
10:15 – 10:45	Begin Interactive session IV - Running Marxan with ZC and understanding output files
10:45 – 11:00	Morning break
11:00 – 12:30	Continue Interactive session IV - Running Marxan with ZC and understanding output files
12:30 – 1:30	Lunch
1:30 – 2:15	Talk VI - Marxan case study application
2:15 – 3:00	Interactive session V - Calibration, configuration editor, and cluster analysis
3:00 – 3:30	Talk VII – Introduction to Marxan with Zones
3:30 – 4:30	Continue interactive sessions, question/answer session, extra activities

Zonae Cogito:

Decision Support Software for Marxan

Delivered by: **Trevor Wiens**

Materials provided by:

PacMARA

info@pacmara.org

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Based on materials developed by:

Matthew Watts, Lindsay Kircher, and Hugh Possingham

Applied Environmental Decision Analysis
Commonwealth Environmental Research Facility

The University of Queensland
Australia

What is ZC?

Name means "to think about zones"

Designed for use with Marxan / Marxan with Zones

- Decision support
- Database management
- Uses open-source GIS
- Available for **free** on www.uq.edu.au/marxan

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What can you do with ZC?

Decision support system designed to help you use Marxan in many ways:

- Edit Marxan files
- Change Marxan parameters
- Run Marxan
- View results
- Automate creation of files, cluster analysis
- And more!

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Scenario Management

- Explore a different problem definition by changing a major parameter:
  - Target levels
  - Cost layer
  - Amount of clumping
- Each **new scenario** requires a **new Marxan database**
  - Input files
  - Output folder
  - Shapefile

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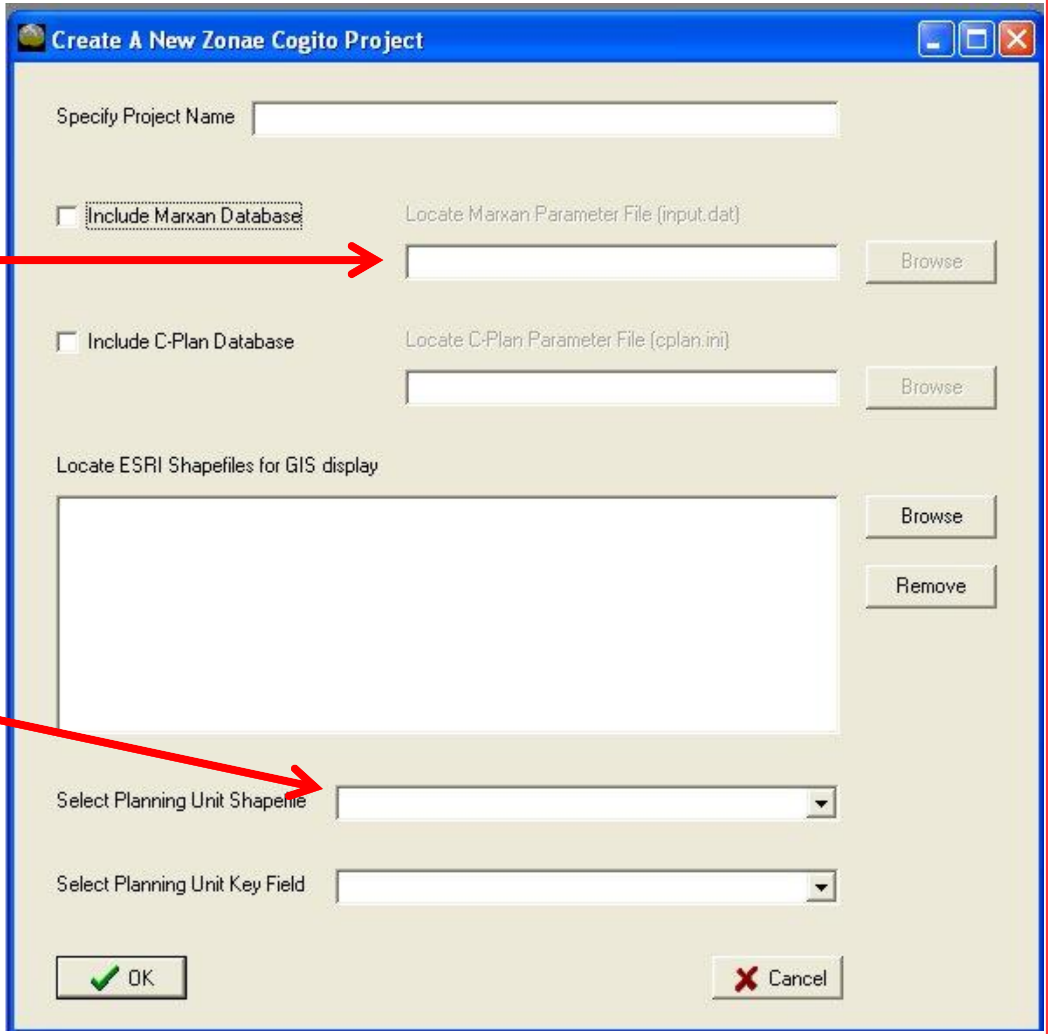
Create a Project

Link to your Marxan database with the correct **input.dat**

Link to your **planning unit shapefile** for that scenario



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Input.dat

```
input.dat - Notepad
File  Edit  Format  View  Help

Input file for Annealing program.

This file generated by Inedit.exe.
written by Ian Ball and Hugh Possingham.
iball@maths.adelaide.edu.au
hpossing@maths.adelaide.edu.au

General Parameters
VERSION 0.1
BLM  1.00000000000000E+0000
PROP  5.00000000000000E-0001
RANDSEED -1
BESTSCORE -1.00000000000000E+0000
NUMREPS 10

Annealing Parameters
NUMITNS 1000000
STARTTEMP -1.00000000000000E+0000
COOLFAC  6.00000000000000E+0000
NUMTEMP 10000

Cost Threshold
COSTTHRESH  0.00000000000000E+0000
THRESHPEN1  1.40000000000000E+0001
THRESHPEN2  1.00000000000000E+0000

Input Files
INPUTDIR input
SPECNAME spec.dat
PUNAME pu.dat
PUVSPRNAME puvsp.dat
BOUNDNAME bound.dat

Save Files
SCENNAME output
SAVERUN 3
SAVEBEST 3
SAVESUMMARY 3
SAVESCEN 0
SAVETARGMET 3
SAVESUMSOLN 3
SAVELOG 2
SAVESNAPSTEPS 0
SAVESNAPCHANGES 0
SAVESNAPFREQUENCY 23
OUTPUTDIR output

Program control.
RUNMODE 1
MISSLEVEL  1.00000000000000E+0000
ITIMPTYPE 0
HEURTYPE -1
CLUMPTYPE -1
VERBOSITY 1
SAVESOLUTIONMATRIX 3
```

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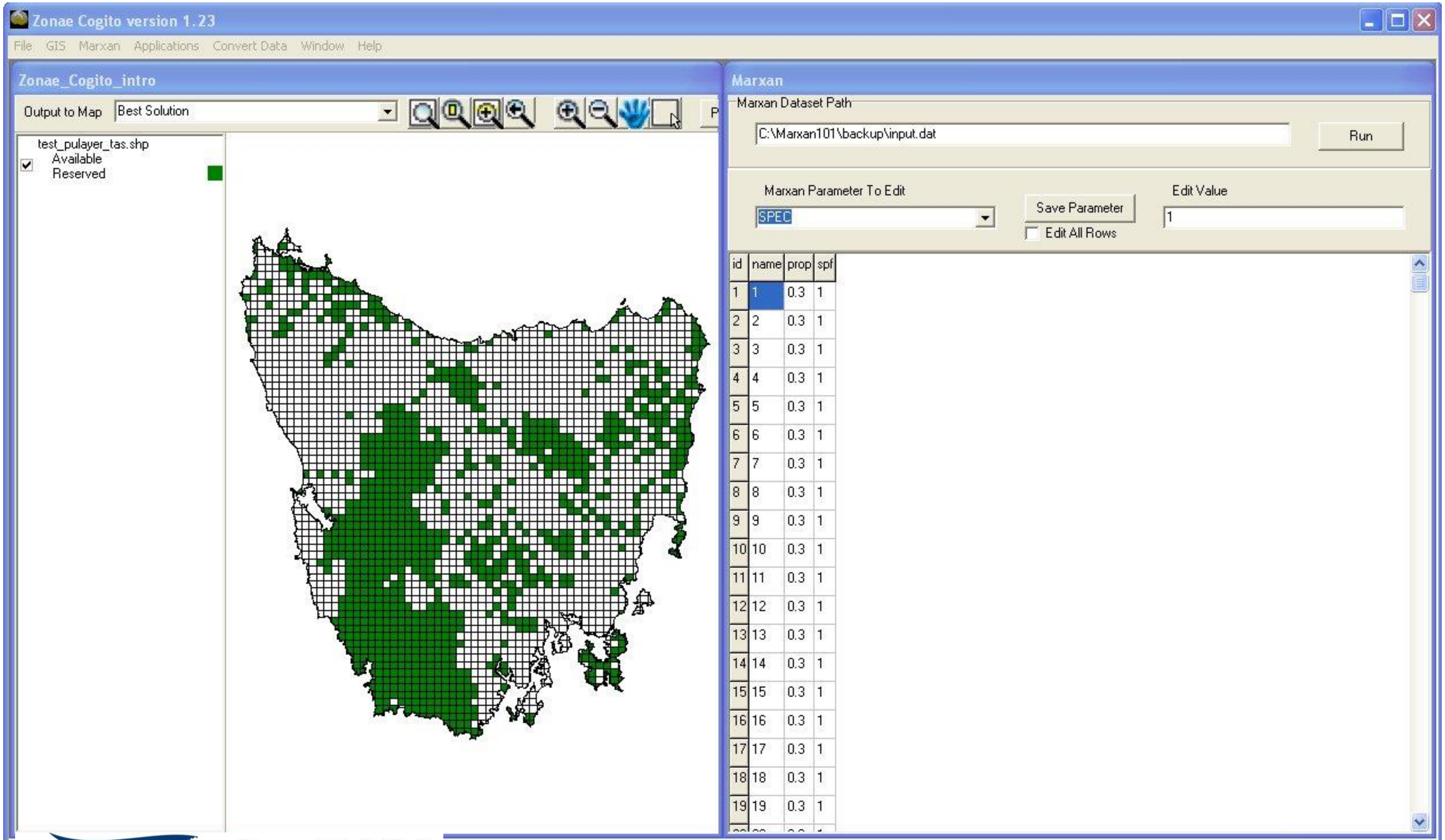
Edit, run and view maps in ZC



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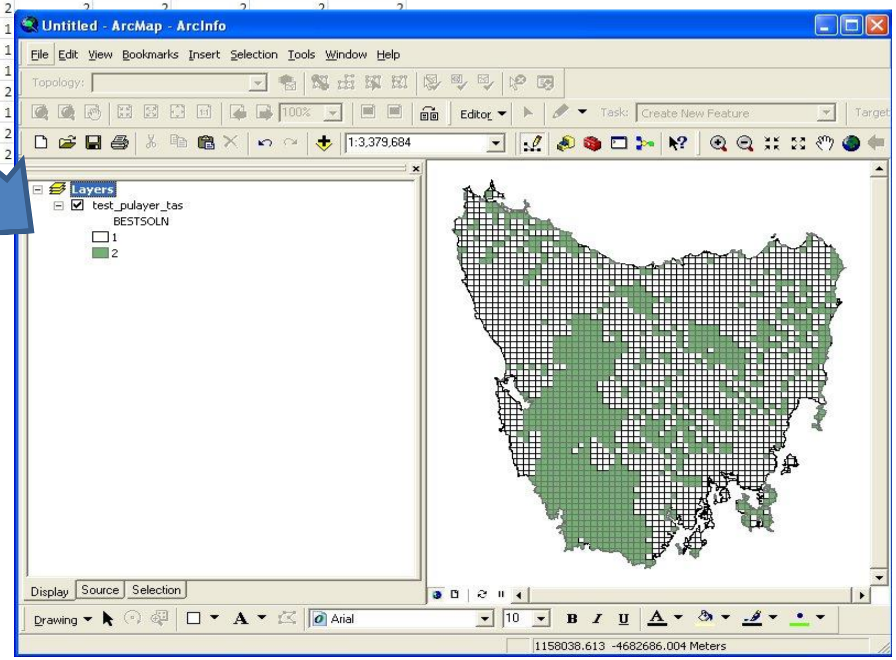
Results write to planning unit shapefile

test_pulayer_tas.DBF

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	PUID	SSOLN	BESTSOLN	SSOLN1	SSOLN2	SOLN1	SOLN2	SOLN3	SOLN4	SOLN5	SOLN6	SOLN7	SOLN8	SOLN9	SOLN10
2	1	10	2	0	10	2	2	2	2	2	2	2	2	2	2
3	2	10	2	0	10	2	2	2	2	2	2	2	2	2	2
4	3	10	2	0	10	2	2	2	2	2	2	2	2	2	2
5	4	10	2	0	10	2	2	2	2	2	2	2	2	2	2
6	5	10	2	0	10	2	2	2	2	2	2	2	2	2	2
7	6	10	2	0	10	2	2	2	2	2	2	2	2	2	2
8	7	10	2	0	10	2	2	2	2	2	2	2	2	2	2
9	8	10	2	0	10	2	2	2	2	2	2	2	2	2	2
10	9	10	2	0	10	2	2	2	2	2	2	2	2	2	2
11	10	10	2	0	10	2	2	2	2	2	2	2	2	2	2
12	11	10	2	0	10	2	2	2	2	2	2	2	2	2	2
13	12	10	2	0	10	2	2	2	2	2	2	2	2	2	2
14	13	10	2	0	10	2	2	2	2	2	2	2	2	2	2
15	14	10	2	0	10	2	2	2	2	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16	15	0	1	10	0	1	1	1	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
17	16	1	1	9	1	1	1	1	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18	17	0	1	10	0	1	1	1	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
19	18	10	2	0	10	2	2	2	2	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20	19	5	1	5	5	2	2	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
21	20	10	2	0	10	2	2	2	[illegible]	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
22	21	10	2	0	10	2	2	2	[illegible]	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



- This only happens if using ZC to run Marxan
- Note that here PUs with value “1” means not selected and “2” selected.

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Output Files

- **Best Solution (output_best)** shows which planning units were selected in the solution with the lowest objective function score

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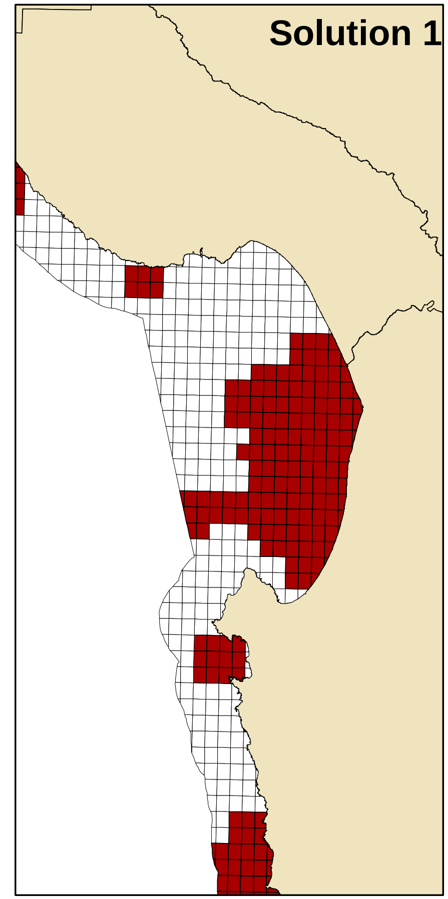
Individual Solutions

planning unit	solution
2818	1
2817	1
2816	1
2815	1
2814	1
2813	1
2802	1
2801	1
2800	1
2799	1
2798	1
2797	1
2796	1
2795	1
2790	1
2783	1
2782	1
2781	1
2780	1
2779	1
2778	1
2777	1
2776	1
2775	1
2774	1
2773	1
2769	1
2768	1
[illegible]	[illegible]

- Use: Every solution has a file that can be displayed as a map
- The planning units chosen in **individual solutions** are **complementary**
- **The "Best" Solution** shows planning units selected in the solution with the lowest objective function score



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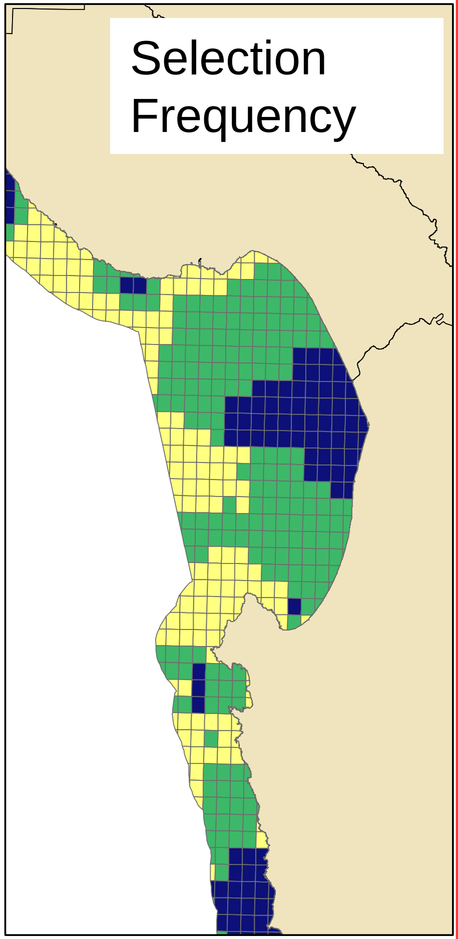
Output Files

- **Summed Solution / Selection Frequency (output_ssoln)** shows the frequency of each planning unit being chosen in a run

Selection Frequency

planning unit	number
0	0
1	100
2	0
3	0
4	0
5	0
6	1
7	1
8	1
9	0
10	9
11	0
12	0
13	0
14	0
15	0
16	1
17	7
18	14
19	10
20	2
21	0
22	0
23	0
24	78
25	0
26	0
27	0
28	99

- Ssoln (Summed Solution) files show the **selection frequency** of each planning unit
- **Selection frequency** is not a solution, and collections of highly selected areas are not complementary
- Use: A map of this file can help identify areas that are always, often, rarely, or never included across all of the Marxan runs in a scenario



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Output Files

- **Summary (ouput_sum)** for each run: score, cost, boundary length, etc.

  Use:

  - Compare runs
  - Check for missing values and shortfall (calibrate SPF)

Run Number	Score	Cost	Planning Units	Boundary Length	Penalty	Shortfall	Missing Values
1	2636563.574	848742.3672	1071	1767534.056	20287.15072	5800000	3
2	2625178.127	790617.9712	953	1831974.256	2585.899475	176000	2
3	2628049.619	845337.61	975	1779790.759	2921.249483	601000	4
4	2639164.932	895154.944	927	1732433.295	11576.69286	3363000	3
5	2658528.819	776195.4352	892	1878587.506	3745.87856	1254000	4
6	3040574.019	761764.194	890	2271826.781	6983.044812	1244000	4
7	2487140.025	889157.0442	1014	1570987.97	26995.01112	9395000	4
8	2752941.109	820237.6892	1006	1922383.661	10319.75855	4148000	5
9	2707027.335	772874.076	947	1929911.198	4242.060815	1462000	4
10	2699710.214	828851.634	1032	1867552.43	3306.14996	1325000	5
11	2531502.152	866077.348	1002	1653242.094	12182.7094	2801000	5
12	2570115.839	890678.051	1090	1676393.126	3044.66219	599000	2
13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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Output Files

Conservation Feature	Feature Name	Target	Amount Held	Occurrences Held	Target Met
64	64	3319470000	3318160000	167	no
63	63	56844000	58500000	44	yes
62	62	25701000	26440000	41	yes
61	61	10113000	11870000	33	yes
60	60	121407000	123740000	50	yes
59	59	39120000	40110000	33	yes
58	58	282363000	346200000	54	yes
57	57	68100000	68320000	33	yes
56	56	127896000	128230000	85	yes
55	55	21336000	21780000	62	yes
54	54	5394000	7360000	30	yes
53	53	28002000	37010000	80	yes
52	52	75750000	104200000	79	yes
51	51	712482000	795810000	97	yes
50	50	176550000	180350000	41	yes
49	49	330450000	539850000	192	yes
48	48	164520000	382460000	128	yes
47	47	205044000	316040000	163	yes
46	46	233520000	269150000	179	yes
45	45	82515000	90210000	121	yes
44	44	896790000	1965720000	204	yes
43	43	325536000	327490000	83	yes
42	42	160455000	262810000	137	yes
41	41	320169000	555730000	138	yes
40	40	63876000	162220000	134	yes
39	39	111879000	112580000	139	yes
38	38	23880000	25280000	72	yes
37	37	17235000	30840000	91	yes
36	36	1406688000	1756100000	163	yes
35	35	1385310000	1385830000	224	yes
34	34	269781000	309870000	170	yes
33	33	239439000	372070000	166	yes
32	32	13170000	27450000	40	yes

- **Missing Value (output_mv**“NoSolution”**)** for each solution shows the amount of features met, if target were met, etc.

  Use:

  - For a particular solution, you can examine conservation feature target achievement

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Output Files

output_log.dat - Notepad

File Edit Format View Help

```
       Marxan v 2.4

   Marine Reserve Design via Annealing

   Coded by Ian Ball, modified by Matthew Watts
   Written by Ian Ball and Hugh Possingham

ian.ball@aad.gov.au
h.possingham@uq.edu.au
m.watts@uq.edu.au

   Marxan website

http://www.uq.edu.au/marxan


Entering in the data files
   There are 12221 Planning units.
  12221 Planning Unit names read in
  62 species read in
  36754 connections entered
41059 conservation values counted, 757702 big matrix size, 5.41888% density of
Time passed so far is 0 secs

Pre-processing Section.

Run 1   Using Calculated Tinit = 41224200.0000 Tcool = 0.99851711
  Creating the initial reserve

  Init:Value 140561463335.0 Cost 20178412805.0 PUs 6074 Connection 24076610.1

  ThermalAnnealing:Value 34036388876.1 Cost 12272476058.0 PUs 3414 Connection

  Iterative Improvement:Value 34036388859.1 Cost 12272476041.0 PUs 3413 Connec
```

- **Log (output_log)** of what you see on the screen when Marxan is running
- Indicates which Run or Solution is the **best solution**.

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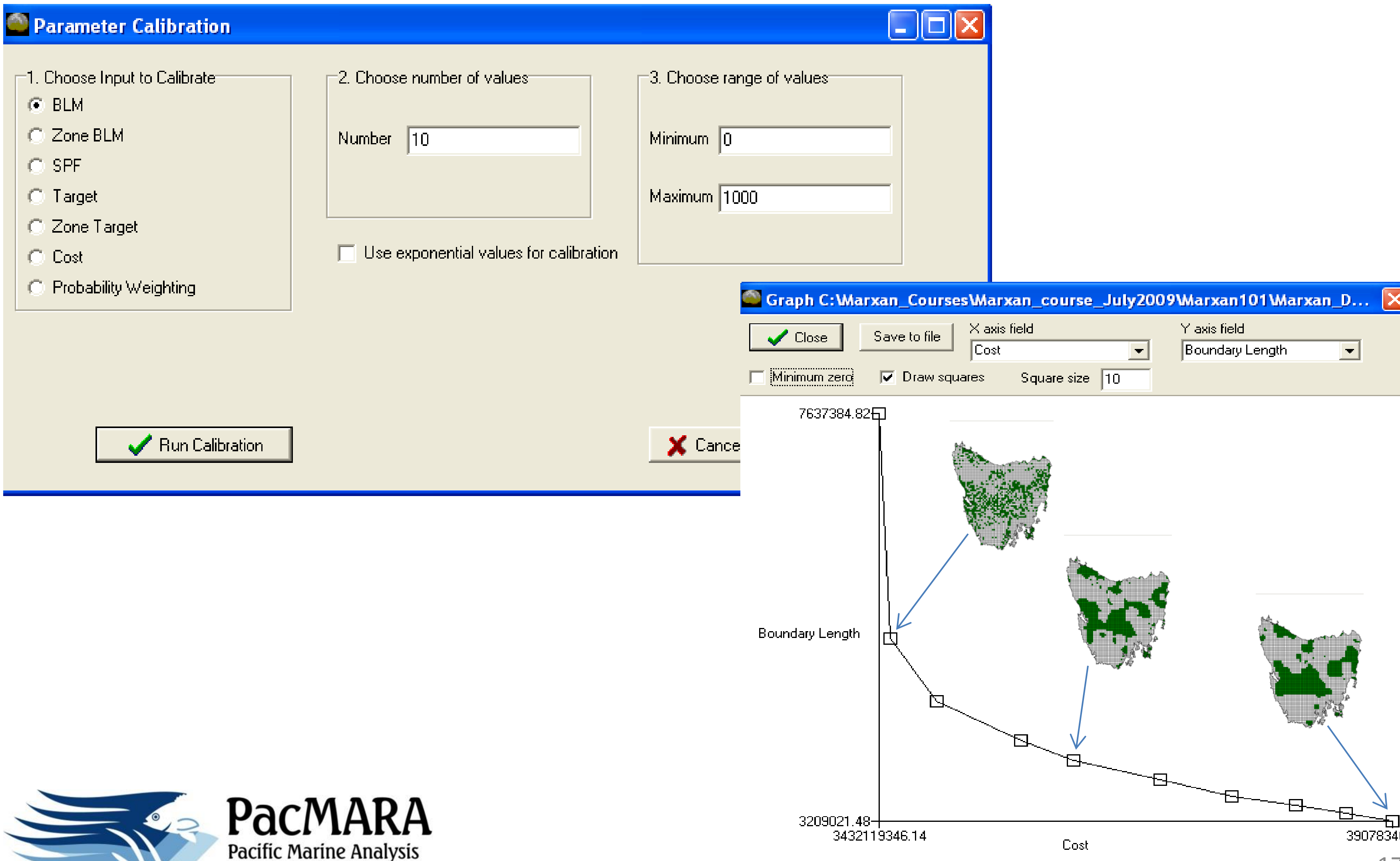
Calibration Tool



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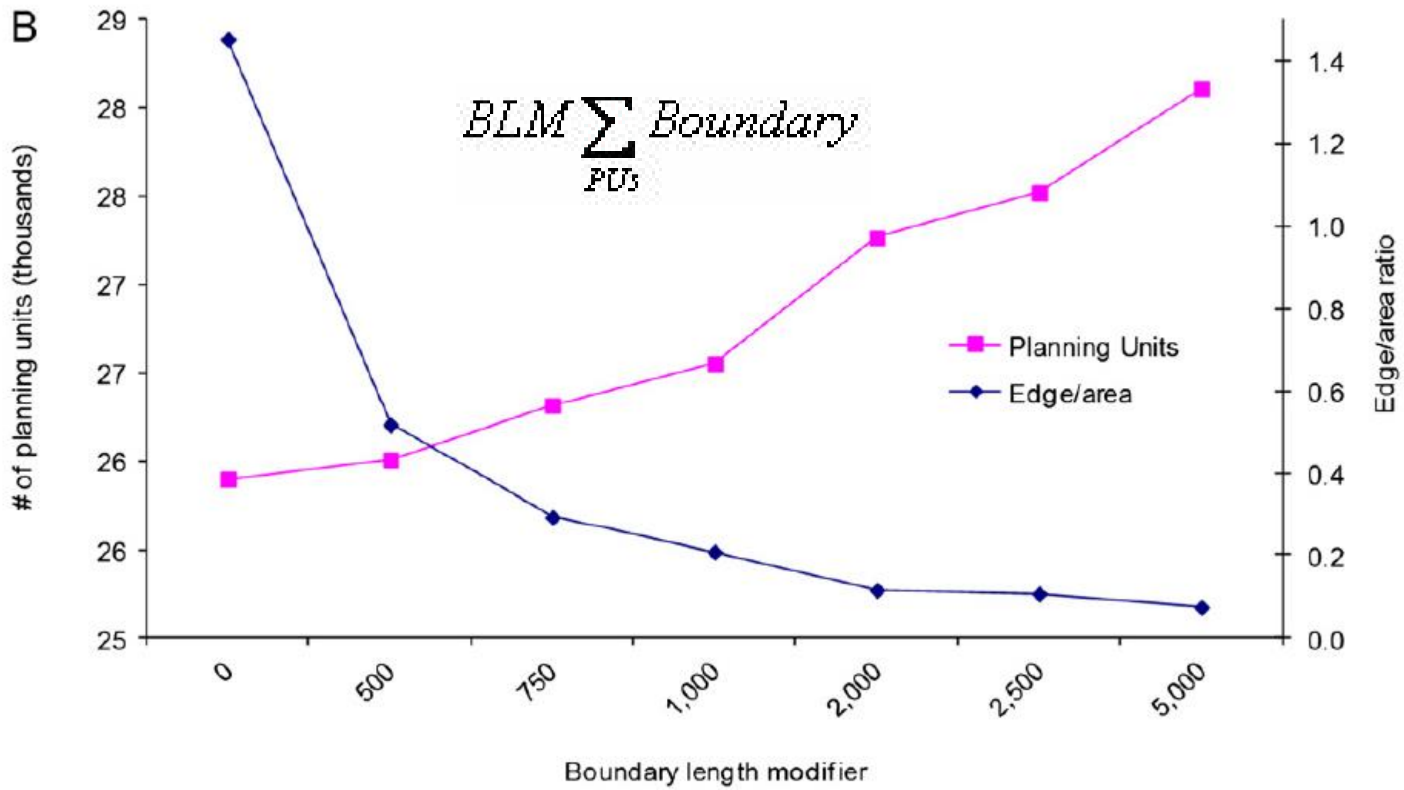
Boundary Length Modifier (BLM)

- BLM controls the size of "clumps" in a Marxan solution
- As the BLM ↑, the size of the clumps ↑ (and ↑ cost)



Source: Ban et al., 2013

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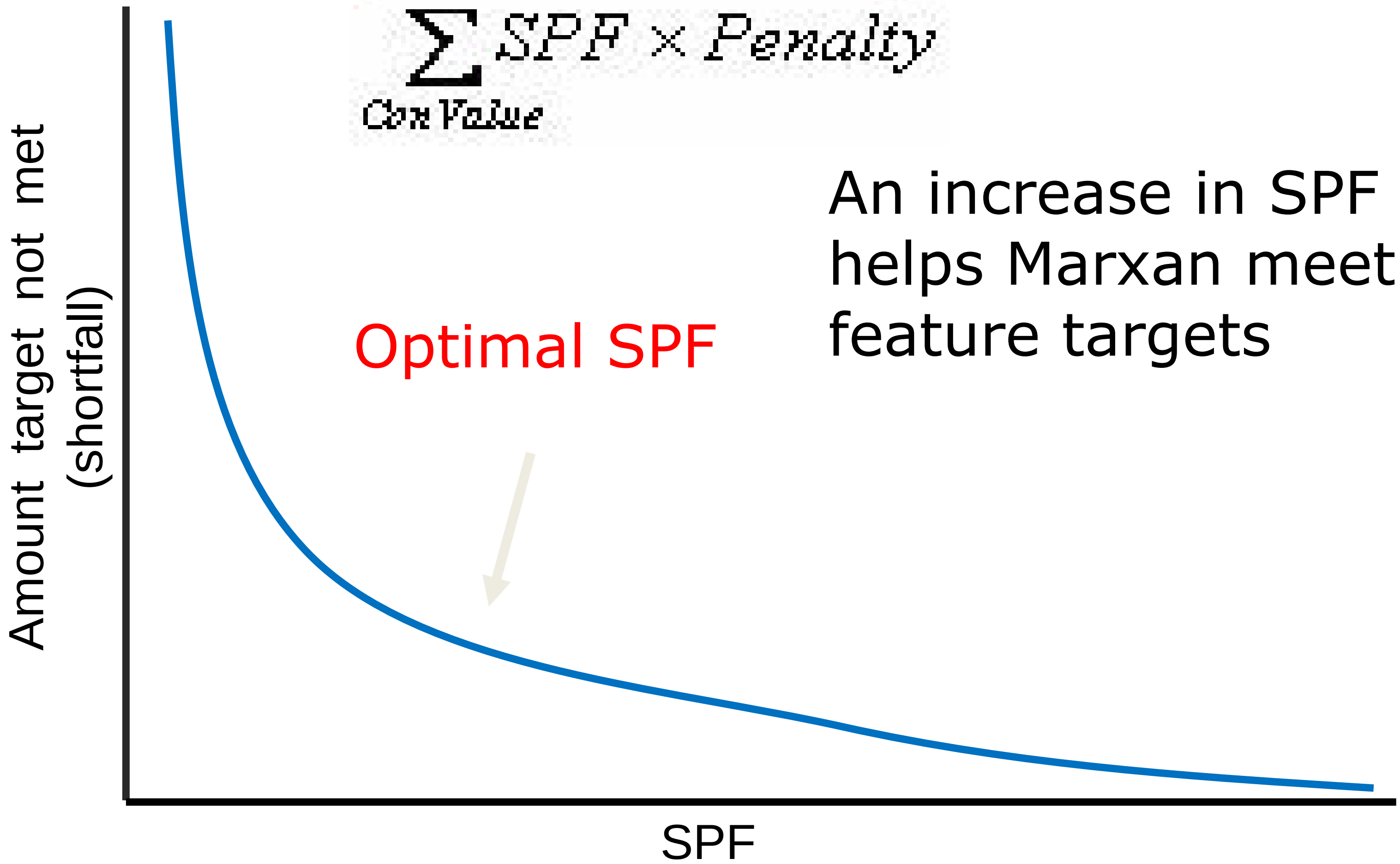
Species Penalty Factor (SPF)

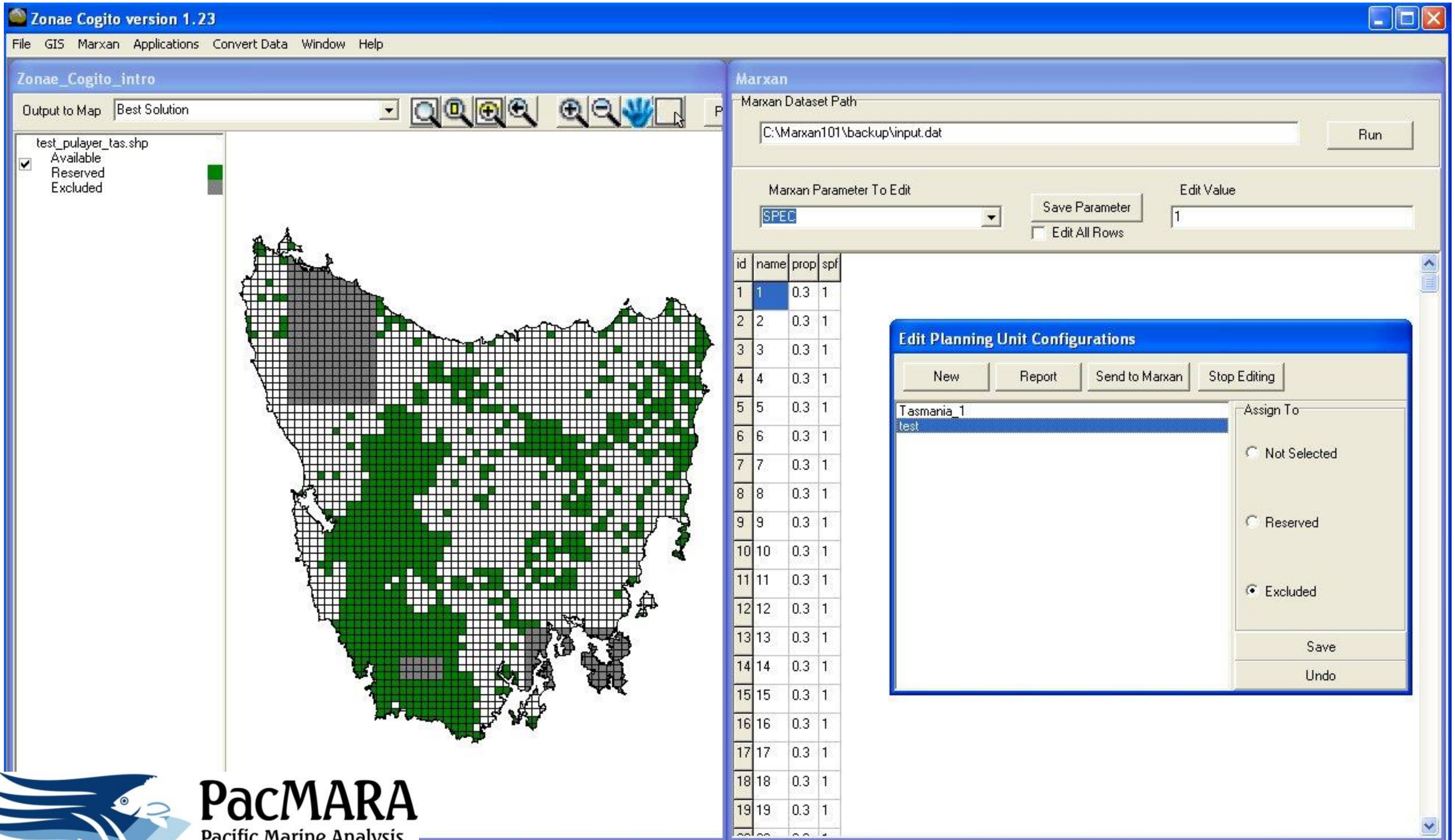
$$\sum_{ConValue} SPF \times Penalty$$

An increase in SPF helps Marxan meet feature targets



Configuration Tool

Edit solutions and report on new configuration



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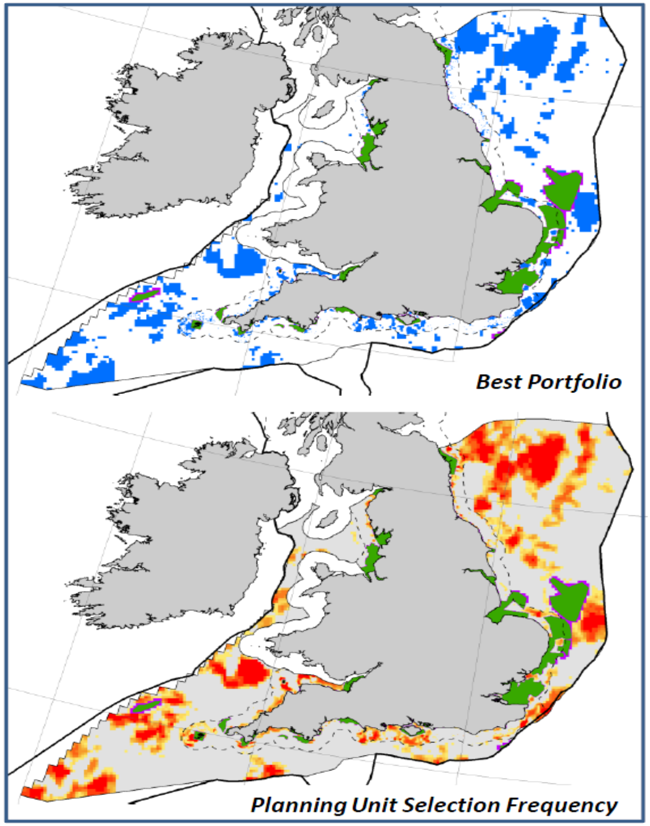
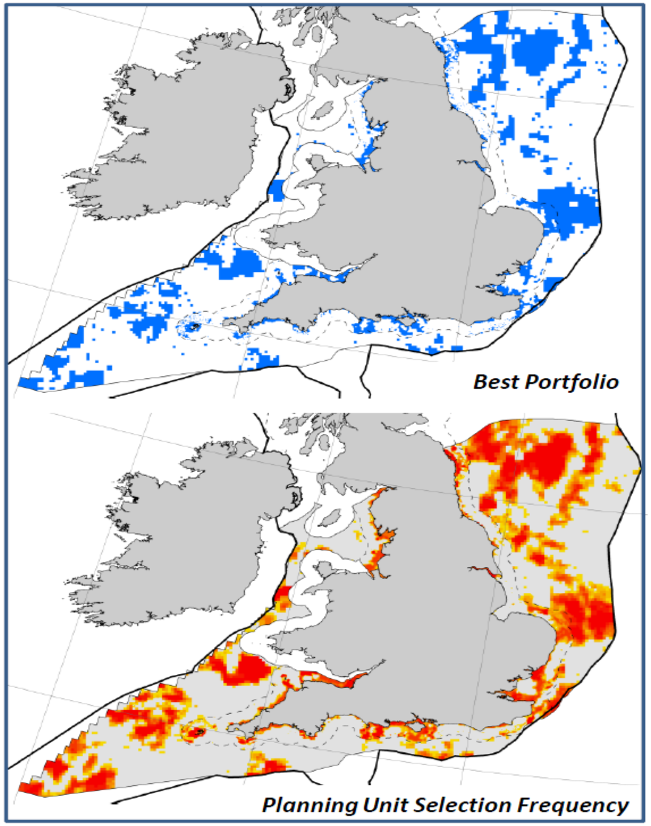
Including Existing Reserves in Marxan

Locking in existing reserves



All PUs are included



Source: Metcalfe, 2011

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Cluster analysis of Marxan solutions

- Links Marxan with the statistical package, R
- Computes similarity of Marxan solutions
- Identifies reserve configurations that are spatially different from each other using an automated hierarchical cluster analysis

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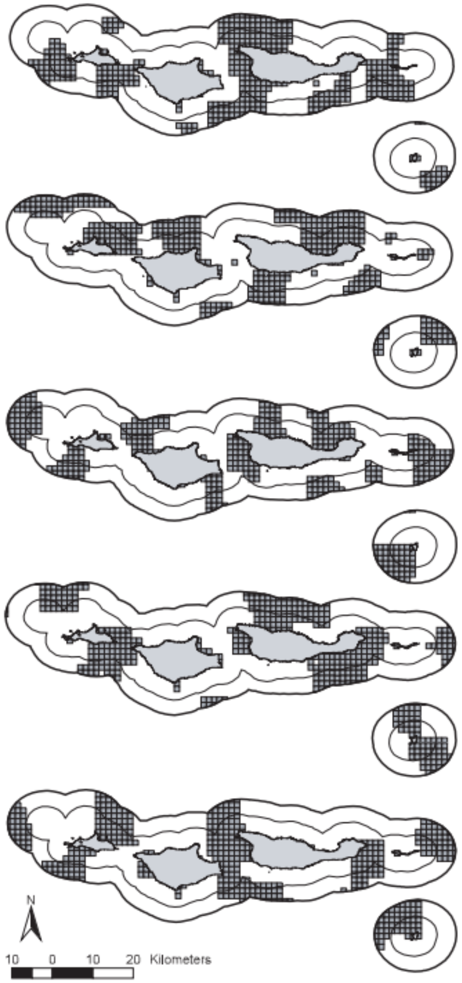
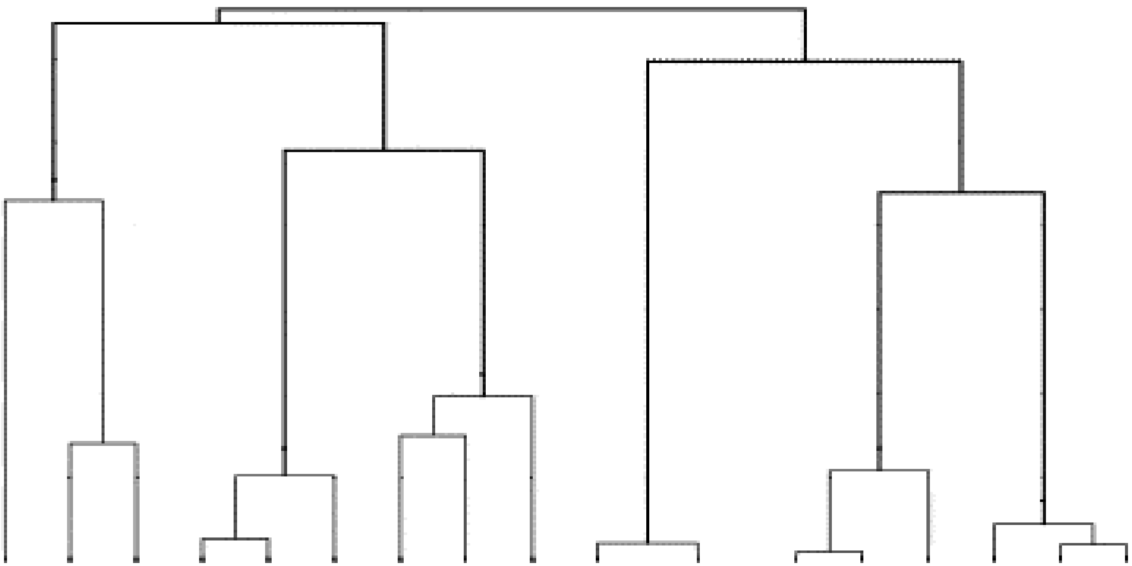
Channel Islands NMS

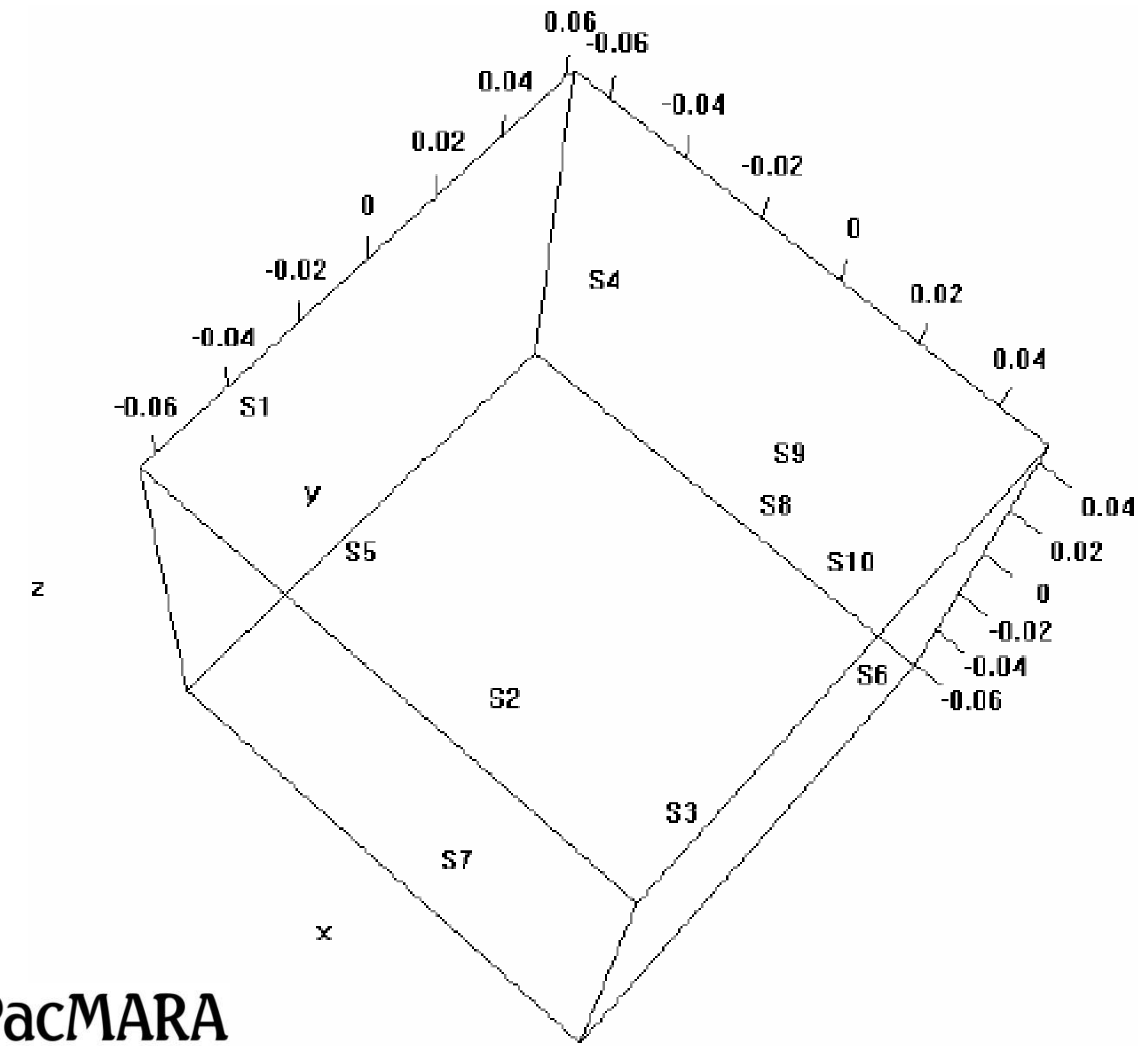
Cluster analysis of Marxan solutions



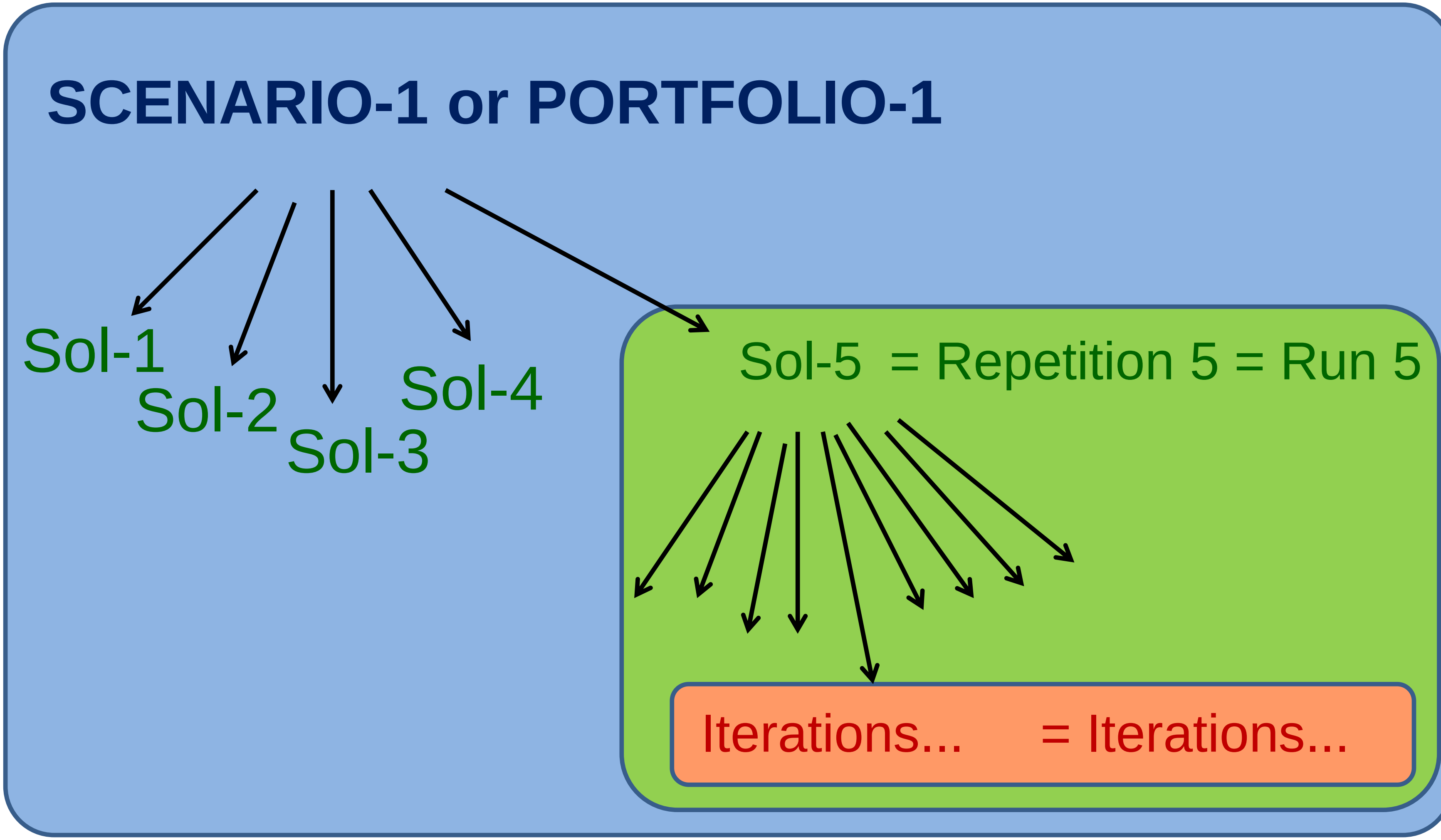


Bray-Curtis dissimilarity matrix - Dendogram with 17 solutions

3d Plot – Explore solutions



Terms Used in Marxan



Connectivity Columns in output_sum.txt

- With Marxan 2.43 there were changes to connectivity columns in output_sum.txt
- There are all measures of the edge values within a solution
- They can be used to gain insight into the relative efficiency of different solutions

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Connectivity Column Definitions – 1

- Connectivity_Total = Connectivity_In + Connectivity_Edge + Connectivity_Out
- Connectivity_Total is the sum of all paired boundary lengths in solution space
- Connectivity_Edge is the Boundary_Length; the sum of all edges within a solution

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Connectivity Column Definitions – 2

- Connectivity_In is the sum of all paired and adjacent boundaries within a solution
- Connectivity_Out is the sum of all paired boundaries not in the solution
- Connectivity_In_Fraction = Connectivity_In / Connectivity_Total (a rough measure of efficiency)

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