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BioFrag

Edge_response software

Novel computational methods for Landscape Ecology

USER MANUAL

Fragmented landscapes analysis

from continuous maps (e.g. Tree Cover, NDVI, …)

- → Mapping Edge Influence
  includes influence of multiple edges and full range of patch contrasts
- → Configuration Index and Core ratio
  quantification of landscape configuration and edge effects

Species response to fragmentation

from field data of species abundance

- → Species sensitivity to Edge Influence
  Quantification and species classification
- → Maps of predicted abundance
  based on sensitivity to Edge Influence and land cover
- → Fragmentation Impact on species
  proportion of species lost to the landscape due to fragmentation

Source code: https://github.com/VeroL/BioFrag

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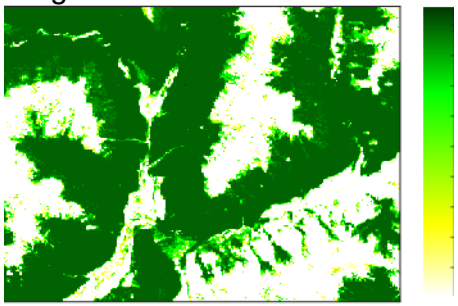
Edge_response software overview

The software analyses a continuous map of land cover:

e.g.: % Tree cover



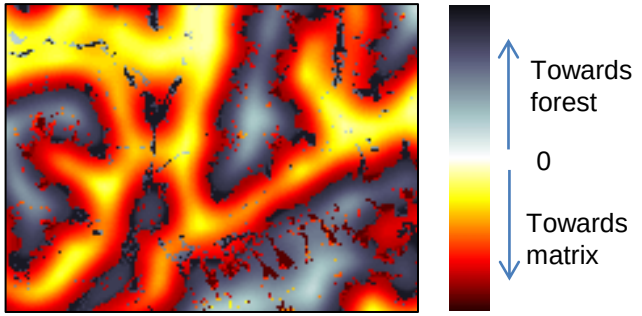
Spatial filtering (local land cover variations)

'Edge Influence' is a single metric that accounts for :

- the influence of all edges (and not only the nearest)
- the shape of edges and fragments
- the full range of local contrasts (patch contrast)
- fragment sizes
- fragments distance to each other (local configuration)

..and outputs a map of Edge Influence (EI), which gives a measure of landscape fragmentation:

Edge Influence map



Then given measurements of species abundance, and their coordinates in the landscape:

Species matrix

Plot name	Species 1	Species 2	Species k …
Plot 1	5	0	..
Plot 2	2	25	..
Plot n…	..	..	..

Plot coordinates

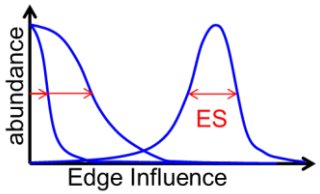
Plot name	Latitude (or Geo X)	Longitude (or Geo Y)
Plot 1	16.7698550908	-62.2112243079
Plot 2	16.7599899977	-62.2122900003
Plot n…	..	..

..the software computes for each species:

Edge response type

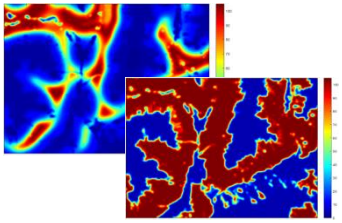
e.g.:
-'Forest Core'
-'Forest Edge'
-'Forest noPref'
-'Matrix Core'
-…
-'Generalist Edge'
-Unknown

Edge Sensitivity (ES)



Length of the range of EI values for which a species is abundant

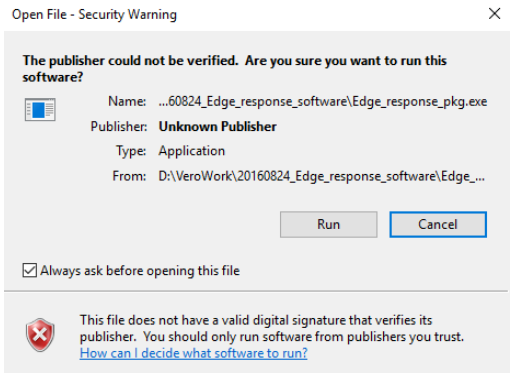
Fragmentation Impact (FI)



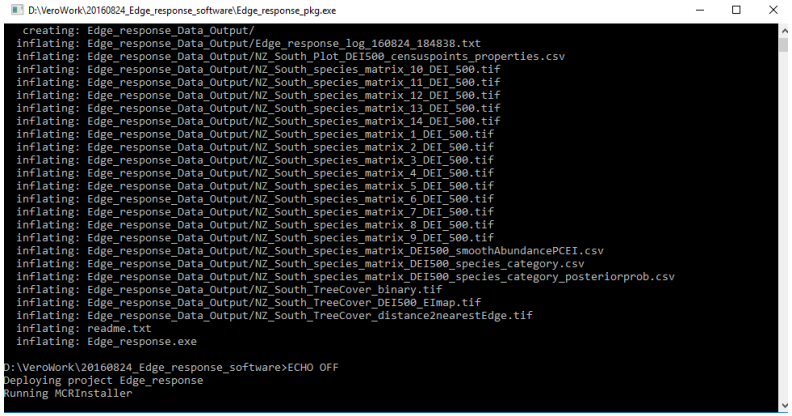
Proportion of individuals lost to the landscape due to fragmentation

Installation guide (1)

- Executable is a .exe suitable for Windows 7 64 bit, Windows 8, Windows 10
- Download the file Edge_response_pkg.exe and **save it in a new folder**
- Edge_response_pkg.exe is a self extracting archive, double click to run:

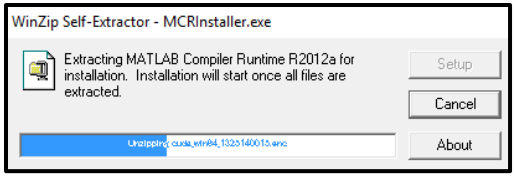


You may receive an ‘Unknown Publisher’ warning
Click Run

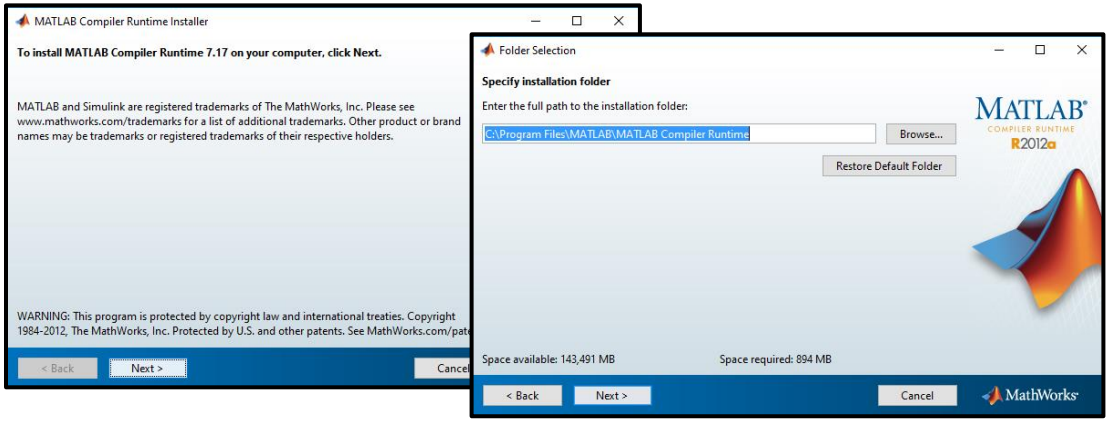


A command prompt window will open showing files extraction

Installation guide (2)

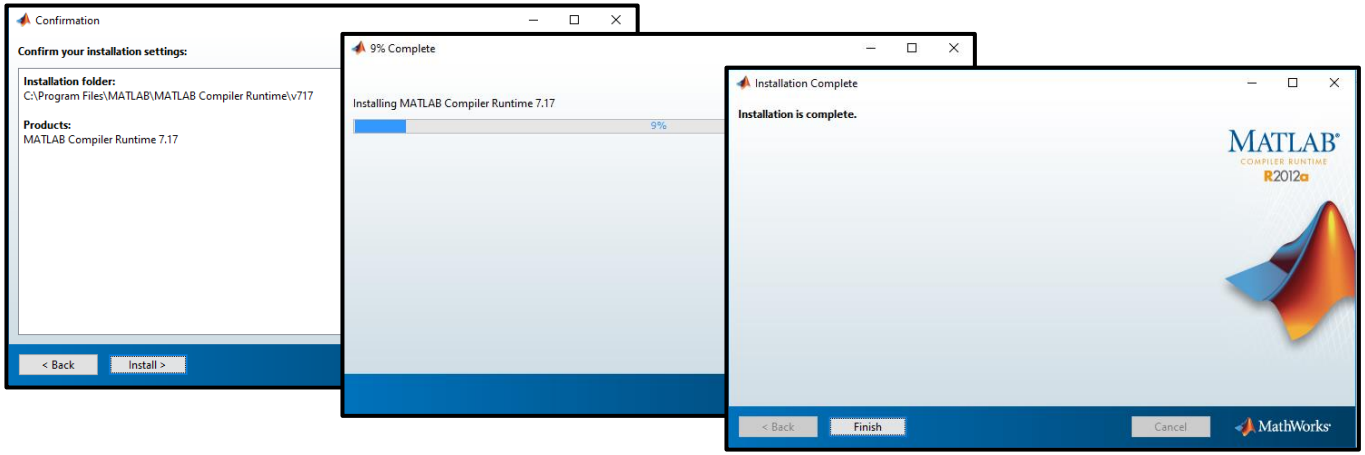


Edge response software is implemented in Matlab® 2012a. The Matlab Compiler Runtime (MCR) automatically starts its installation when you run Edge_response_pkg.exe (along with C++ libraries if needed)



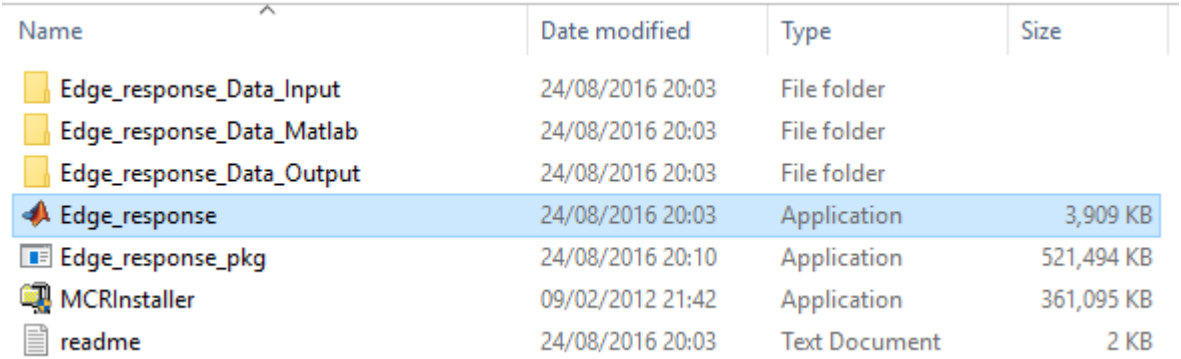
Click Next
Check installation folder
Click Install
Click Finish

Space needed: ~900MB



Installation guide (3)

At the end of the installation you will have the following folders and files in your newly created folder:



Name	Date modified	Type	Size
Edge_response_Data_Input	24/08/2016 20:03	File folder	
Edge_response_Data_Matlab	24/08/2016 20:03	File folder	
Edge_response_Data_Output	24/08/2016 20:03	File folder	
Edge_response	24/08/2016 20:03	Application	3,909 KB
Edge_response_pkg	24/08/2016 20:10	Application	521,494 KB
MCRInstaller	09/02/2012 21:42	Application	361,095 KB
readme	24/08/2016 20:03	Text Document	2 KB

Edge_response(.exe) is the Edge_response software executable

MCRInstaller(.exe) allows you to (re)install the MCR

Edge_response_Data_input contains an example input dataset: ‘NZ_South’

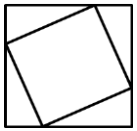
Edge_response_Data_output contains software outputs for the example dataset ‘NZ_South’

Input data preparation (1): Land cover map

- Land cover map:

Example: Edge_response_Data_Input\NZ_South_TreeCover.tif

  - Should be the continuous variations of a single variable, e.g.:
    - % Tree Cover (e.g. Hansen's dataset (Science, 2013))
    - NDVI (bounded between ~ 0.1 → 0.8 (to better represent vegetation cover)
    - Vegetation greenness
    - If your map is categorical please rank each label in order of 'habitat suitability', with values from 0 to 100. E.g.: grassland = 0, plantations = 40, sparse forest = 60, dense forest = 100
    - NB: Your studied habitat **does not have to be 'forest'**. However because the software was originally developed to study fragmented forests, the results will be labelled using 'Forest' and 'Matrix' terms (please refer to the output section of this manual, p. 15).
  - **Map values MUST be scaled between 0 and 100**
  - The map must be **projected**
  - The file must be in **GeoTiff format (with projection and resolution information)**
  - The map MUST NOT contain 'no data' cells. Fill in these cells with interpolation. If the map is 'at an angle' please crop it so that the GeoTiff image does not contain map borders (as these will be interpreted as land cover edges).



- Non-habitat map (optional):

Example: Edge_response_Data_Input\NZ_South_nonhabitatmask.tif

  - MUST be GeoTiff format, same extent, projection, resolution as your Land cover map
  - MUST be binary, pixel values must be 1 or 0:
    - 1 = any non habitat (water, road, urban, …)
    - 0 = any natural habitat (grassland, plantation, forest..)

Input data preparation (2): species abundance and spatial coordinates of measurements (plot)

- Plot coordinates file (.csv, .xls or .xlsx) with format:

Example: Edge_response_Data_Input\NZ_South_Plot.csv

with latitude and longitude:

Plot name	Latitude	Longitude
Plot 1	16.7698550908	-62.2112243079
Plot 2	16.7599899977	-62.2122900003
Plot n…	..	..

or with Geo X and Y in same projection as your land cover map:

Plot name	X	Y
Plot 1	20156.24647	546846.21456
Plot 2	20156.75547	546887.87462
Plot n…	..	..

Ensure that all plots fall within the extent of your land cover map, and 2 km away from the map borders for best results.

- Species matrix file (.csv, .xls or .xlsx) with format:

Example: Edge_response_Data_Input\NZ_South_species_matrix.csv

Plot name	Species 1	Species 2	Species k …
Plot 1	5	0	..
Plot 2	2	25	..
Plot n…	..	..	..

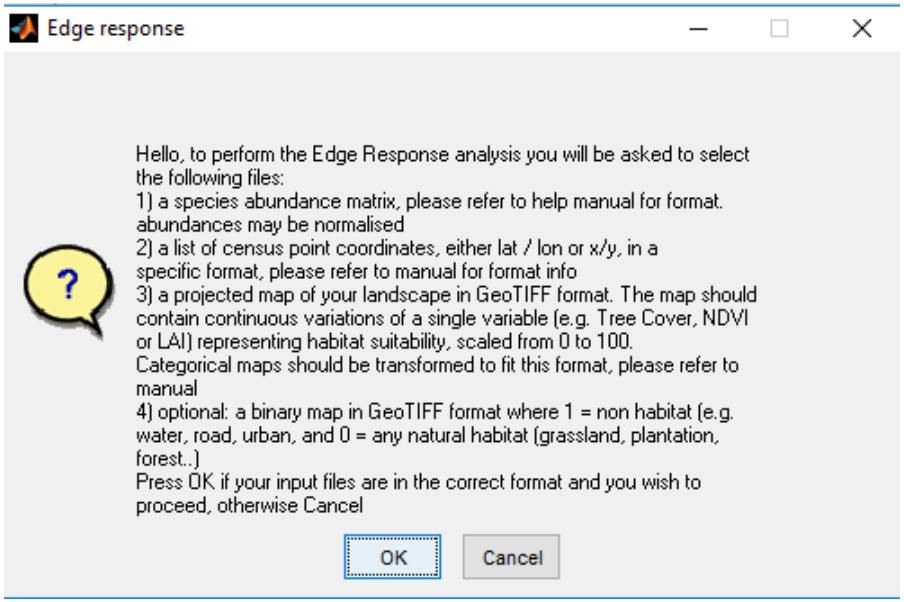
Giving the species names, and their abundance for each measurement (plot) locations. Abundance values can be normalised.

The list of plot names should be the same in both files.

Edge_response software run guide (1)

Optional: Place your GeoTiff map(s), species abundance and plot coordinate files in the **Edge_response_Data_input** folder.

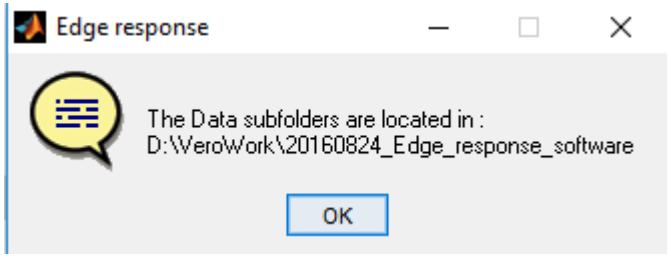
Run Edge_response.exe



The software will remind you of the input data needed for the analysis.

If you are ready, click OK.

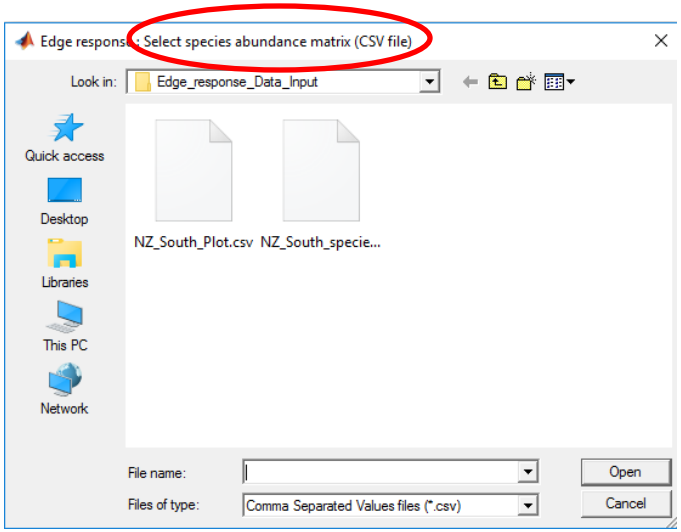
You can also use the example input files provided to try the software.



The software looks for the **Edge_response_Data_XXX** folders in the run folder. If you are running the software from its installation folder (and not from a shortcut), it will send confirmation that it has found the data subfolders.

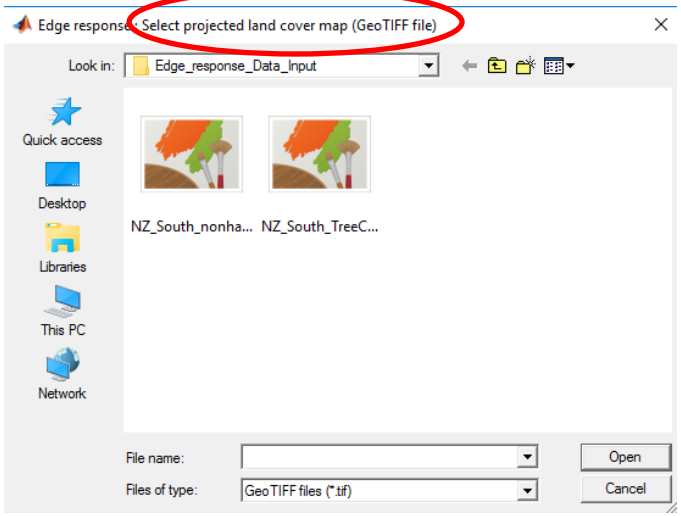
If not you will be prompted to select a location for these folders.

Edge_response software run guide (2)



The software prompts you to select your species matrix file, then your plot coordinate file.

If they are not located in Edge_response_Data_Input please browse to your input files location.



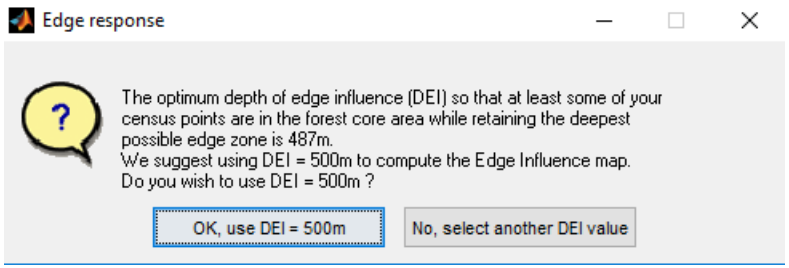
The software then prompts you to select your land cover map file, then allows you to select a non-habitat map if you have one.

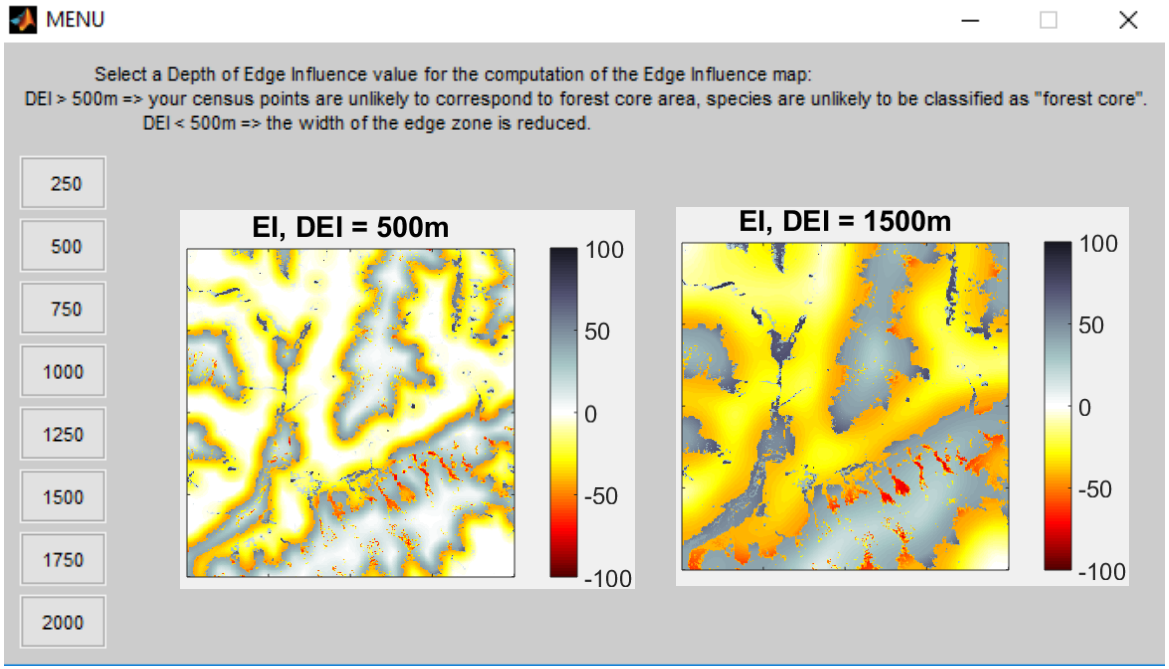
Edge_response software run guide (3)

The software will suggest an optimal Depth of Edge Influence (DEI) given your map and plot locations.

The optimal Depth of Edge Influence is estimated so that some of your plots are in habitat ‘core’ areas (Locations where there are no edges within a DEI radius, i.e. areas exempt of edge effects, where the Edge Influence is close to 0).

The computation of the Edge Influence map accounts for all edges within the DEI distance of a focal point.





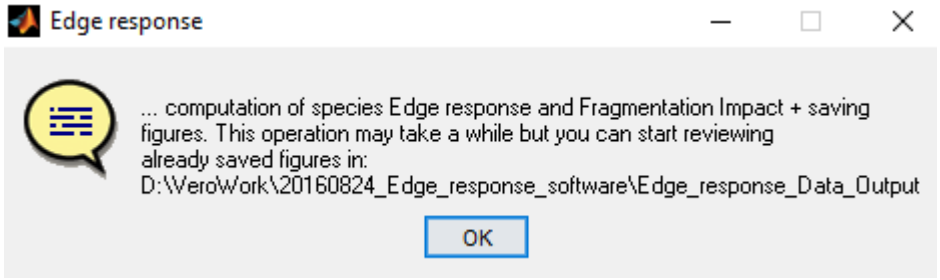
If you do not wish to use the suggested DEI you can select its value from 250m to 2000m.

Edge effects are believed to be felt for up to 1km within forest habitat (Ewers et al. 2006).

As DEI increases the area of core habitat decreases (and computation time of the EI map increases).

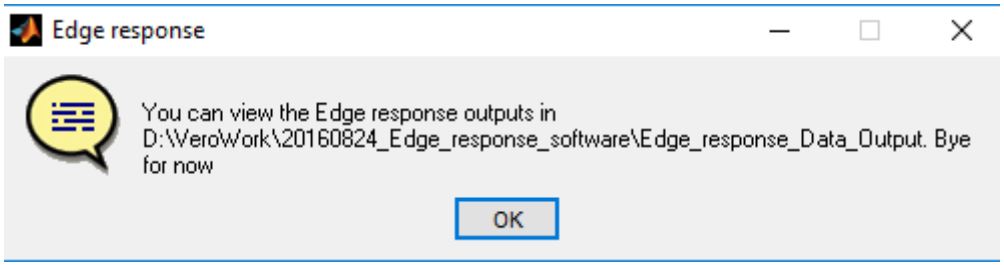
Ewers, R.M., Didham, R.K., 2006. Continuous response functions for quantifying the strength of edge effects. Journal of Applied Ecology 43, 527–536.

Edge_response software run guide (4)

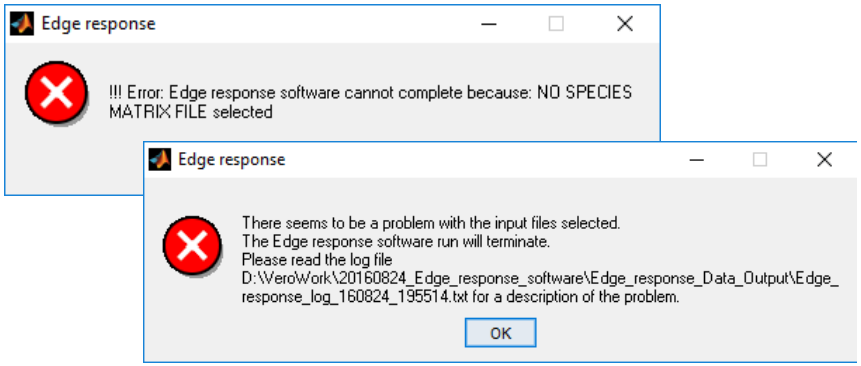


During processing of your data the Edge_response software will keep you informed of ongoing operations.

The last step processes your species one by one and creates a figure for each of them.
You can check these figures as they are being created.



This is the last message of a successful run, letting you know in which folder the result files are stored.

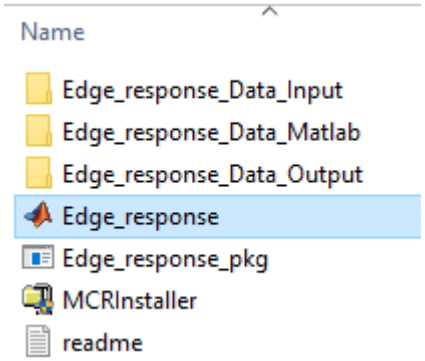


Alternatively, if something goes wrong you will receive error messages.

If the error is known (input error), please follow instructions to correct it.

If the error is unknown, please follow instructions to email me your log file.

Edge_response software run guide (5)



Re-running the software using the same input file names:

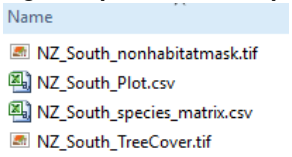
The Edge_response software does not produce new outputs when run with the same input files (same file names) as a previous run.

This is because output files are named using the names of the input files, and if output files already exist in folder Edge_response_Data_Output they are not overwritten.

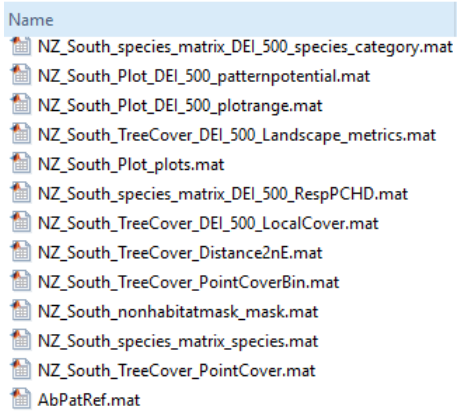
This is useful when you want to run the software for several species matrix files and plot files using the same land cover map: the software loads the previously computed Edge Influence map instead of re-computing it, thereby saving time.

However, if you modify the content of your input files, you need to either also modify their names, or delete the output files whose names include the names of your modified input files, in folder Edge_response_Data_Output AND in folder Edge_response_Data_Matlab (containing intermediate results in Matlab data file format). If in doubt, delete all files in both folders and re-run the software (it will only take a bit longer).

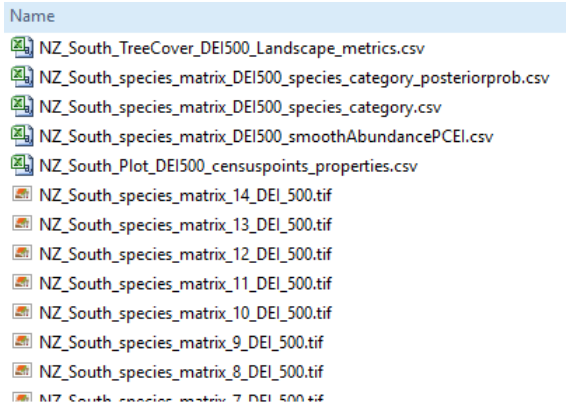
Edge_response_Data_Input



Edge_response_Data_Matlab



Edge_response_Data_Output



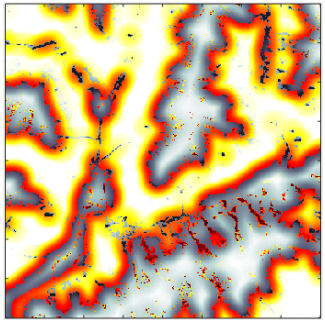
Description of Edge_response outputs (1) - Maps

A successful run of the Edge_response software creates the following files in Edge_response_Data_Output:

- **3 GeoTIFF files:**
  - Map of Edge Influence
  - Map of distance to nearest edge (provided for comparison)
  - Binary map of suitable habitat (used to compute distance to nearest edge)
- **5 CSV files containing:**
  - Species edge response categories and metrics
  - Census points properties (EI, distance)
  - Species abundance smoothed w.r.t. PC and EI + outliers indicated as NaN (if any)
  - Classification posterior probabilities
  - Landscape metrics
- **1 illustrative figure per species present**
- **1 log file per run**

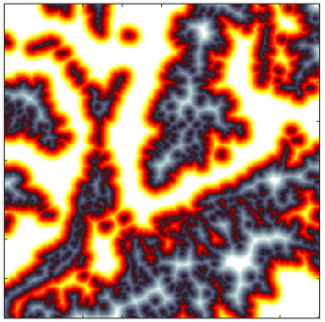
3 Maps:

Edge Influence



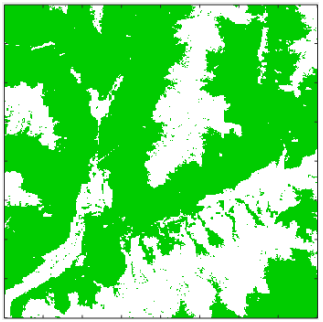
named as:
[your map filename]
_DEI [DEI value]
_Eimap.tif

Distance to nearest edge



named as:
[your map filename]
_distance2nearestEdge.tif

Habitat binary



named as:
[your map filename]
_binary.tif

Edge Influence can vary between -100 (high EI in 'high' land cover values, e.g. forest) and 100 (high EI in 'low' land cover values, e.g. grassland). EI = 0 means no edge effect.

Distance to nearest edge is given in metres, positive in land cover values above max contrast threshold (e.g. in forest habitat, 1 in binary map), negative below (e.g. in grassland, 0 in binary map).

All maps have the same geo info as your input land cover map , are saved in GeoTIFF format, and can be read by GIS software.

Also see Methods p.21-22

Examples in Edge_response_Data_Output :

NZ_South_TreeCover_DEI500_Eimap.tif
NZ_South_TreeCover_distance2nearestEdge.tif
NZ_South_TreeCover_binary.tif

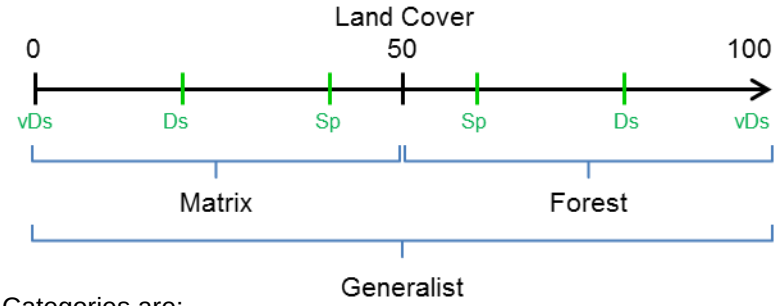
Description of Edge_response outputs (2.1) - Species Response

The CSV file containing the species response categories and metrics is named:
[your species filename]_DEI [DEI value]_**species_category**.csv **Example: NZ_South_species_matrix_DEI500_species_category.csv**

Species name	Habitat	EIPref	Category	Posterior prob	Pattern Label	DEI opt	mean abundance	median abundance	fragmentation impact	EI sensitivity	dataset rating
Mdea rueps	Forest Sp	Edge T3 highside	Forest Edge	0.99837193	489	500	1.084395396	0.415453633	0.654278141	0.692354136	0.833333333
Myclorax rocolis	Matrix vDs	Core 0	Matrix Core	0.999471138	708	500	1.638589922	0.483037986	0.830942505	0.648675201	0.833333333
Praus frois	Matrix Sp	Core 0	Matrix Core	0.903647461	1059	500	2.635391354	0.241518993	0.753358888	0.649948972	0.833333333
Cicer sp.4	Matrix Sp	Edge T2 lowside	Matrix Edge	0.967444085	894	500	2.225998783	0	0.674423339	0.478425153	0.833333333

Habitat:

Part of the Land Cover spectrum preferred by the species



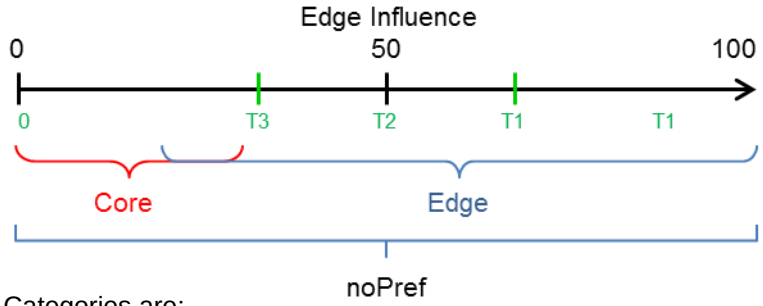
Categories are:
Forest (top half)
Matrix (bottom half)
Generalist (whole spectrum)
(or Absent / Nonabundant / Unknown)

The spectrum is further divided in:
Sp: Sparse (40 or 60)
Ds: Dense (20 or 80)
vDs: very Dense (0 or 100)

NB: If the high values in your land cover map do not represent forest, please interpret the 'Forest' category as the top half of values in your land cover map.

EIPref:

Part of the Edge Influence spectrum preferred by the species



Categories are:
Core (low EI <20, decreasing response)
Edge(EI > 20, peak or increasing response)
noPref (whole spectrum, flat response)

Also see Methods p.23

The edge spectrum is further divided in:
T1: small patches
T2: main straight edges
T3: near main edges

highside = location has 'higher land cover' than surroundings
lowside = location has 'lower land cover' than surroundings
overflow = species is present on both sides of the edge

Description of Edge_response outputs (2.2) - Species Response

The CSV file containing the species response categories and metrics is named:
[your species filename]_DEI [DEI value]_**species_category**.csv

Species name	Habitat	EIPref	Category	Posterior prob	Pattern Label	DEI opt	mean abundance	median abundance	fragmentation impact	EI sensitivity	dataset rating
Mdea rueps	Forest Sp	Edge T3 highside	Forest Edge	0.99837193	489	500	1.084395396	0.415453633	0.654278141	0.692354136	0.833333333
Myclorax rocolis	Matrix vDs	Core 0	Matrix Core	0.999471138	708	500	1.638589922	0.483037986	0.830942505	0.648675201	0.833333333
Praus frois	Matrix Sp	Core 0	Matrix Core	0.903647461	1059	500	2.635391354	0.241518993	0.753358888	0.649948972	0.833333333
Cicer sp.4	Matrix Sp	Edge T2 lowside	Matrix Edge	0.967444085	894	500	2.225998783	0	0.674423339	0.478425153	0.833333333

Category:
gives the main Habitat + main EIPref categories
i.e. ignores subcategories
e.g. 'Forest Edge'

Posterior prob:
Likelihood of the species to belong in the given category. Between 0 and 1.

Pattern Label:
Index of training set pattern from which the species response is closest to. This may help to further regroup species that have similar responses.

DEI opt:
Depth of Edge Influence (DEI) in metres used to compute the Edge Influence map. Locations where there are no edges within a DEI radius are considered core areas.

mean abundance:
mean abundance of species in landscape

median abundance:
median abundance of species in landscape

fragmentation impact:
proportion of individuals lost to the landscape due to edge effects (between 0 and 1). The fragmentation impact (FI) increases as the total edge influence increases in the landscape (amount of edges), and as the species sensitivity to EI increases.

$$FI = 1 - \frac{\sum abundance\ of\ species\ in\ landscape\ (interpolated\ from\ EI\ and\ land\ cover)}{\sum abundance\ if\ species\ was\ insensitive\ to\ edge\ effects\ (interpolated\ from\ land\ cover\ only)}$$

FI = 1 – realised abundance

Also see Methods p.25-26

EI sensitivity:
sensitivity of species to Edge Influence: length of the range of EI values for which a species is abundant (proportion, between 0 and 1).

$$\text{EI sensitivity} = 1 - \frac{\sum abundance\ wrt\ land\ cover\ and\ EI, on\ graph}{\sum abundance\ wrt\ land\ cover\ only, on\ graph}$$

EI is the proportion of individuals lost on the EI spectrum, for all PC values.
The EI sensitivity is independent of landscape, therefore enables species comparison across landscapes (provided experimental protocols and DEI used are the same).

A species with a smaller EI sensitivity value can occupy more of its habitat.

dataset rating:
estimation of how well the spatial distribution of the census points enables to assess the species edge response. (between 0 and 1)
verifies that enough census points are present in low and high values of both land cover and EI, and deep enough in habitats (> 500m from edge)

Description of Edge_response outputs (2.3) - Species Response

The CSV file containing values of species abundance smoothed with respect to both EI and land cover is named:
[your species filename]_DEI [DEI value]_**smoothAbundancePCEI**.csv

Example: NZ_South_species_matrix_DEI500_smoothAbundancePCEI.csv

Plot name	Proeltis virs	Cs sp.2	Ctena sp.4	Eaea sp.	Meslon sp.1	Ptiae sp.1	Mellma sp.4	Mphthalma
NewSite014	0.389174	3.353406	0.09155	1.234799	1.211673	6.189789	25.60492	12.85563
NewSite015	0.159464	0.200557	0.662491	0.50119	1.086238	4.217268	13.68285	1.581968
NewSite016	0.159464	0.200557	0.662491	0.50119	1.086238	4.217268	13.68285	1.581968

The format is the same as your species matrix.
Abundance values are smoothed in 2D as a function of land cover (or Point Cover PC) and EI.
This operation averages abundance values taken in plots of similar PC and EI, but not necessarily close in space.
Species categories are computed from these smoothed abundance values.

The CSV file containing the likelihoods of species to belong to each of the main categories is named:
[your species filename]_DEI [DEI value]_**species_category_posteriorprob**.csv

Example: NZ_South_species_matrix_DEI500_species_category_posteriorprob.csv

Species name	Forest Core	Forest Edge	Forest noPref	Matrix Core	Matrix Edge	Matrix noPref	Generalist Core	Generalist Edge	Generalist noPref	Unknown	Nonabundant	Absent
Proeltis virscen	0	1	0	0	0	0	0	0	0	0	0	0
Cs sp.2	0	0	1	0	0	0	0	0	0	0	0	0
Ctena sp.4	0	0	0	0	1	0	0	0	0	0	0	0
Eaea sp.	1	0	0	0	0	0	0	0	0	0	0	0

Generally species can be classified within a category with a high likelihood, as in the example given.
Checking this table is useful when a species cannot be classified with high certainty, or when species are classified as 'Unknown' or 'Nonabundant' but have a non-zero likelihood to belong to another category.

Description of Edge_response outputs (2.4) - Plot and landscape metrics

The CSV file containing plot properties is named:
[your plot filename]_DEI [DEI value]_**censuspoints_properties**.csv

Example: NZ_South_Plot_DEI500_censuspoints_properties.csv

Plot name	X	Y	row	column	Distance	Point Cover	Edge Influence
NewSite014	613873	5277232	355	218	52.08204	90	-37.9196
NewSite015	614050.9	5277363	350	224	-15	38	40.04786
NewSite016	614051.8	5277361	350	224	-15	38	40.04786
NewSite017	614053.1	5277358	350	224	-15	38	40.04786

The format is the same as your plot file.
X, Y: geographic coordinates
row, column: cell (pixel) indices in map

Distance: distance to nearest edge (provided for comparison)
Point Cover: Land cover value at plot location
Edge Influence: Edge Influence value at plot location

The CSV file containing landscape metrics is named:
[your map filename]_DEI [DEI value]_**Landscape_metrics**.csv

Example: NZ_South_TreeCover_DEI500_Landscape_metrics.csv

Land Cover map	Non-habitat mask	DEI (in m)	habitat amount (in ha)	configuration index	core score
NZ_South_TreeCover	NZ_South_nonhabitatmask	500	6467.805736	0.18305704	0.43383

Land Cover map:
your map file name without file extension

Non-habitat mask:
your mask file name without extension, if you used one

DEI (in m):
Depth of Edge Influence used to compute the EI amp, in metres

habitat amount (in ha):
Area of land cover above 60 (soft sigmoidal threshold), in hectares

Also see Methods p.27

configuration index:
core score for your landscape at standard scale.
Enables to compare landscapes configurations independently of habitat amount or landscape size.
Low CI indicate convoluted edges, numerous perforations, numerous and small patches
High CI indicate compact landscape, with low or no land cover variations

core score:
Ratio of core area (|EI|<20) in landscape and habitat area (PC>60) in landscape (soft sigmoidal threshold).
This gives the proportion of 'effective area' (area exempt from edge effects) within the habitat.
It is an indication of the amount of edge effects in the landscape, or edge zone. It varies with the size and shape of fragments.

Description of Edge_response outputs (2.5) - species figures

Figures are named:
[your species filename]_[**species_number**]_DEI_[DEI value].tif

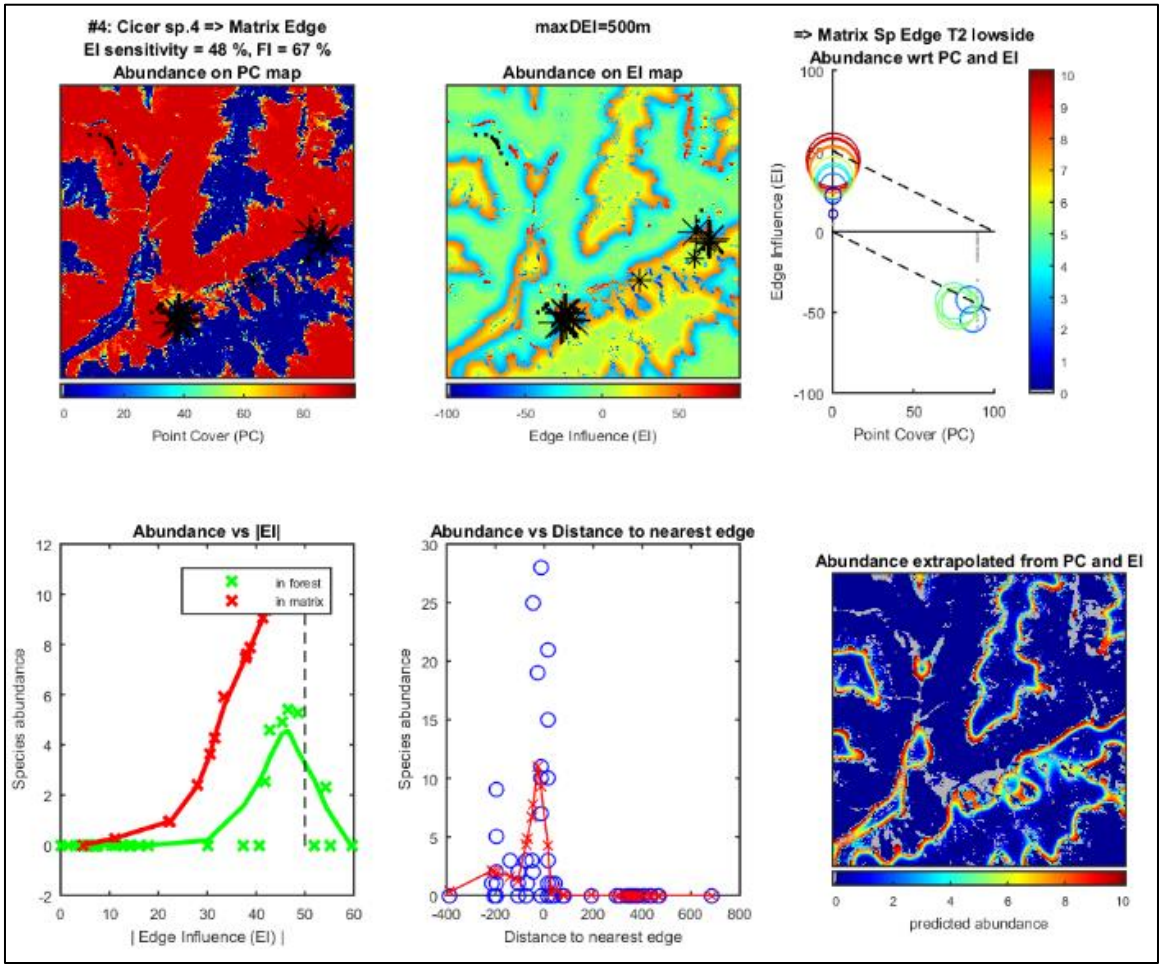
Example: NZ_South_species_matrix_6_DEI_500.tif

There is 1 figure for each species present in the landscape, giving:
species name, number, category, EI sensitivity and Fragmentation Impact (FI),
and showing:

1. Abundance on the land cover map
2. Abundance on the EI map
3. Abundance surface as a function of PC and EI (redder markers mean higher abundance)

   [and for 1,2, and 3 bigger markers mean higher abundance]
4. Abundance curves as a function of |EI|, averaged for PC <40 (matrix), and PC>60 (forest)
5. Abundance curve as a function of distance to nearest edge, for comparison
6. And predicted abundance in the landscape, for PC and EI combinations. This map is used for the computation of the Fragmentation Impact (FI).

   Greyed areas are areas where abundance could not be predicted because of a lack of census points in similar PC and EI values.
   Typically small patches of grassland within forests (forest perforations) are greyed out as few experimenters measure there.



Description of Edge_response outputs (2.6) - log file

There is 1 log file per run and it is named:
Edge_response_log_YYMMDD_HHmmss.txt [date_time the run was started]

Example: Edge_response_log_160825_193055.txt

The log file gives the list of completed operations.
This is useful if the program crashes so you can see where the problem happened.

The log files also gives the list of input files used in the software run, and the list of generated outputs.

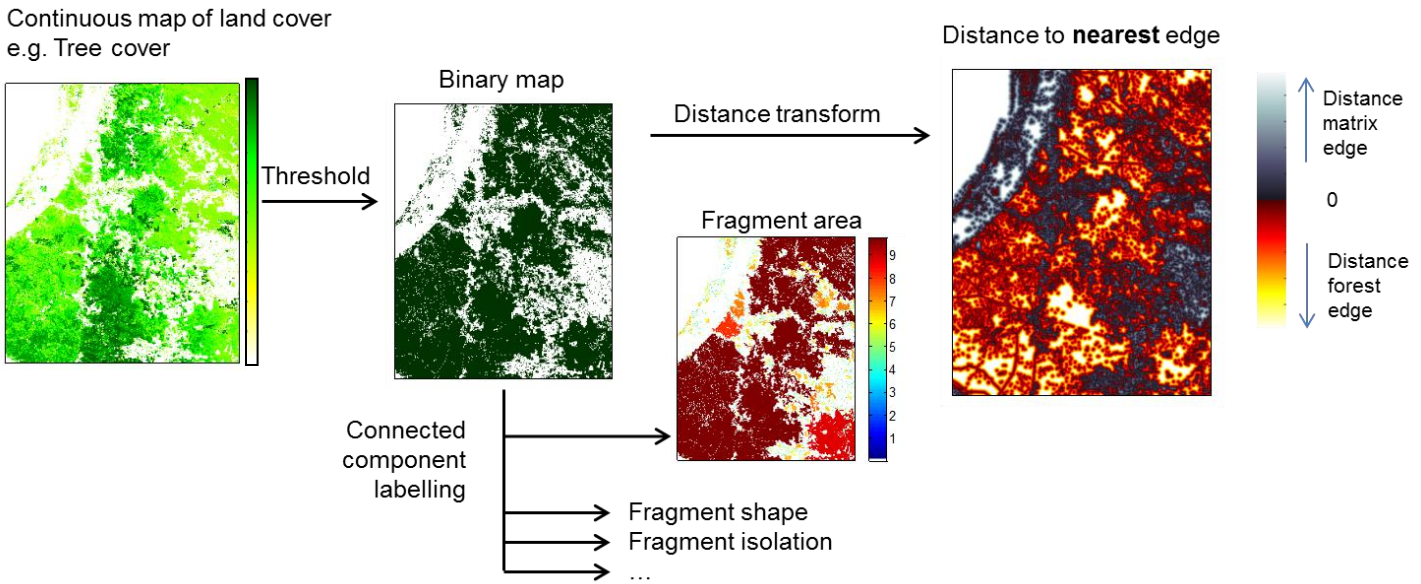
Example:

```
Imported and stored Point Cover map from file: D:\Terragen\Main_projects\Software_Edge_response_runtime\Edge_response_Data_Input\NZ_South_TreeCover.tif
Imported and stored mask map from file: D:\Terragen\Main_projects\Software_Edge_response_runtime\Edge_response_Data_Input\NZ_South_nonhabitatmask.tif
Imported census points from file: D:\Terragen\Main_projects\Software_Edge_response_runtime\Edge_response_Data_Input\NZ_South_Plot.csv
Imported species matrix from file: D:\Terragen\Main_projects\Software_Edge_response_runtime\Edge_response_Data_Input\NZ_South_species_matrix.csv
Files D:\Terragen\Main_projects\Software_Edge_response_runtime\Edge_response_Data_Input\NZ_South_Plot.csv and
D:\Terragen\Main_projects\Software_Edge_response_runtime\Edge_response_Data_Input\NZ_South_species_matrix.csv have been successfully checked and stored
* Edge response is computed using the following files:
-> Point Cover map: D:\Terragen\Main_projects\Software_Edge_response_runtime\Edge_response_Data_Input\NZ_South_TreeCover.tif
-> mask map: NZ_South_nonhabitatmask.tif
-> Census point coordinates: D:\Terragen\Main_projects\Software_Edge_response_runtime\Edge_response_Data_Input\NZ_South_Plot.csv
-> Species abundance matrix: D:\Terragen\Main_projects\Software_Edge_response_runtime\Edge_response_Data_Input\NZ_South_species_matrix.csv
[…]
... computation of Edge Influence map
A Depth of Edge Influence (DEI) of 500m has been selected to match the experimental design.
computed LC, SD, EI maps with Depth of Edge Influence = 500 for map NZ_South_TreeCover
... computation of Edge Influence for each census point + smoothed species abundance
plot PC and LCopt and HDopt added in plotLoc for D:\Terragen\Main_projects\Software_Edge_response_runtime\Edge_response_Data_Matlab\NZ_South_Plot_plots.mat
... smoothing each species abundance wrt PC/EI for NZ_South_species_matrix
species abundance smoothed wrt PC/EI for NZ_South_species_matrix
[…]
Binary map exported to tif for NZ_South_TreeCover
Distance map exported to tif for NZ_South_TreeCover
EI map exported to tif for NZ_South_TreeCover
census points properties saved as CSV for NZ_South_Plot
species abundance smoothed wrt PC and EI saved as CSV for NZ_South_species_matrix
species category DEIopt saved as CSV for NZ_South_species_matrix
species POSTERIOR Matrix DEIopt saved as CSV for NZ_South_species_matrix
Landscape metrics saved as CSV for NZ_South_TreeCover
8 output files were generated in total, overwriteL = 0 and overwriteD = 0.
 ****** Edge response completed successfully for NZ_South_TreeCover, NZ_South_Plot, and NZ_South_species_matrix
You can view the Edge response outputs in D:\Terragen\Main_projects\Software_Edge_response_runtime\Edge_response_Data_Output. Bye for now
```

Methods (1) – Assessing habitat fragmentation

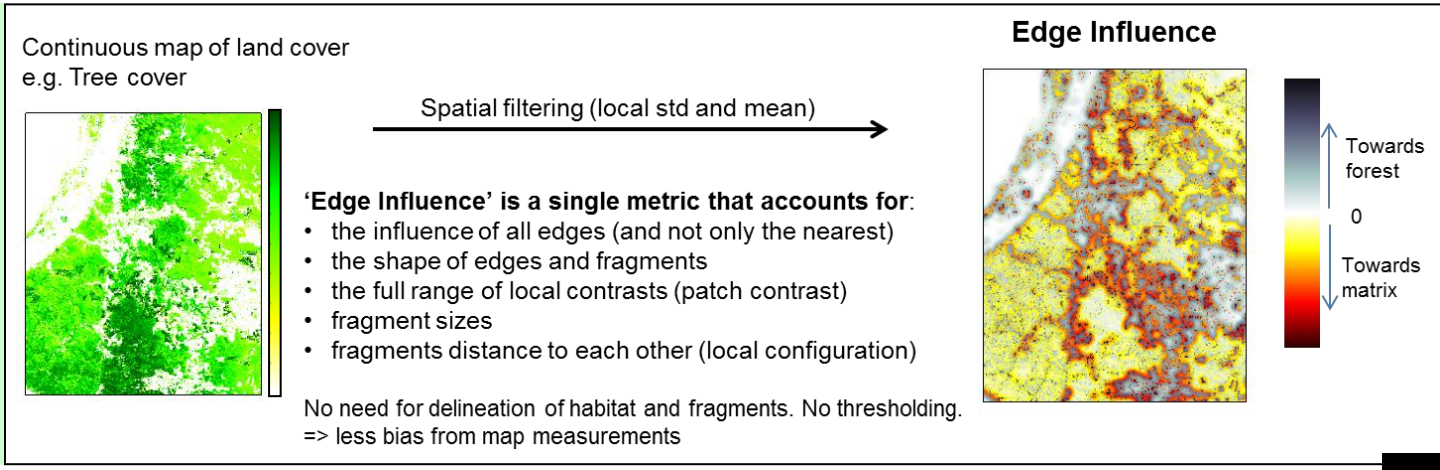
Standard method to assess habitat fragmentation:

- Plurality of interdependent metrics
- Multiple edge effects and patch contrast often overlooked
- Species response difficult to interpret



Our method: Computation of an Edge Influence map

- Spatial approach
- Fully describes landscape composition and configuration
- Clarifies species abundance variations through fragmented landscapes



Methods (2) – Edge Influence (EI)

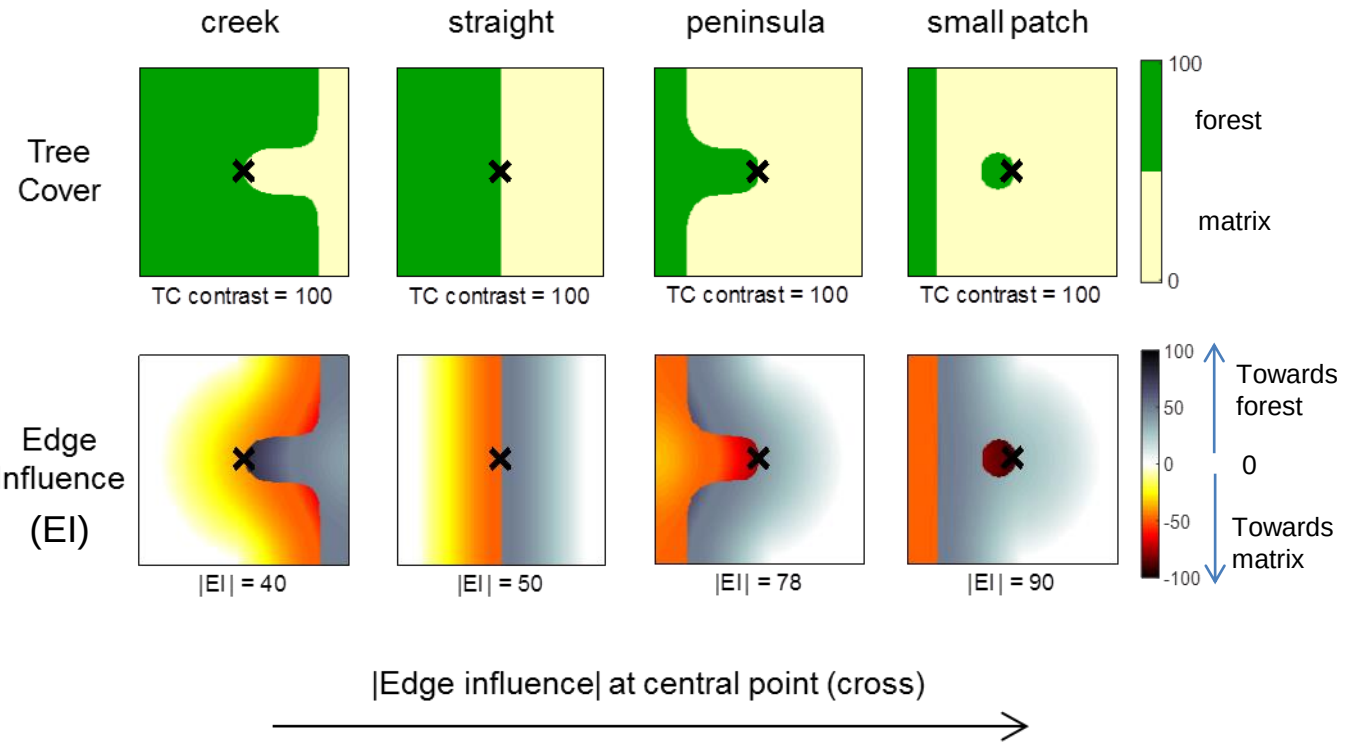
$$EI = \max (SD, |LC - PC|) \times \text{sign}(LC-PC)$$

where:
PC is Point Cover: a map of land cover (e.g. tree cover)
SD is the local PC Standard Deviation within a Depth of Edge Influence (DEI) radius, typically 1km
LC is the Local average Cover within the same DEI radius
LC-PC is the point deviation
LC and SD are computed with 2D Gaussian filters of sigma = DEI / (2 x map resolution)

EI is the maximum of the standard and point deviations within a DEI radius, with the sign of the point deviation.

EI maps for different basic land cover configurations:

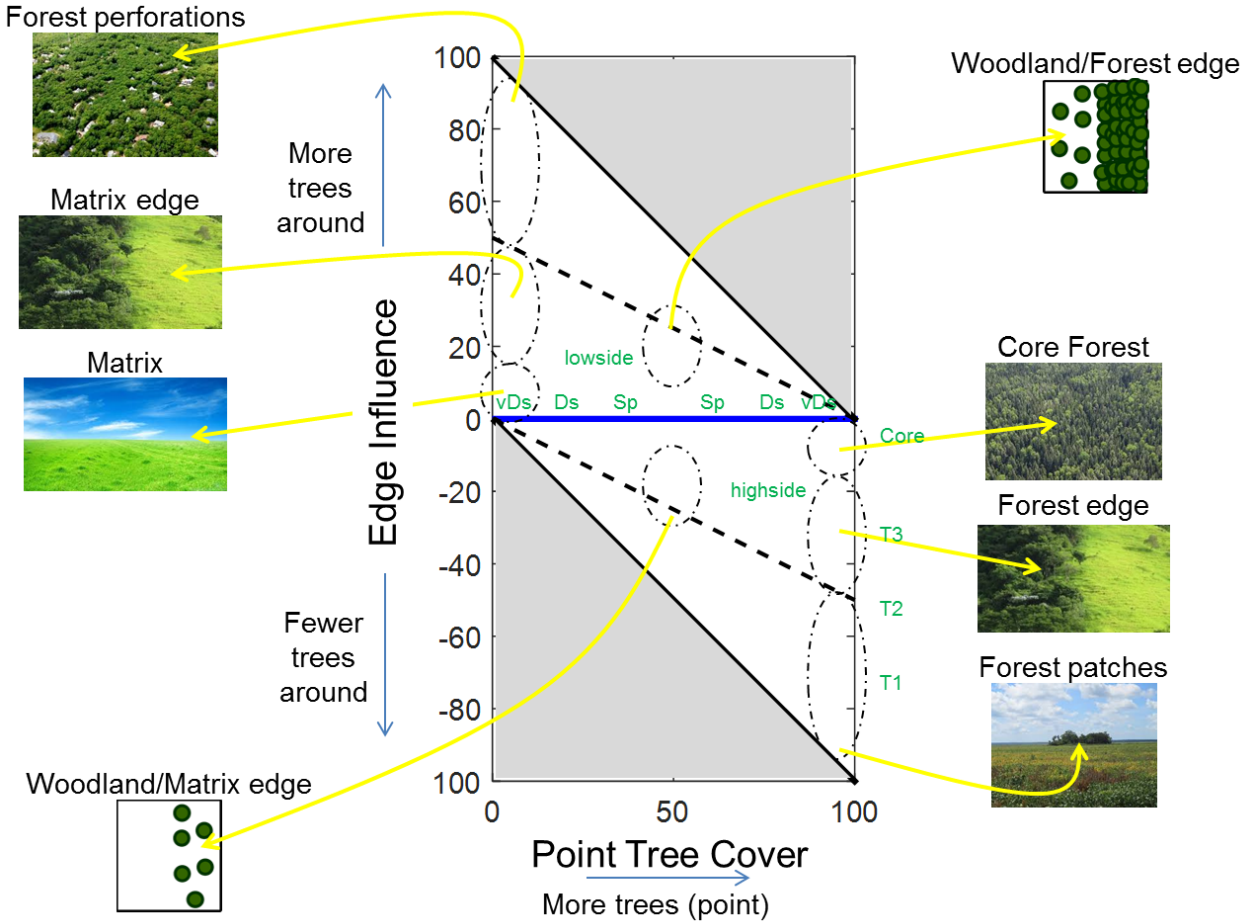
EI varies with distance to edges, edge shape, fragment size, fragment proximity.
EI also varies with patch contrast (not shown)

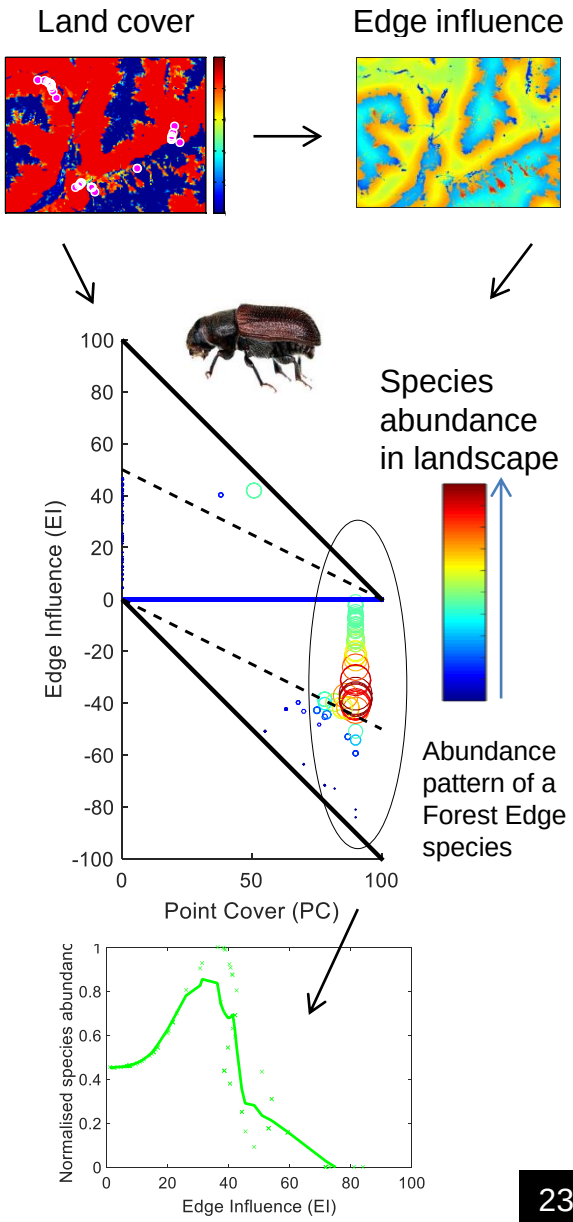


Methods (3) – Species response to Edge Influence

We analyse the species response to Edge Influence (EI) and to Point tree Cover conjointly.

This allows to fully account for patch contrast, and the species sensitivity to tree cover, as well as to EI. Combinations of tree cover and EI denotes different landscape configurations:

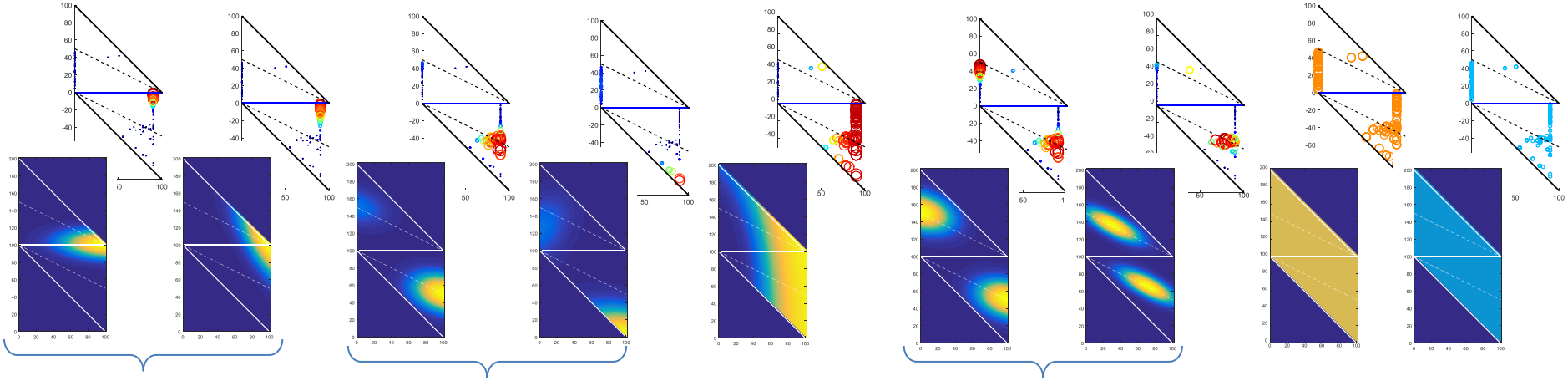




Methods (4) – Automated edge response classification

Automated classification of species response to Edge Influence and land cover:

Using a Naïve Bayes classifier, and a pattern training set on the tree cover / EI graph:



Forest Core

Forest Edge

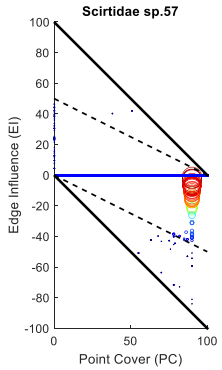
Forest non-sensitive

Generalist edge

Generalist non-sensitive

Unknown

Species abundance pattern to classify



Several patterns per category, not all represented here (>1000 patterns)

If areas of the graph do not contain any plots, corresponding patterns are excluded from the training set (e.g. if no measurements in forest perforations).

Methods (5) – Species EI Sensitivity (ES)

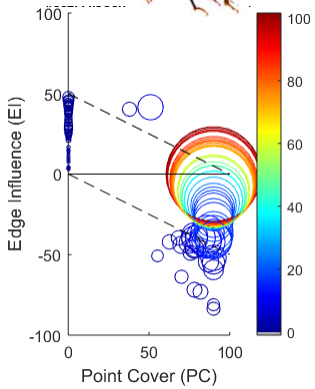
Species EI sensitivity is computed from the species abundance interpolated on the full PC/EI graph:

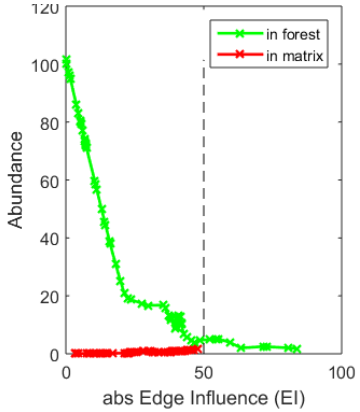
Species abundance in plot locations as a function of PC and EI:

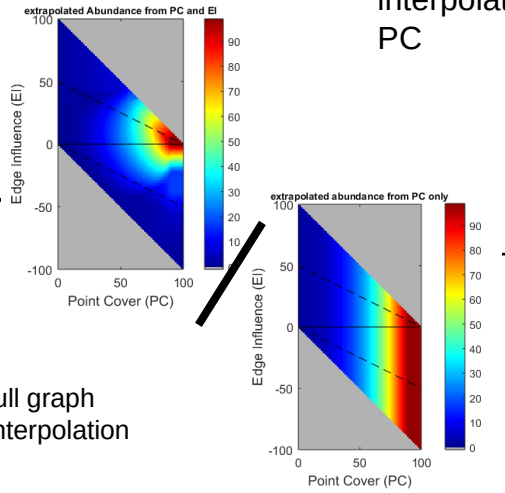
Species abundance in plot locations as a function of |EI| in forest and matrix:

ES = 1 - Σ abundance interpolated with PC and EI / Σ abundance interpolated with PC

Aleocharinae



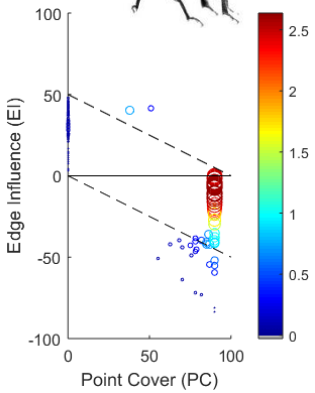


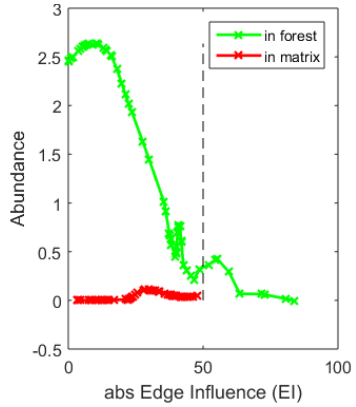
1- 

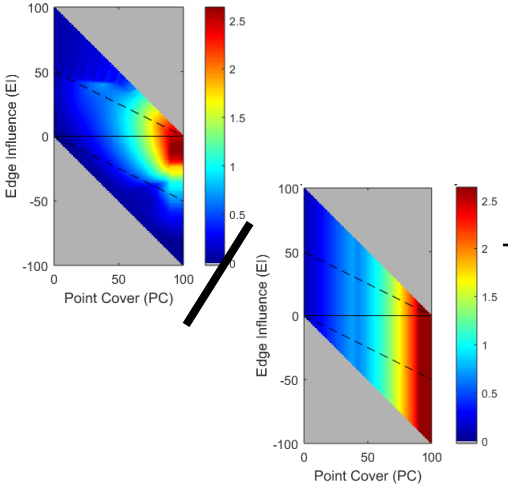
full graph interpolation

→ ES = 0.59

Ocalea



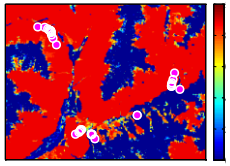


1- 

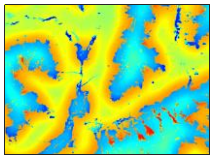
→ ES = 0.48

Methods (6) – Species Fragmentation Impact (FI)

Point Cover



Edge influence

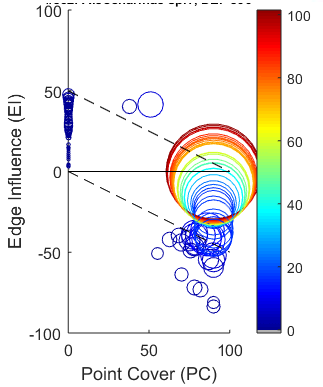


$$\text{Fragmentation Impact} = 1 - \frac{\Sigma \text{ Landscape abundance interpolated with PC and EI}}{\Sigma \text{ Landscape abundance interpolated with PC}}$$

Proportion of individuals lost to the landscape due to edge effects.

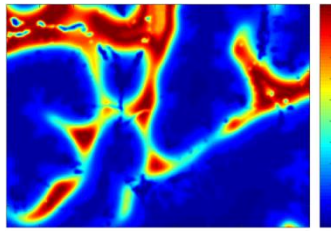
Species abundance measured in landscape

Aleocharinae

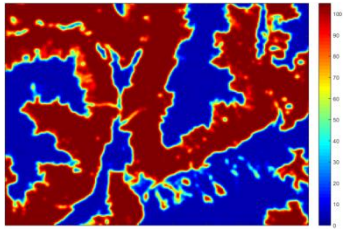


Predicted abundance with:
- Tree Cover
- and Edge Influence

1-



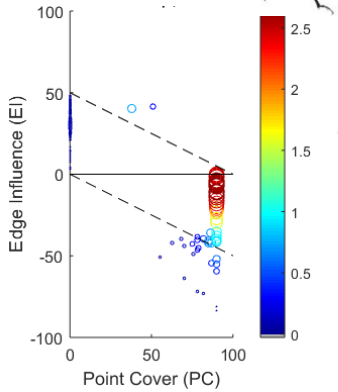
Predicted abundance with:
- Tree Cover



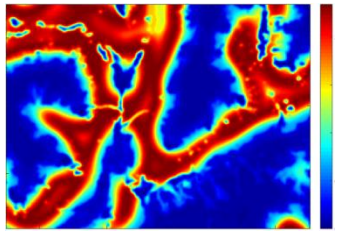
Fragmentation Impact (FI):

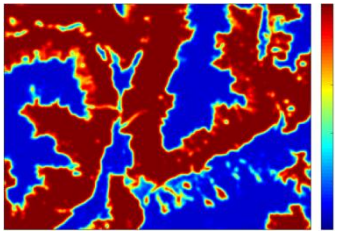
FI = 0.48

Ocalea



1-

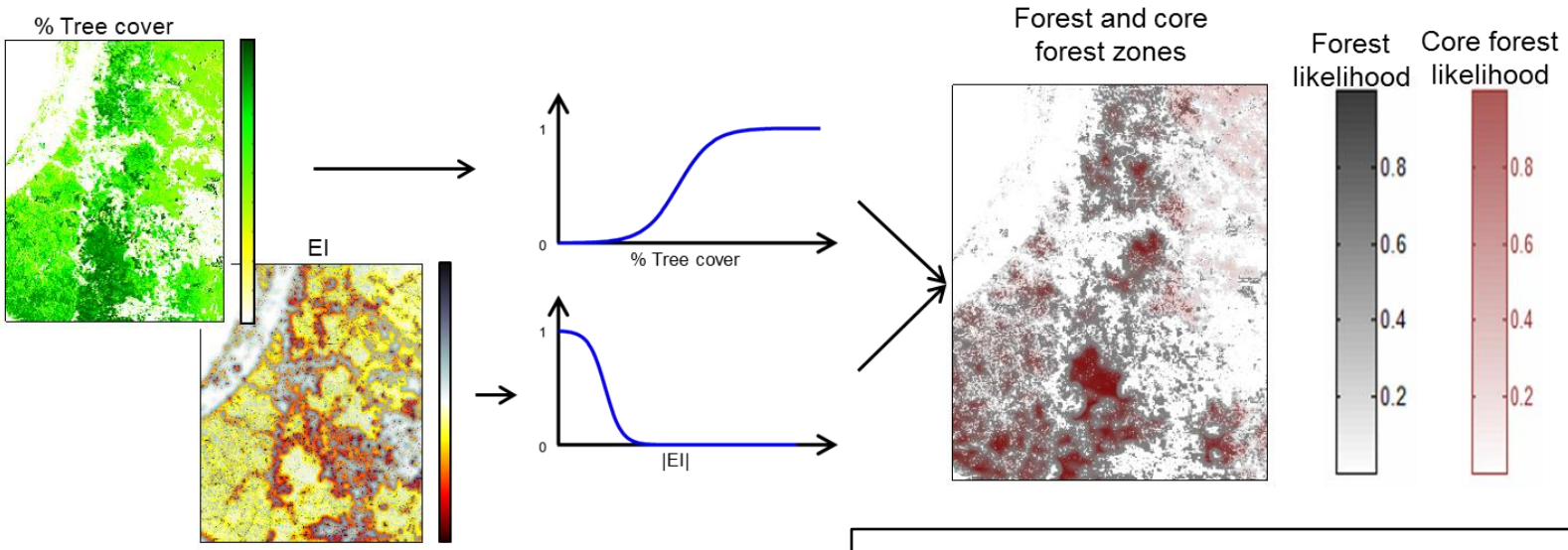




FI = 0.25

Methods (7) – Landscape metrics

Landscape metrics are computed by first detecting core and habitat zones via soft sigmoidal thresholds of EI and Point Cover, respectively:



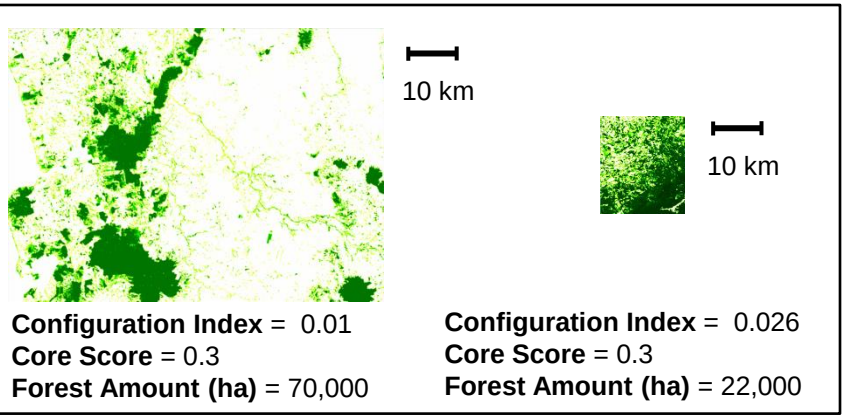
Forest Core score = $\frac{\sum core\ likelihood \times forest\ likelihood}{\sum forest\ likelihood}$

The Forest Core score is equivalent to the ratio of core forest area and forest area ($\frac{Core\ Forest\ area}{Forest\ area}$), except with soft thresholds.

Configuration Index = Forest Core Score computed with an EI map where DEI is rescaled with respect to the size of the landscape:

DEI_used_for_CI = $\frac{\sqrt{area\ of\ clipped\ map\ in\ m^2}}{10}$

This is a relative index, useful to compare configuration across landscapes independently of size, as long as the same relative DEI reference is used.



Comparison of landscapes of similar Core Score but different size and configuration index.

Useful to disentangle the effects of habitat amount and configuration.
(c.f.: Fahrig, L., 2003. Effects of habitat fragmentation on biodiversity.)

Edge_response software: Contribute!
Open license – Source code available

The source code for the Edge_response software is hosted on GitHub: https://github.com/VeroL/BioFrag

The code is in Matlab R2012a, but we are working to re-write in Python 3.

We are open to all contributions, and you can also use the code in your own project.

We are currently using a GNU GENERAL PUBLIC LICENSE: http://choosealicense.com/licenses/gpl-3.0/

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Patent Use	State Changes	
Private Use		

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