HABITAT & BIODIVERSITY MODELER IN TERRSET:

RESERVE SELECTION WITH MARXAN

Habitat & Biodiversity Modeler in Terrest

RECAP

- Habitat suitability/ Species Distribution Modeling
- Impact analysis: habitat assessment, habitat change analysis of Bob Cat
- Biodiversity analysis (Alpha, Beta and Gamma Diversity)
- Corridor planning, conservation planning

Reserve selection using MARXAN

Marxan (Ball and Possingham 2000):

A planning software for reserve selection for a particular species target at the lowest cost by the evaluation of current reserve networks.

Author And Year	TITLE
Carvalho et al., 2010	Simulating the effects of using different types of species distribution data in reserve selection.
Januchowski-Hartley et al., 2011	A systematic approach for prioritizing multiple management actions for invasive species.
Drever et al., 2019	Conservation through co-occurrence: Woodland caribou as a focal species for boreal biodiversity

In Marxan, optimization of land is done by heuristic methods. Simulated annealing is the main optimization.

Simulated annealing is the optimizer but the objective function is helps to find what is desirable in a reserve system. The lower the value of the objective function is the better the reserve. Objective function value get by economic cost of the reserve, boundary area and a penalty.

EXERCISE 6-6: HBM: RESERVE SELECTION WITH MARXAN

Data:

\Data\HBM\Marxan folder

Marxan software (version 1.8.10) download
http://www.uq.edu.au/marxan/

Objective of exercise:

To explore the use of Marxan to evaluate Bolivia's current protected area network, and select a new protected area network to fulfill a specific species area target.

10 Input maps

1. Planning units map

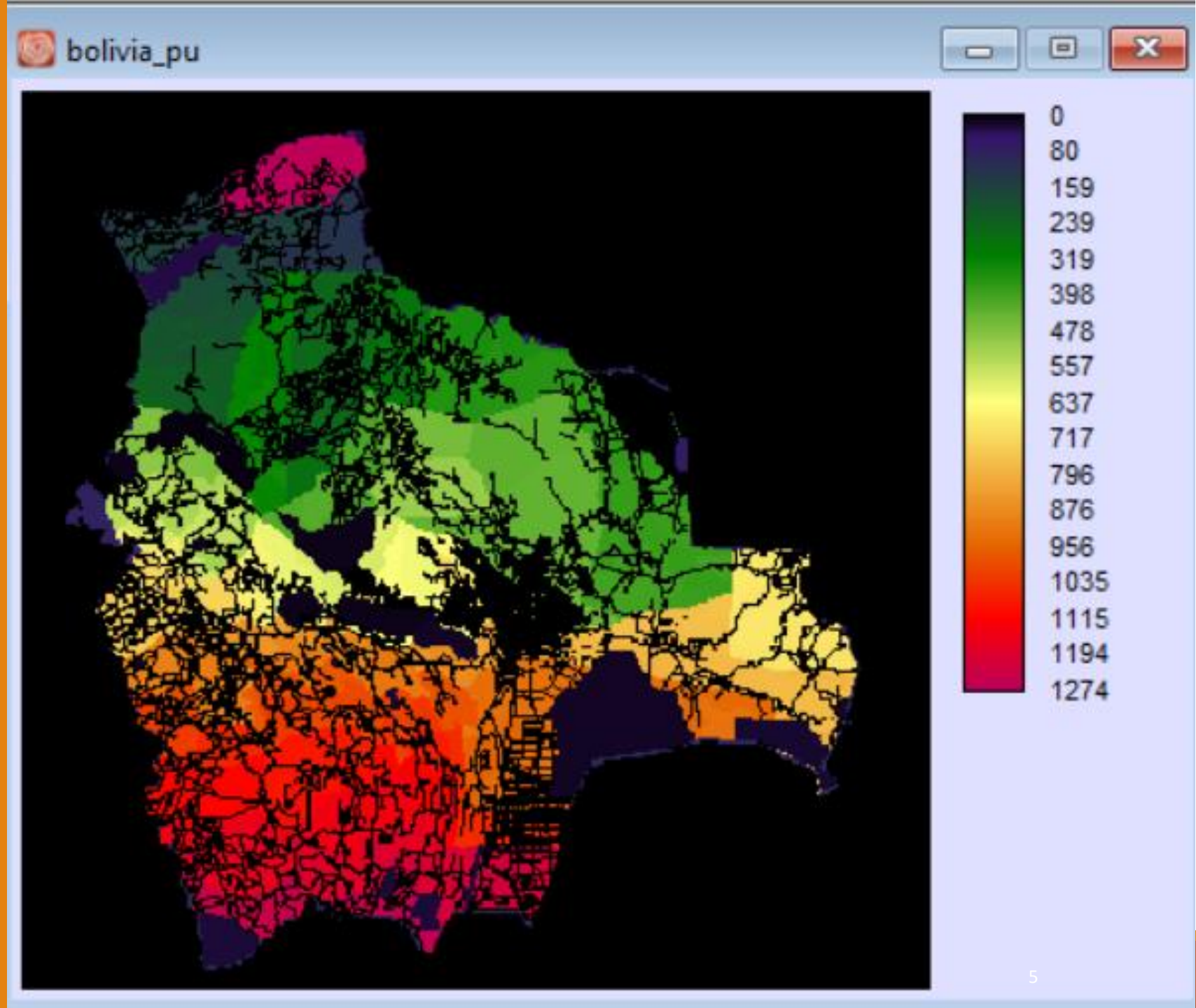
The base map for the land allocation to define the protected areas.

This map can be considered the minimum mapping unit (MMU) for the protected area allocation.

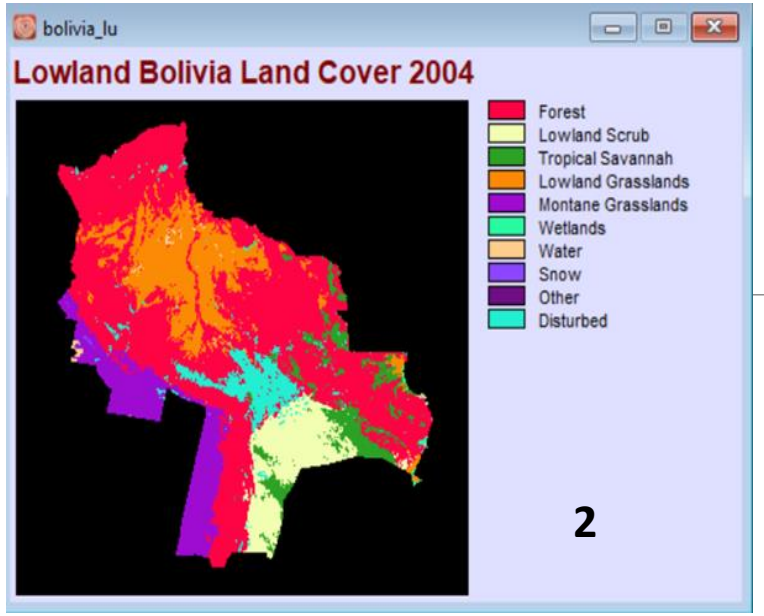
MMU of this image is square pixel level by using the administrative units of river basins, ecoregions, and land use to identify the different planning units.

During a MARXAN run, each planning unit will be evaluated on whether it should be included in the reserve network.

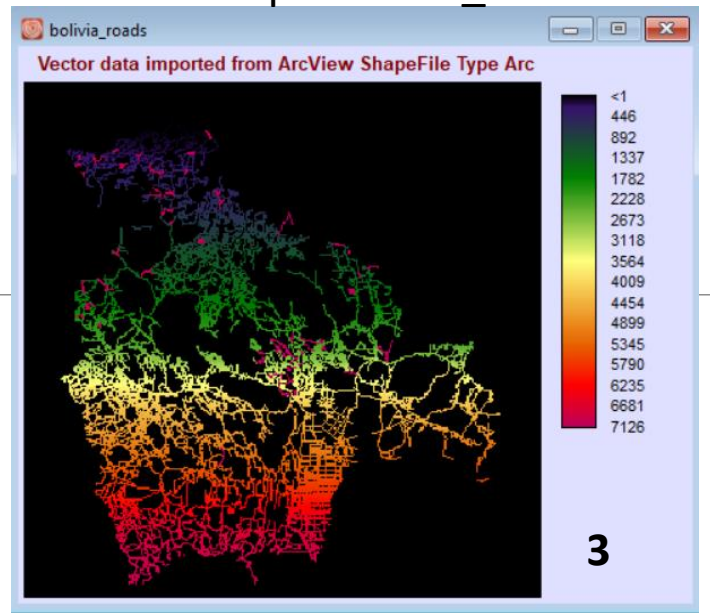
This has created at provinces level, then subdivided the provinces based on basins and ecoregions. Finally, the information on land use, roads and protected areas have added.



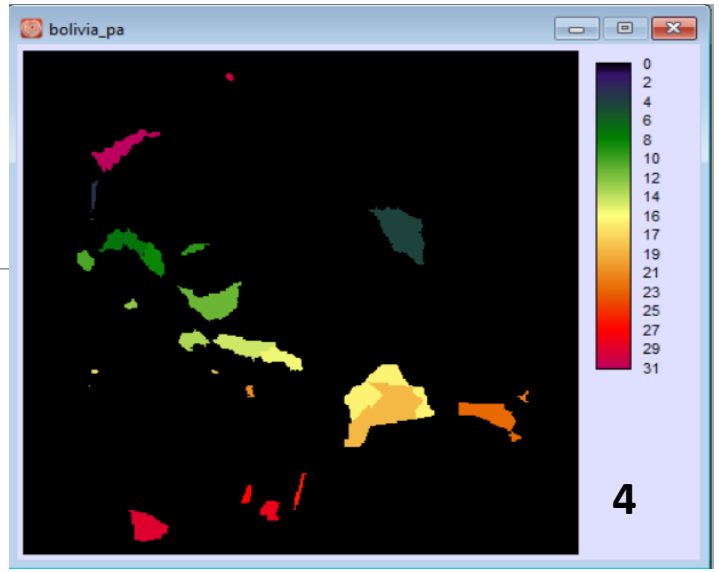
2. The map BOLIVIA_LU.



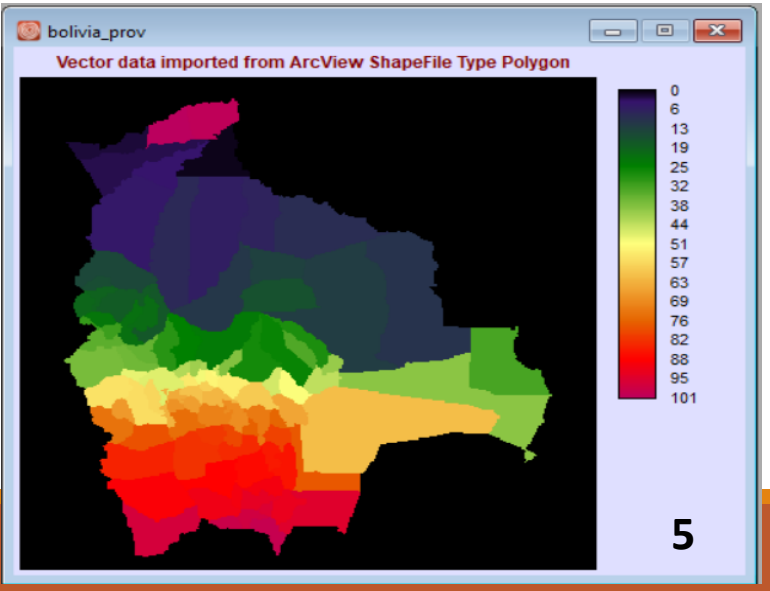
3. The map BOLIVIA_ROADS.



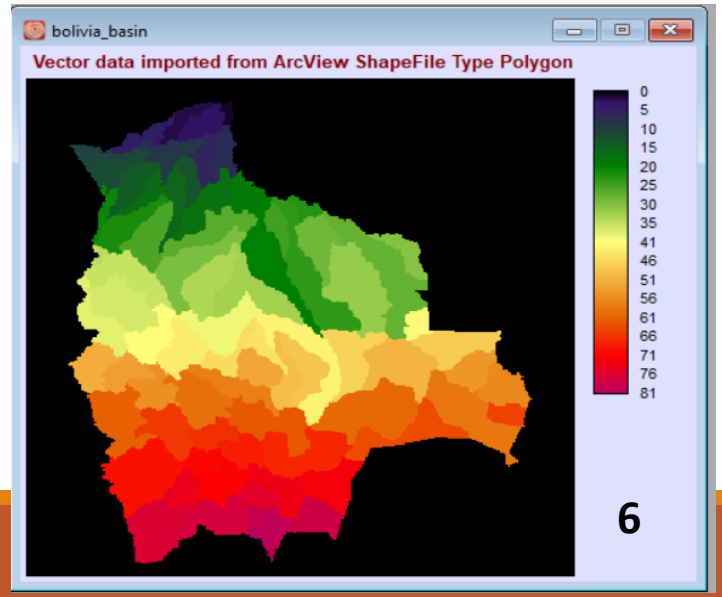
4. The map BOLIVIA_PA.



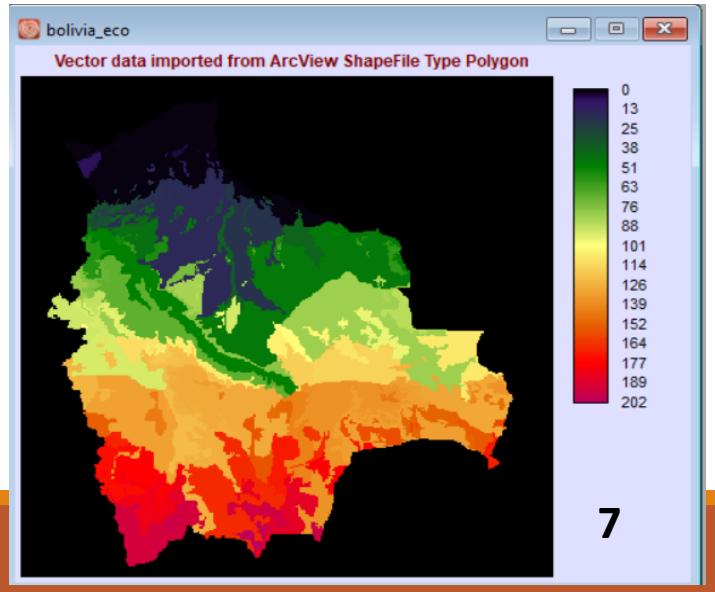
5. The map BOLIVIA_PROV.

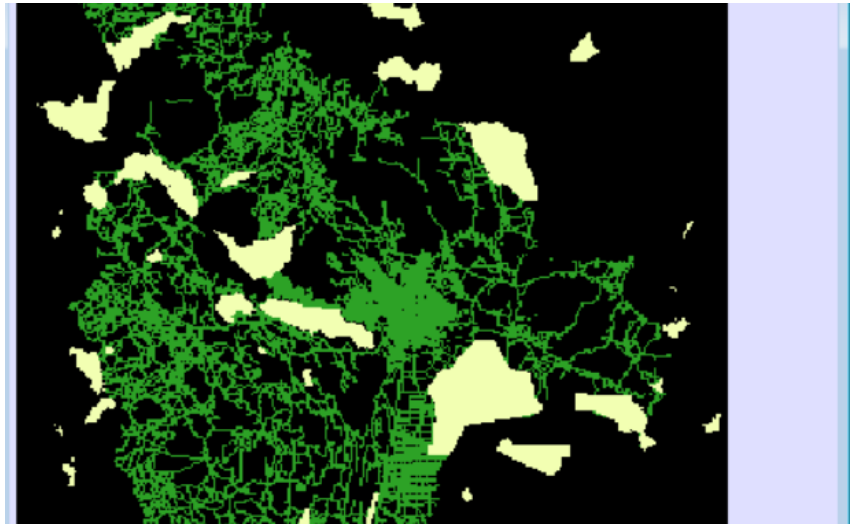


6. The map BOLIVIA_BASIN



7. The map BOLIVIA_ECO





8. Species distribution maps:

73 species dataset In a raster group file BOLIVIA_ENDEMICS.RGF

9. Planning unit tenure (or planning unit status):

The planning unit tenure map used in this analysis is derived from the land use map of Bolivia, the map of protected areas and the road map.

0: Locations that can be allocated to a reserve network

1: Locations that can be allocated to a reserve network

2: The current reserve network

3: Excluded areas/disturbed areas

10. The map PU_TENURE_PAASSESS

A modified tenure map to determine whether the current reserve network is protecting Bolivia's endemic diversity

Parameters

Along with the input images, Marxan requires the following parameters.

01

Target: The target indicates how much of the species range needs to be protected and is specified in the number of cells.

02

Species penalty factor (SPF): This is a value given to a particular species or group of species to indicate its importance for inclusion in the reserve network. The higher the value, the more likely that species' target is met

03

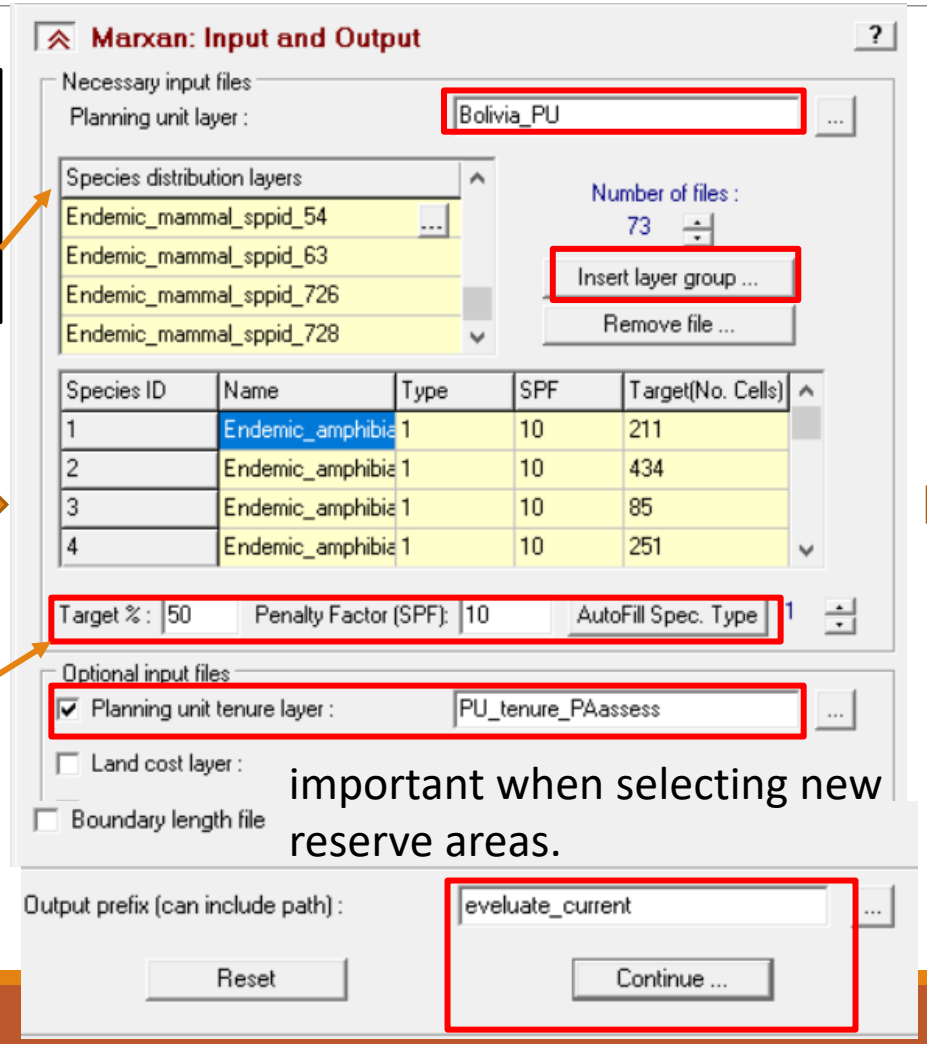
Boundary length file: If **reserve compactness** is important and you want to consider this for reserve selection, select the checkbox.

Determining whether the current reserve network is protecting Bolivia's endemic diversity

BOLIVIA_ENDEMICS.RGF
(73 endemic species
in Bolivia; 16 mammals,
21 birds, 36 amphibians)

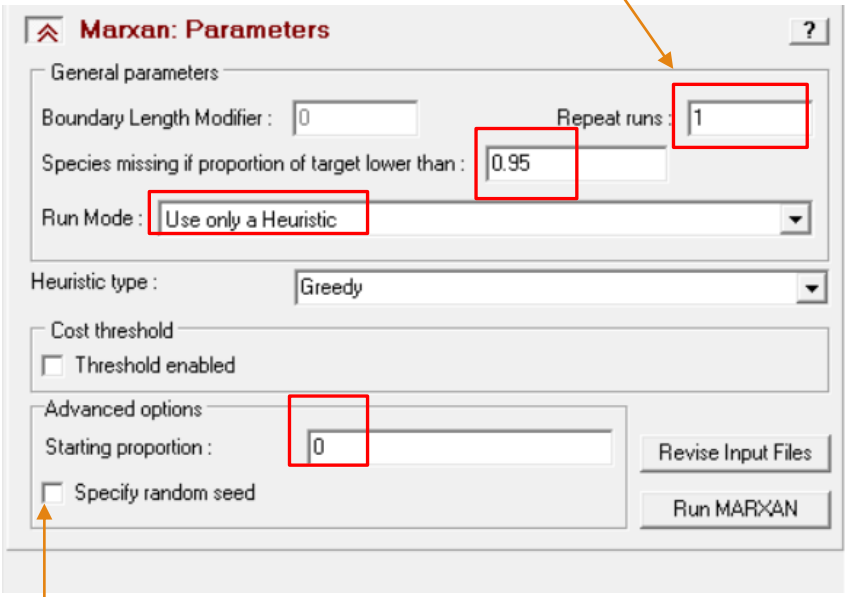
Input

a uniform target and SPF



important when selecting new reserve areas.

just evaluating the current protection network



No land cost layer or boundary length file.

Output :Evaluation of current reserves

The total area of final reserves is 5019
The total area of existing reserves is 97699
The total area of newly added reserves is -92680
The total number **of unprotected species** under current parameters is 55

From the 73 endemic species in Bolivia (16 mammals, 21 birds and 36 amphibians), the protection target of 50% of range is fulfilled (target met) ;

for only **18 species**.

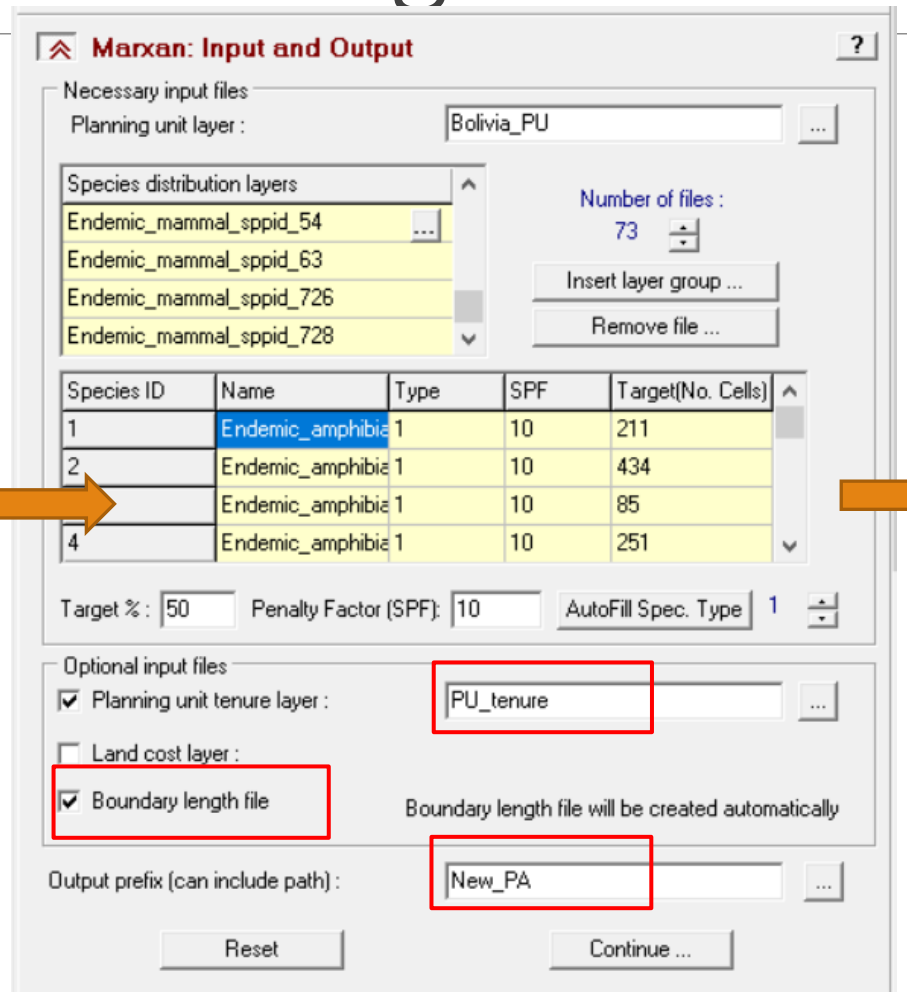
- Two mammals, 1 bird and 15 amphibians meet the target,
- representing 12.5% of the endemic mammals,
- 4.76% of the endemic birds
- 41.67% of the endemic amphibians

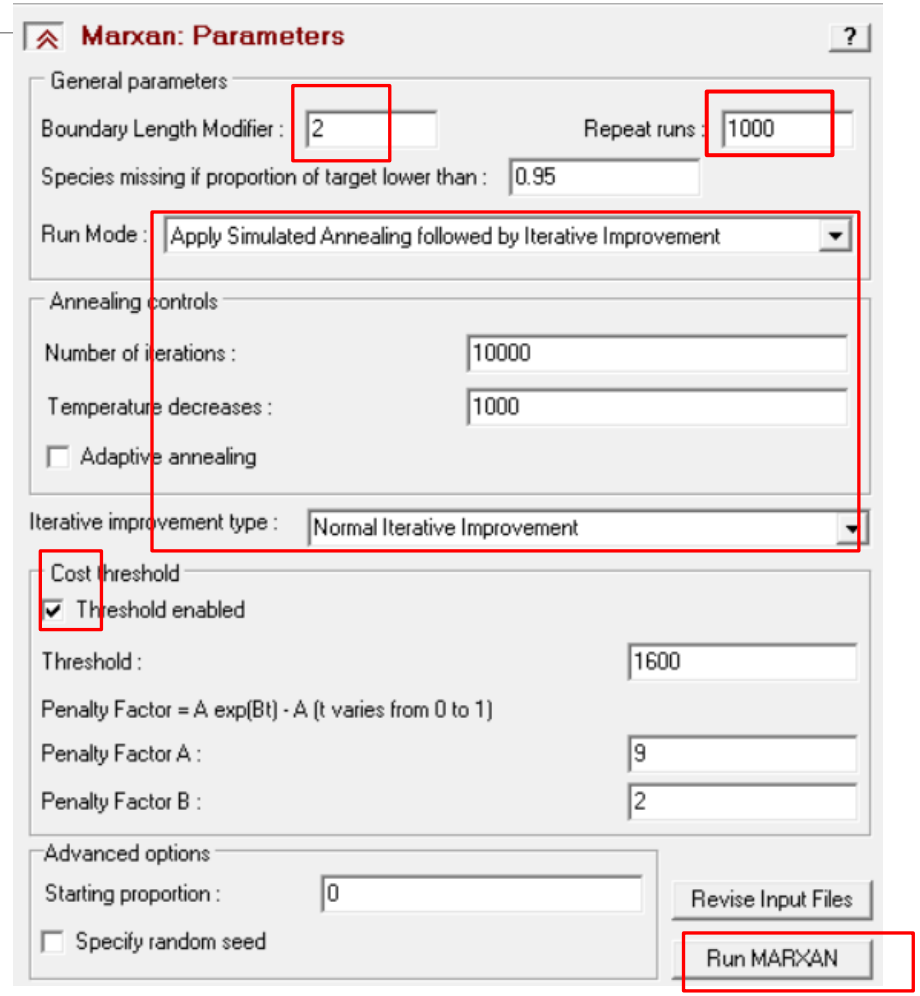
Total Protected Species within 50% target at the current reserve network

24.66%

To identify new protected areas to meet specified target at lowest cost

Input





Output : Identification of new protected areas

The total area of final reserves is 14315
The total area of existing reserves is 7345
The total area of newly added reserves is 6970
The total number of **unprotected species** under current parameters **is 7**

From the 73 endemic species in Bolivia;

the new conservation system would allow the protection of 50% of ranges (target met)

for 65 species.

- Twelve mammals, 19 birds and 34 amphibians met the target,
- 75% of the endemic mammals
- 90.5% of the endemic birds
- 94.4% of the endemic amphibians

Total Protected Species within 50% target from New reserve network

86.3%

Map of Cost-efficient reserve networks for all species in Bolvia

Clustered groups of planning units/ protect reserve network map= Best fit solution map

This comprised **273 planning units**

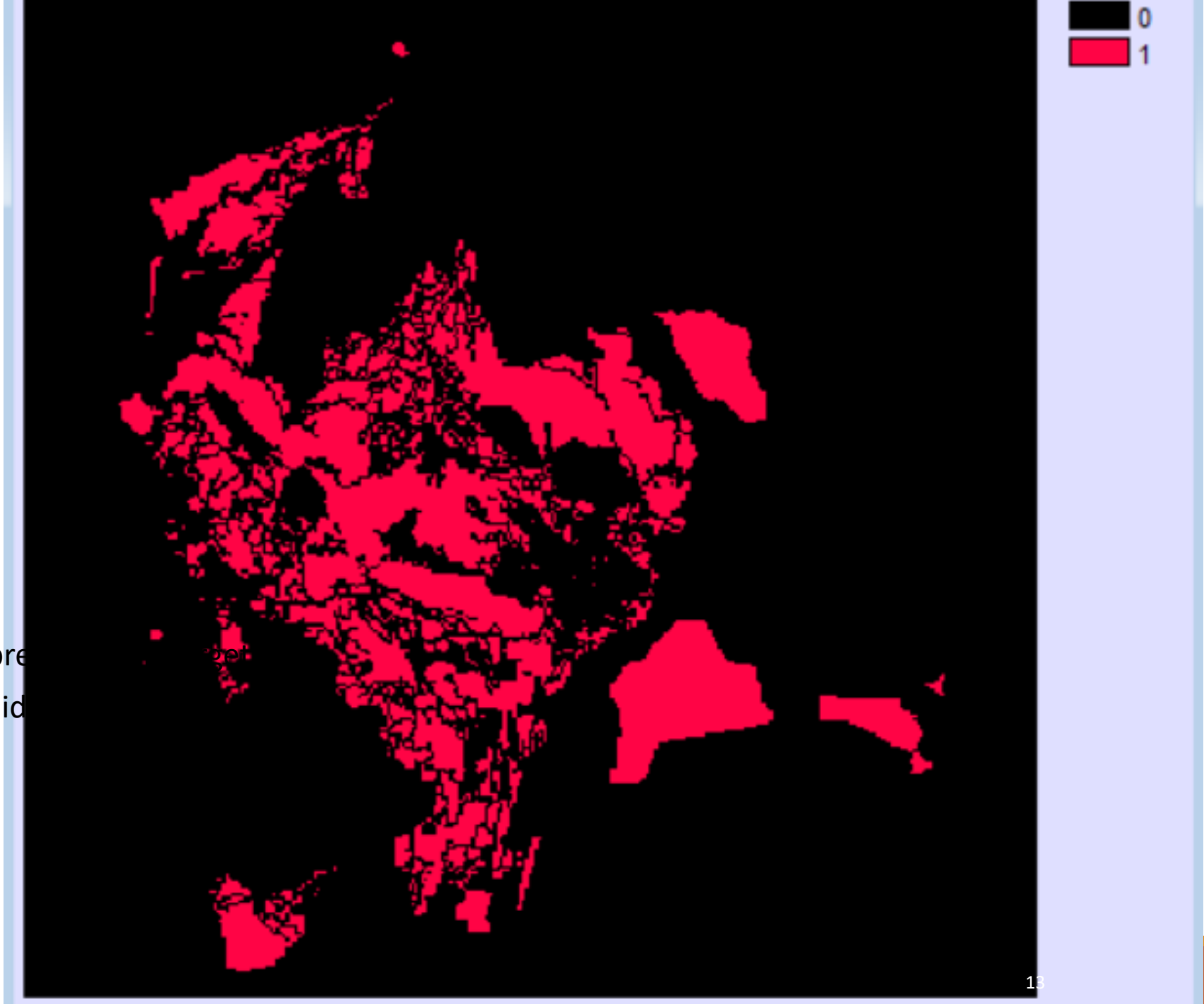
covering area-unknown

Only 7 species did not meet the areal repre

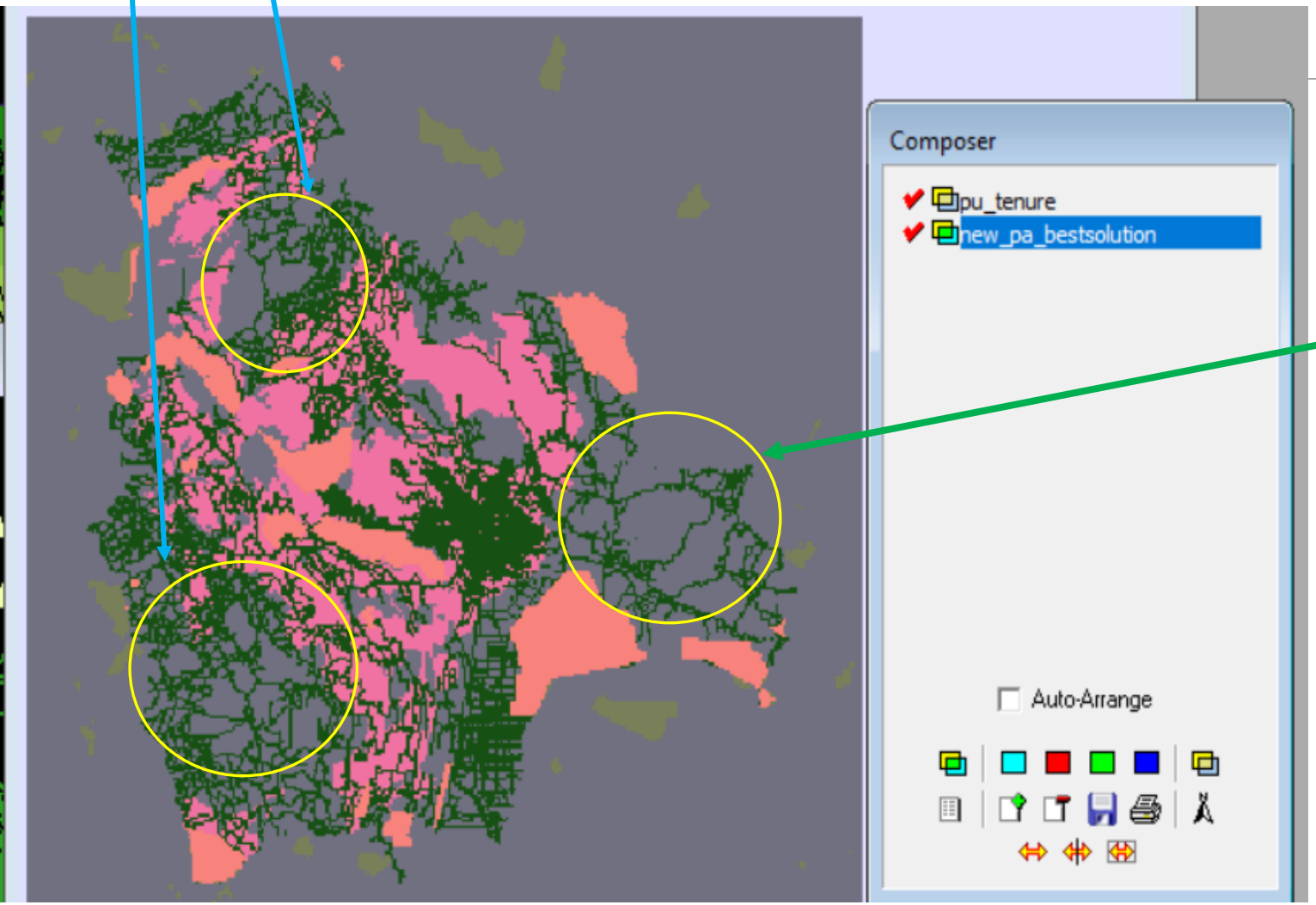
With <8,000 km2 in the reserve network id

best solution by MARXAN.

(this study area-cost based)



From tenure map, these disturbed areas have no new reserve network, it might due to high cost and less species richness in a PU unit



Eastern part: less disturbed areas and it has forest so, land cost is not might high. But why no reserve areas???

MARXAN is based on the probability of species presence in a planning unit. This area might has less total species richness. But some species may be high compare to other species. But, this area Land use is a Forest mostly.

But why no reserve areas???

Also other way, using species richness in a particular cell, may not be good indicator all time because it depend on many reasons such as anthropogenic pressure (Drever et al., 2019)

Conclusions

Total Protected Species within 50% target at

---the current reserve network 24.66%

---New reserve network 86.3%

Total new reserve consist of 273 planning units, only 7 species not did not meet the 50% protection target in <8,000 km2 area.

84% of species population protect by this new reservation at minimum cost. Thus, the this reserve network is good with further validation.

Mostly Southern area of Bolvia have high disturbed areas, so might expensive lands, low penalty rate there. These areas aren't included in the cost effective new reserve network.

Eastern part of Bolvia is not much disturbed and it is mostly forest areas but, it is not in new reserve network. The study need more survey and validation of this final network map.

Limitation n recommendations

Limitation: 1. However, in reality, management of protected areas does not occur at a square pixel level. In this exercise, we will use the administrative units of river basins, ecoregions, and land use to identify the different planning units.

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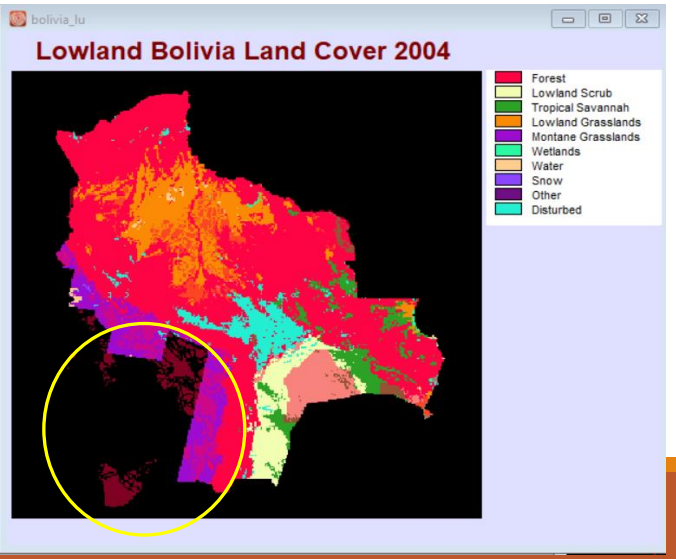
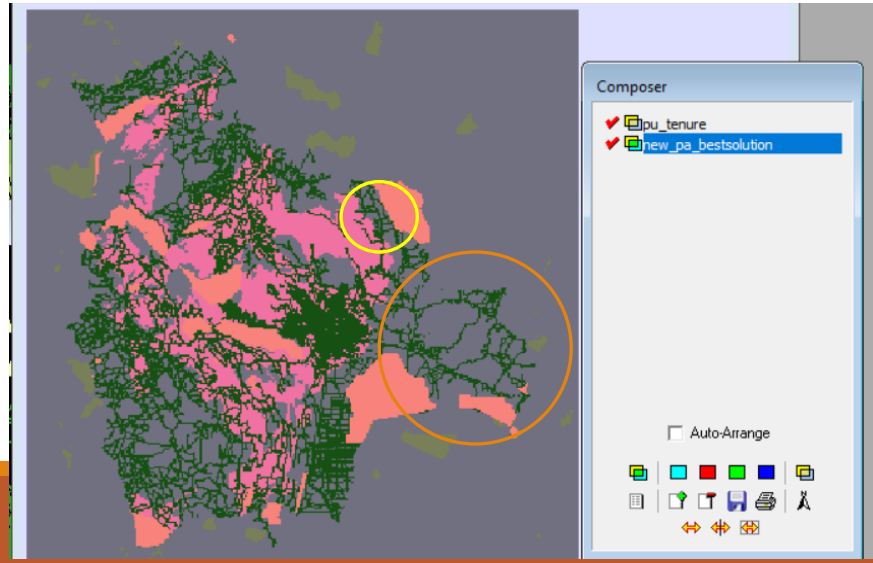
2. Land cover map is not consisted of complete information

3. Study use species richness in a PU unit, as a indicator use to find reserve identification. But it might not a good when there is **anthropogenic pressure** some species are not living but some species are living. Therefore, need more detailed studies, survey and validations with Marxan.

4. the reasons for Eastern part of study without any new reserves, fragmentation of new reserve area are not explained without other information such as anthropogenic pressure, landscape fragmentation etc. Therefore different scenario need to approach when reserve allocation





References

Ball, I. R. and H. P. Possingham, (2000) MARXAN (V1.8.2): Marine Reserve Design Using Spatially Explicit Annealing, a Manual.

Drever, C.R., Hutchison, C., Drever, M.C., Fortin, D., Johnson, C.A. and Wiersma, Y.F., 2019. Conservation through co-occurrence: Woodland caribou as a focal species for boreal biodiversity. *Biological Conservation*, *232*, pp.238-252.

Carvalho, S.B., Brito, J.C., Pressey, R.L., Crespo, E. and Possingham, H.P., 2010. Simulating the effects of using different types of species distribution data in reserve selection. *Biological Conservation*, *143*(2), pp.426-438.

Januchowski-Hartley, S.R., Visconti, P. and Pressey, R.L., 2011. A systematic approach for prioritizing multiple management actions for invasive species. *Biological invasions*, *13*(5), pp.1241-1253.

Thank you