Fragmentation indicator FRA (EUSALP)

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Summary Representation of the influence of landscape fragmentation on ecological connectivity. Fragmentation is expressed as the effective mesh density. It is one of the indicators belonging to the continuum suitability indices CSI (consisting of LAN, POP, FRA, TOP and ENV).

Legend

10	6	2
9	5	1
8	4	0
7	3	

1 Introduction

Based on island biogeography (Simberloff and Abele, 1976), areas rich in biodiversity need to be of a minimum size in order to maintain their species richness. Small disconnected areas that do not allow for movement lose their biodiversity within a short time. Fragmentation is a landscape-level phenomenon – it results from habitat loss and subsequent division of large and continuous areas into small isolated remnants, and alters community structure and ecosystem functioning (Didham, 2010). The aim of the fragmentation index is to represent the influence of landscape fragmentation on ecological connectivity. It is expressed as the effective mesh density, a measure based on effective mesh size (Jaeger, 2000).

2 Data

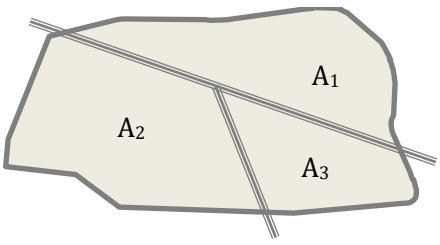
We used roads and railroads of the EuroGlobalMap (IGN, 2016). The dataset comprises all railroads, national motorways, primary and secondary routes, as well as roads of class 3. It is based on the official datasets of national topographic agencies. Roads and railroads did not match at the border between Croatia and Slovenia; this dataset therefore had to be corrected manually based on the Esri World Topographic map.

3 Methods

Fragmentation was calculated twice: 1) using the whole dataset, and 2) using only high- and motorways. With this approach, high- and motorways are assigned greater importance. For the analysis of the whole dataset, tunnels with a length of 1km were deleted, and for the analysis of high-/motorways, tunnels with a length of more than 4km. Shorter tunnels were treated as fragmentation geometries. The effective mesh size (meff; Jaeger, 2000) was calculated for both datasets as:

$$m_{eff} = \frac{1}{A_{tot}} \sum_{i=1}^{n} A_i^2$$

A schematic example of the calculation of the effective mesh size is sketched in Figure 1.



$$m_{eff} = \frac{1}{A_{tot}} (A_1^2 + A_2^2 + A_3^2)$$

Figure 1:Schematic example of effective mesh size (m_{eff})

In order to omit border effects, the cross-boundary connections approach of the effective mesh size presented by Moser et al. (2007) was applied. It is sketched in Figure 2.

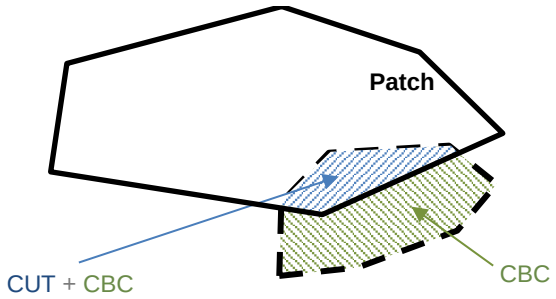


Figure 2:Sketch of the CBC method and the commonly applied cutting-out procedure CUT.

Instead of evaluating the effective mesh size for administrative boundaries as done by Bertiller et al. (2007) and many others, it was calculated for a regular grid. For every point, the effective mesh size was calculated for the surrounding 50km^2. For the evaluation of fragmentation, the effective mesh density s_{eff}CBC per 1000km^2 was used – it is directly derived from the effective mesh size:

$$s_{eff}CBC = 1000\ km^2 / m_{eff}CBC$$

The effective mesh density was reclassified according to the classification schemes in Table 1. Afterwards, a weighted mean of the two analyses was calculated:

$$FRA = 0.75 * value_{(Seff,all)} + 0.25 * value_{(seff,motor-/highway)}$$

Table 1: Classification schemes

s_{eff}(all)		s_{eff}(motor-/highway)	
Number of meshes per 1000 km^2 (s_{eff})	**Indicator Value (0-10)**	**Number of meshes per 1000 km^2 (s_{eff})**	**Indicator Value (0-10)**
<0.5	10	<0.0001	10
0.5-1	9		9
1-2	8		8
2-5	7		7
5-10	6	0.0001-0.0005	6
10-20	5	0.0005-0.001	5
20-30	4	0.001-0.005	4
30-50	3	0.005-0.01	3
50-75	2	0.01-0.05	2
75-100	1	>0.05	1
>100	0		0

4 References

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Didham, R. K., 2010, Ecological Consequences of Habitat Fragmentation, in: *Encyclopedia of life sciences* John Wiley & Sons Ltd, Chichester.

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Jaeger, J. A., 2000, Landscape division, splitting index, and effective mesh size: new measures of landscape fragmentation, *Landscape ecology* **15**(2)**:**115-130.

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