

Appendix 2 - Formulas used for the computation of metrics for landscapes, classes, and patches in Machadinho d'Oeste and Vale do Anari (McGarigal and Marks 1995).

Term	Definition
$E'$	Total length (m) of edge in landscape; includes entire landscape boundary and background edge segments regardless of whether they represent true edge
$e_{ik}$	Total length (m) of edge in landscape between patch types (classes) i and k; includes landscape boundary segments representing true edge only involving patch type i
$e'_{ik}$	Total length (m) of edge in landscape between patch types (classes) i and k; includes all landscape boundary and background edge segments involving patch type i, regardless of whether they represent true edge
$e''_{ik}$	Total length (m) of edge in landscape between patch types (classes) i and k; includes the entire landscape boundary and background edge segments, regardless of whether they represent true edge
$N$	Total number of patches in the landscape, excluding any background patches
$n = n_i$	Number of patches in the landscape of patch type (class) i
$n_{ij}^c$	Number of disjunct core areas in patch ij based on specified buffer width (m)
$m$	Number of patch types (classes) present in the landscape, excluding the landscape border if present
$m'$	Number of patch types (classes) present in the landscape, including the landscape border if present
$m_{max}$	Maximum number of patch types (classes) present in a landscape
$g_{ik}$	Number of adjacencies (joins) between pixels of patch types (classes) i and k
$P_i$	Proportion of the landscape occupied by patch type (class) i

Term	Definition
Subscripts:	
i	1, ... , m or m' patch types (classes)
j	1, ... , n patches
k	1, ... , m or m' patch types (classes)
Symbols:	
A	Total landscape area (m <sup>2</sup> )
a <sub>ij</sub>	Area (m <sup>2</sup> ) of patch ij
a <sub>ijs</sub>	Area (m <sup>2</sup> ) of patch ijs within specified neighborhood (m) of patch ij
a <sub>ij</sub> <sup>c</sup>	Core area (m <sup>2</sup> ) of patch ij based on specified buffer width (m)
a <sub>ijq</sub> <sup>c</sup>	Area (m <sup>2</sup> ) of disjunct core area q in patch ij based on specified buffer width (m)
P <sub>ij</sub>	Perimeter (m) of patch ij
P <sub>ijk</sub>	Length (m) of edge of patch ij adjacent to patch type (class) k
E	Total length (m) of edge in landscape; includes landscape boundary and background edge segments if the user decides to treat boundary and background as edge; otherwise, only boundary segments representing true edge are included

## METRICS USED FOR LANDSCAPES

- **LARGEST PATCH INDEX:** percentage of landscape accounted for by largest patch

$$LPI = \frac{\max_{j=1}^n(a_{ij})}{A} (100)$$

Units: Percent.

Range:  $0 < LPI \leq 100$ .

- PATCH DENSITY: number of patches per 100 ha for a landscape

$$PD = \frac{N}{A} (10,000)(100)$$

Units: Number per 100 hectares.

Range:  $PD > 0$ , without limit.

- MEAN PATCH SIZE: average patch size for a landscape

$$MPS = \frac{A}{N} \left( \frac{1}{10,000} \right)$$

Units: Hectares.

Range:  $MPS > 0$ , without limit.

- PATCH SIZE STANDARD DEVIATION: population standard deviation for patch sizes of a landscape

$$PSSD = \sqrt{\frac{\sum_{i=1}^m \sum_{j=1}^n \left[ a_{ij} - \left( \frac{A}{N} \right) \right]^2}{N} \left( \frac{1}{10,000} \right)}$$

Units: Hectares.

Range:  $PSSD \geq 0$ , without limit.

- PATCH SIZE COEFFICIENT OF VARIATION: population coefficient of variation in patch size relative to the mean patch size for a landscape

$$PSCV = \frac{PSSD}{MPS} (100)$$

Units: Percent.

Range:  $PSCV \geq 0$ , without limit.

- EDGE DENSITY: length of edge per hectare for a landscape

$$ED = \frac{E}{A} (10,000)$$

Units: Meters per hectare.

Range:  $ED \geq 0$ , without limit.

- LANDSCAPE SHAPE INDEX: ratio of sum of edge lengths to total area for a landscape measured against a circle standard

$$LSI = \frac{E'}{2\sqrt{\pi} \circ A}$$

Units: None.

Range:  $LSI \geq 1$ , without limit.

- AREA-WEIGHTED MEAN SHAPE INDEX: average perimeter-to-area ratio for a landscape, weighted by the size of its patches

$$AWMSI = \sum_{i=1}^m \sum_{j=1}^n \left[ \left( \frac{p_{ij}}{2\sqrt{\pi} \circ a_{ij}} \right) \left( \frac{a_{ij}}{A} \right) \right]$$

Units: None.

Range:  $AWMSI \geq 1$ , without limit.

- TOTAL CORE AREA INDEX: core area defined by specified edge distance from the patch perimeter for the entire landscape as a percentage of total landscape area

$$TCAI = \frac{\sum_{i=1}^m \sum_{j=1}^n a_{ij}^c}{A} (100)$$

Units: Percent.

Range:  $0 \leq TCAI < 100$ .

- MODIFIED SIMPSON'S DIVERSITY INDEX: proportional abundance of each patch type within the landscape

$$MSIDI = -\ln \sum_{i=1}^m P_i^2$$

Units: None.

Range:  $MSIDI \geq 0$ .

- MODIFIED SIMPSON'S EVENNESS INDEX: measurement of the distribution of area among patch types within the landscape

$$MSIEI = \frac{-\ln \sum_{i=1}^m P_i^2}{\ln m}$$

Units: None.

Range:  $0 \leq MSIEI \leq 1$ .

- INTERSPERSION AND JUXTAPOSITION INDEX: observed interspersion divided by maximum interspersion for the patch types in a landscape

$$IJI = \frac{-\sum_{i=1}^{m'} \sum_{k=i+1}^{m'} \left[ \left( \frac{e_{ik}}{E} \right) \circ \ln \left( \frac{e_{ik}}{E} \right) \right]}{\ln(1/2[m'(m'-1)])} (100)$$

Units: Percent.

Range:  $0 < IJI \leq 100$ .

## METRICS USED FOR CLASSES

- PERCENTAGE OF LANDSCAPE: percentage of landscape accounted for a class

$$\%LAND = P_i = \frac{\sum_{j=1}^n a_{ij}}{A} (100)$$

Units: Percent.

Range:  $0 < \%LAND \leq 100$ .

- LARGEST PATCH INDEX: percentage of class accounted for by largest patch

$$LPI = \frac{\max(a_{ij})}{A} (100)$$

Units: Percent.

Range:  $0 < LPI \leq 100$ .

- PATCH DENSITY: number of patches per 100 ha for a class

$$PD = \frac{n_i}{A} (10,000)(100)$$

Units: Number per 100 hectares.

Range:  $PD > 0$ , without limit.

- MEAN PATCH SIZE: average patch size for a class

$$MPS = \frac{\sum_{j=1}^n a_{ij}}{n_i} \left( \frac{1}{10,000} \right)$$

Units: Hectares.

Range:  $MPS > 0$ , without limit.

- PATCH SIZE STANDARD DEVIATION: population standard deviation for patch sizes of a class

$$\text{PSSD} = \sqrt{\frac{\sum_{j=1}^n \left[ a_{ij} - \frac{\sum_{j=1}^n a_{ij}}{n_i} \right]^2}{n_i}} \left( \frac{1}{10,000} \right)$$

Units: Hectares.

Range: PSSD  $\geq 0$ , without limit.

- PATCH SIZE COEFFICIENT OF VARIATION: population coefficient of variation in patch size relative to the mean patch size for a class

$$\text{PSCV} = \frac{\text{PSSD}}{\text{MPS}} (100)$$

Units: Percent.

Range: PSCV  $\geq 0$ , without limit.

- EDGE DENSITY: length of edge per hectare for a class

$$\text{ED} = \frac{\sum_{k=1}^{m'} e_{ik}}{A} (10,000)$$

Units: Meters per hectare.

Range: ED  $\geq 0$ , without limit.



- LANDSCAPE SHAPE INDEX: ratio of sum of edge lengths to total area for a class measured against a circle standard

$$LSI = \frac{\sum_{k=1}^m e''_{ik}}{2\sqrt{\pi} \cdot A}$$

Units: None.

Range:  $LSI \geq 1$ , without limit.

- AREA-WEIGHTED MEAN SHAPE INDEX: average perimeter-to-area ratio for a class, weighted by the size of its patches

$$AWMSI = \sum_{j=1}^n \left[ \left( \frac{p_{ij}}{2\sqrt{\pi} \cdot a_{ij}} \right) \left( \frac{a_{ij}}{\sum_{j=1}^n a_{ij}} \right) \right]$$

Units: None.

Range:  $AWMSI \geq 1$ , without limit.

- MEAN CORE AREA INDEX: average of core areas defined by specified edge distance from the patch perimeter for the entire class as a percentage of total class area

$$MCAI = \frac{\sum_{j=1}^n \left( \frac{a_{ij}^c}{a_{ij}} \right)}{n_i} (100)$$

Units: Percent.

Range:  $0 \leq MCAI < 100$ .



- **INTERSPERSION AND JUXTAPOSITION INDEX:** observed interspersion divided by maximum interspersion for patches in a class

$$IJI = \frac{-\sum_{k=1}^{m'} \left[ \left( \frac{e_{ik}}{\sum_{k=1}^{m'} e_{ik}} \right) \ln \left( \frac{e_{ik}}{\sum_{k=1}^{m'} e_{ik}} \right) \right]}{\ln(m' - 1)} \quad (100)$$

Units: Percent.

Range:  $0 < IJI \leq 100$ .

## METRICS USED FOR PATCHES

- **AREA:** area of the patch in hectares

Vector

$$AREA = a_{ij} \left( \frac{1}{10,000} \right)$$

Units: Hectares.

Range:  $AREA > 0$ , without limit.

- **PERIMETER:** perimeter of the patch, including any internal holes in the patch

Vector

$$PERIM = p_{ij}$$

Units: Meters.

Range:  $PERIM > 0$ , without limit.

- **SHAPE INDEX:** ratio of sum of edge lengths to total area for a patch, measured against a circle standard

$$\text{SHAPE} = \frac{p_{ij}}{2\sqrt{\pi \cdot a_{ij}}}$$

Units: None.

Range:  $\text{SHAPE} \geq 1$ , without limit.

- **FRACTAL DIMENSION:** degree of complexity of patches based on a perimeter-to-area ratio

$$\text{FRACT} = \frac{2 \ln p_{ij}}{\ln a_{ij}}$$

Units: None.

Range:  $1 \leq \text{FRACT} \leq 2$ .