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Indicators from existing spatial data - forest fragmentation

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Table 14.2: Potential indicators on ecosystem condition

Ecosystem condition indicators	Further description	Spatial unit	Disaggregation	Unit of measurement
Overall ecosystem condition index		Ecosystem accounting area	Ecosystem type, ecosystem condition classes	Index
Physical state indicator	Overall physical state characteristics of an ecosystem asset (including characteristics on soil structure, water availability)	Ecosystem type	Ecosystem condition sub-classes	Index
Chemical state indicator	Overall chemical state characteristics of an ecosystem asset (including characteristics on soil nutrient levels, water quality, air pollutant concentrations)	Ecosystem type	Ecosystem condition sub-classes	Index
Compositional state indicator	Overall compositional state characteristics of an ecosystem asset (including characteristics on species diversity)	Ecosystem type	Ecosystem condition sub-classes	Index
Structural state indicator	Overall compositional state characteristics of an ecosystem asset (including characteristics on vegetation, biomass, food chains)	Ecosystem type	Ecosystem condition sub-classes	Index
Functional state indicator	Overall functional state characteristics on an ecosystem asset (including characteristics on ecosystem process, disturbances regimes)	Ecosystem type	Ecosystem condition sub-classes	Index
Landscape / seascape indicator	Overall characteristics on landscape (including landscape diversity, connectivity fragmentation, embedded semi-natural elements in farmland)	Ecosystem type	Ecosystem condition sub-classes	Index

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SEEA

UNSD (2020).

SEBI 013 (Streamlining European Biodiversity Indicators)

INDICATOR ASSESSMENT

Fragmentation of natural and semi-natural areas

https://www.eea.europa.eu/data-and-maps/indicators/fragmentation-of-natural-and-semi-1/assessment-1

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A proposal for an integrated modelling framework to characterise habitat pattern

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Habitat landscape pattern and connectivity indices

Used at varying spatial scales for harmonized reporting in the EBONE project

Alterra Report 2297
ISSN 1566-7197

C. Estreguil, G. Caudullo and C. Whitmore

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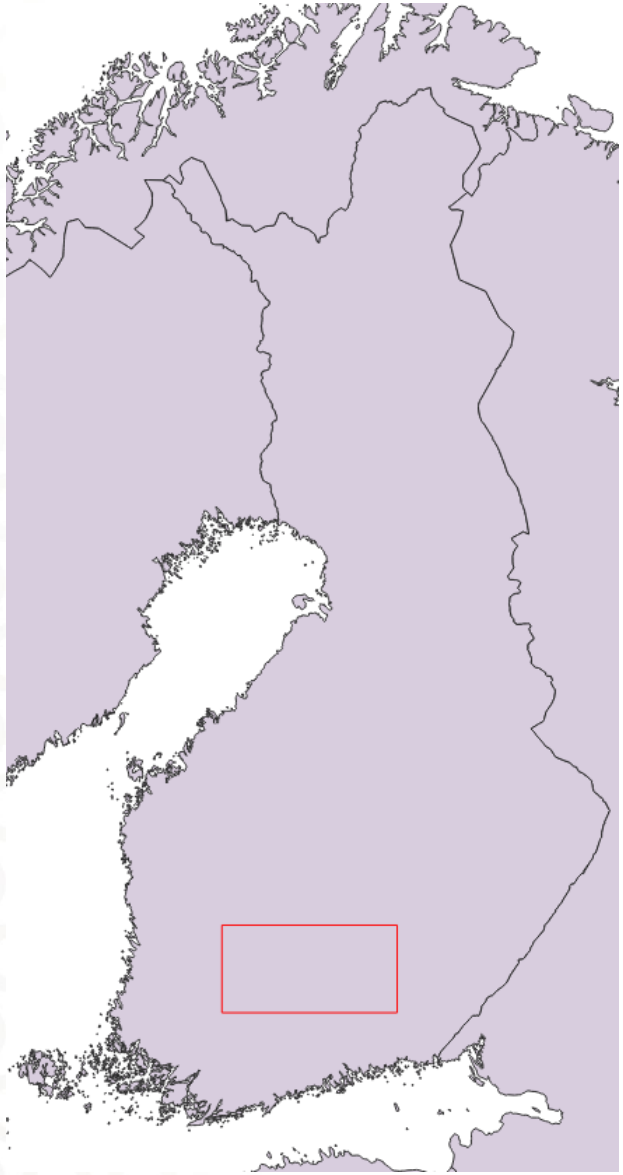
Test study area: NFI mapsheet M4



Total area of EAA: 18 432 km^2
Accounting year: 2017
Reference year: 2009
Ecosystem types (focal habitats):

- *Spruce* -dominated forests
- *Pine* -dominated forests
- *Deciduous* -dominated forests
- *All forests* together

Software:

- QGIS
- GRASS
- Guidos Toolbox

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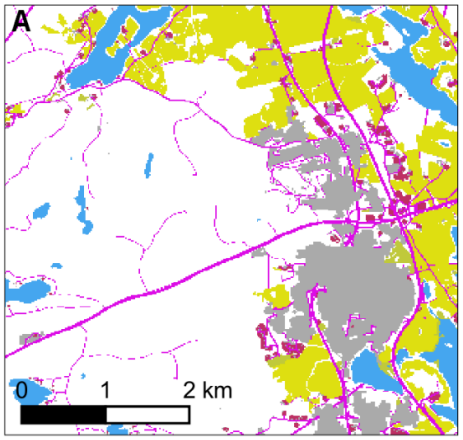
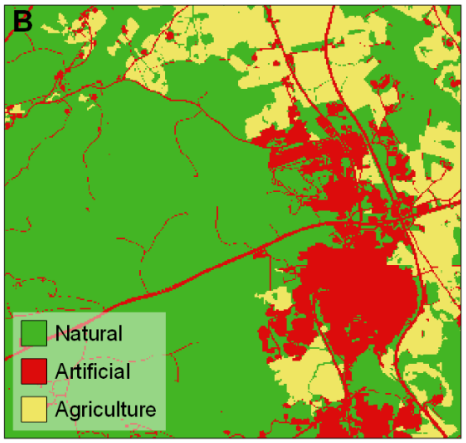
Source data

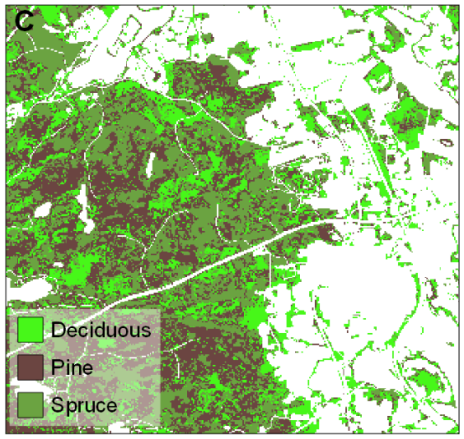
Model input
(grain: 16 m)



Topographic map (NLS), rasterized



Reclassified to general landscape components



MS-NFI (LUKE), extent of focal forest habitat types

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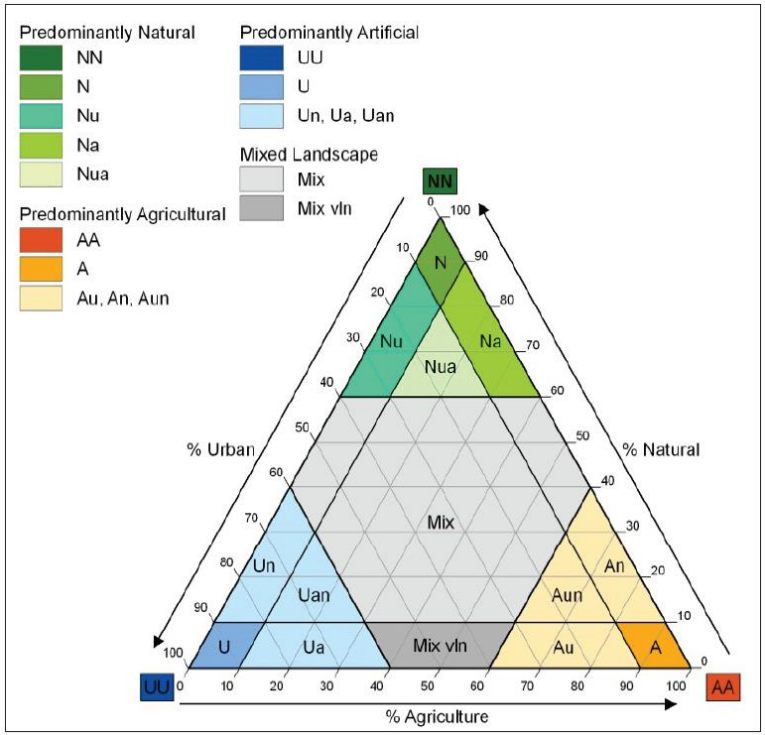
Moving window analysis to calculate landscape mosaic model

			3			
			2			
			1			
3	2	1		1	2	3
			1			
			2			
			3			

Window size	7x7	pix
Pixel size	16	m
Pixel area	256	m^2
Pixel count in window	49	pix
Area coverd by window	1,3	ha
Edge width	48	m



Estreguil et al. (2011)

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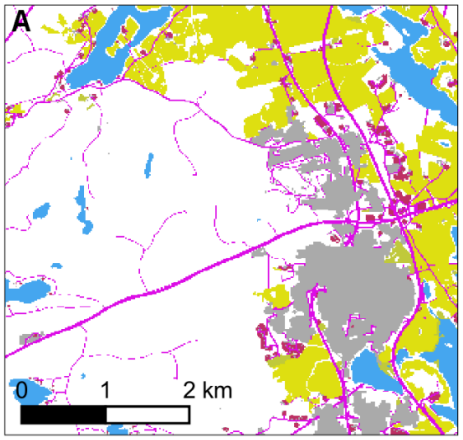
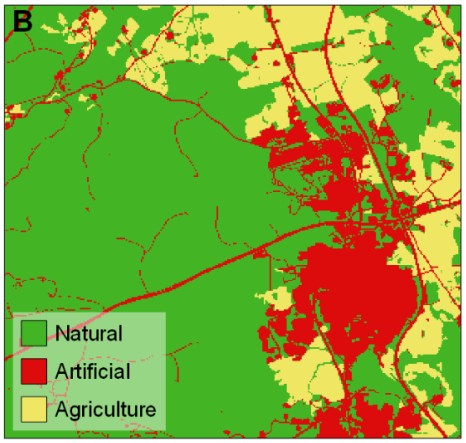
1. General landscape model

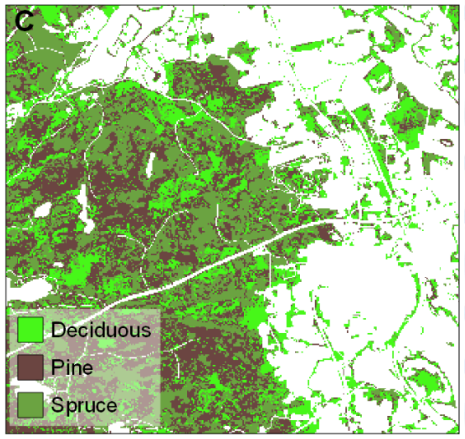
Model input
(grain: 16 m)



Topographic map (NLS), rasterized

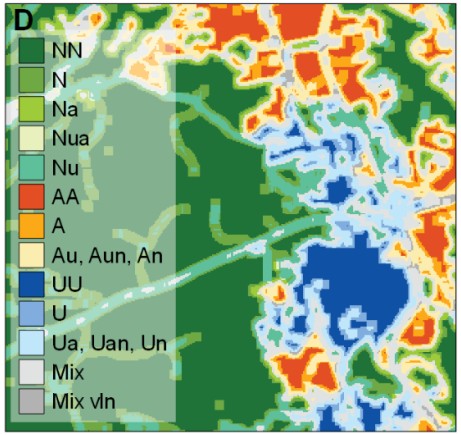


Reclassified to general landscape components

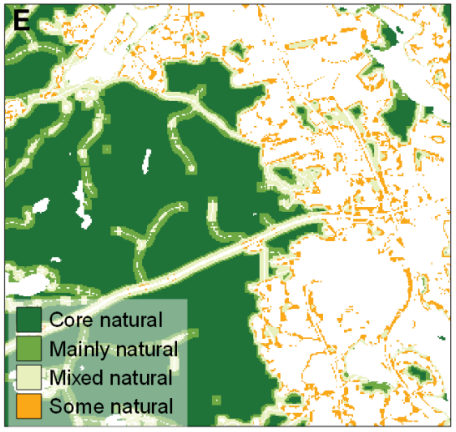


MS-NFI (LUKE), extent of focal forest habitat types

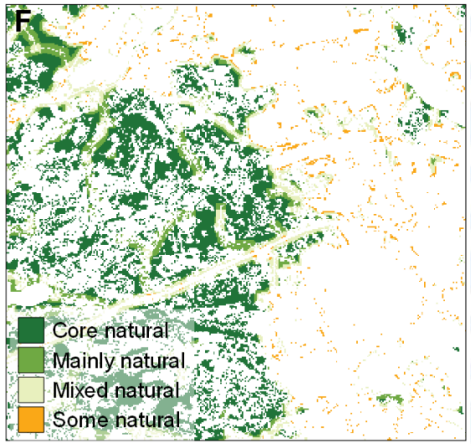
Model output



Landscape mosaic index (dominance of landscape components)



Landscape mosaic index extracted for all forests



Landscape mosaic index extracted for spruce

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Forest ecosystem condition indicators for general landscape context

Indicator	Abbreviation	Measurement unit
Proportion of natural/semi-natural habitat in landscape	NP	%
Proportion of the focal habitat in landscape	FP	%
Proportion of focal habitat in 'core natural' landscape mosaic context	NN-P	%
Proportion of focal habitat in 'mainly natural' landscape mosaic context	N-P	%
Proportion of focal habitat in 'mixed natural' landscape mosaic context	MN-P	%
Proportion of focal habitat in 'some natural' landscape mosaic context	SN-P	%

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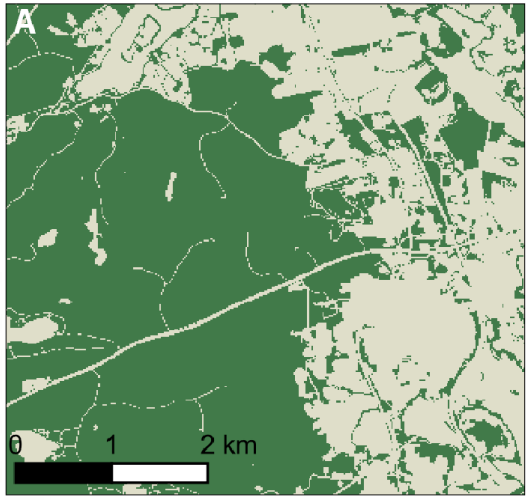
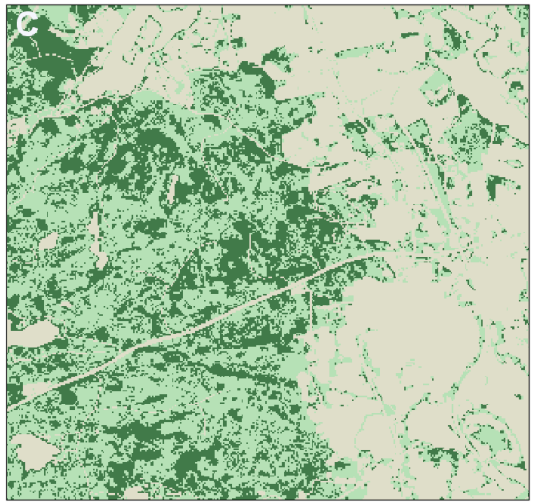
2. Morphological pattern model

Model input



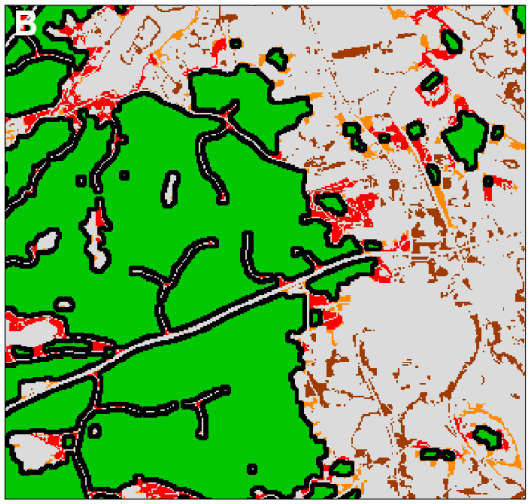
Forest mask, focal habitat: **all forests**



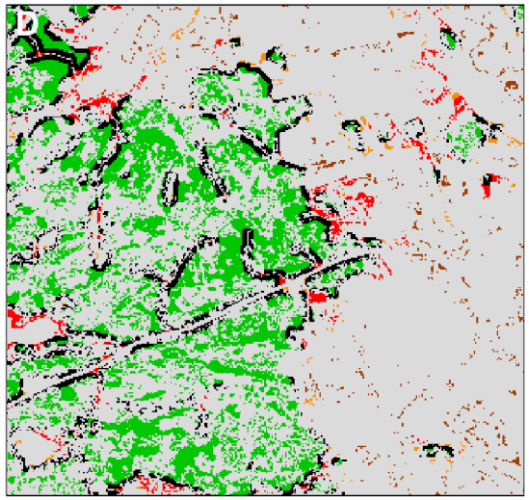
Forest mask, focal habitat: **spruce-dominated forests**

Ignored (non-focal forest habitat)
Background (non-forest)
Foreground (focal forest habitat)

Model output



Morphological model for **all forests**



Morphological model for **spruce-dominated forests**

Edge width: 48 m

Background
Interior (core)
Islet
Boundary
Connector
Branch

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Forest ecosystem condition indicators for morphological patterns

Indicator	Abbreviation	Measurement unit
Proportion of focal habitat in interior	IFP	%
Proportion of focal habitat in interior and in boundaries with natural edge interface (IF + SI-BO_{NN})	IF*P	%
Proportion of focal habitat in islet	ISP	%
Proportion of focal habitat in linear features (boundary, connector and branch)	LIP	%

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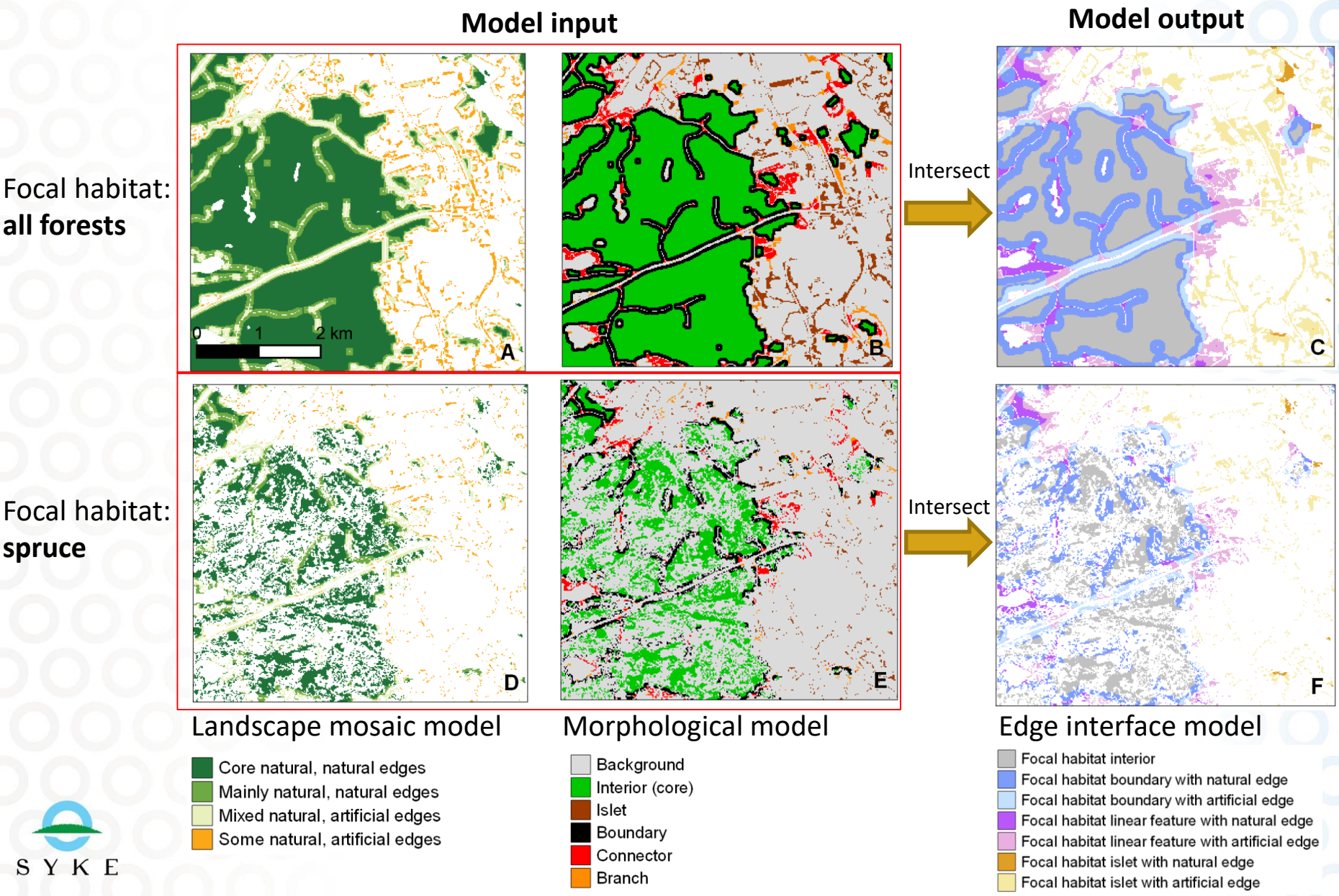
3. Edge interface model



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Forest ecosystem condition indicators for edge interface

Indicator	Abbreviation	Measurement unit
Proportion of focal habitat in boundary with natural edge interface	$SI\text{-}BO_{NN}$	%
Proportion of focal habitat in boundary with artificial edge interface	$SI\text{-}BO_{OTHER}$	%
Proportion of focal habitat in islet with natural edge interface	$SI\text{-}IS_{NN}$	%
Proportion of focal habitat in islet with artificial edge interface	$SI\text{-}IS_{OTHER}$	%
Proportion of focal habitat in linear feature with natural edge interface	$SI\text{-}LI_{NN}$	%
Proportion of focal habitat in linear feature with artificial edge interface	$SI\text{-}LI_{OTHER}$	%

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Forest fragmentation pattern indicators

Forest Ecosystem Condtion Typology: Landscape level charateristics			Accounting area		MVMI mapsheet M4		Accounting area		MVMI mapsheet M4		Accounting area		MVMI mapsheet	
			Reference year		**2009**		**Accounting year**		**2017**		**Accounting year**		**CHANGE 2009-2017**	
			Extent (ha)		1843200		Extent (ha)		1843200		Extent (ha)		1843200	
			Edge width (m)		48		Edge width (m)		48		Edge width (m)		48	
			Neighborhood		7 x 7		Neighborhood		7 x 7		Neighborhood		7 x 7	
			Ecosystem type (i.e. focal habitat)				Ecosystem type (i.e. focal habitat)				Ecosystem type (i.e. focal habitat)			
	Description	Indicator	All forests	Deciduous	Pine	Spruce	All forests	Deciduous	Pine	Spruce	All forests	Deciduous	Pine	Spruce
General landscape	Proportion of natural/semi-natural habitat in landscape	NP	0,848				0,848				#VIITTAUS!			
	Cover of the focal habitat in landscape (ha)	FC	1166594	277803	384769	493170	1166301	308924	378856	504825	-293	31121	-5913	11655
	Proportion of the focal habitat in landscape	FP	0,633	0,151	0,209	0,268	0,633	0,168	0,206	0,274	0,000	0,017	-0,003	0,006
	Proportion of focal habitat in 'core natural' landscape mosaic context	NN-P	0,619	0,505	0,653	0,655	0,606	0,504	0,651	0,635	-0,013	-0,002	-0,002	-0,020
	Proportion of focal habitat in 'mainly natural' landscape mosaic context	N-P	0,178	0,186	0,174	0,178	0,189	0,196	0,182	0,189	0,010	0,011	0,008	0,011
	Proportion of focal habitat in 'mixed natural' landscape mosaic context	MN-P	0,159	0,218	0,143	0,139	0,163	0,215	0,141	0,146	0,004	-0,003	-0,002	0,007
	Proportion of focal habitat in 'some natural' landscape mosaic context	SN-P	0,043	0,091	0,029	0,027	0,042	0,085	0,026	0,029	-0,001	-0,006	-0,004	0,002
Morphology	Proportion of focal habitat in interior	IFP	0,596	0,498	0,626	0,627	0,590	0,497	0,622	0,623	-0,006	-0,001	-0,004	-0,004
	Proportion of focal habitat in interior and in boundaries with natural edge interface (IF + BO_{NN})	IF*P	0,771	0,661	0,797	0,800	0,770	0,669	0,797	0,799	-0,001	0,008	0,000	-0,001
	Proportion of focal habitat in islet	ISP	0,017	0,038	0,017	0,017	0,017	0,036	0,016	0,014	0,000	-0,002	0,000	-0,003
	Proportion of focal habitat in linear features (boundary, connector and branch)	LIP	0,387	0,464	0,357	0,357	0,393	0,467	0,361	0,364	0,005	0,003	0,004	0,007
Interface	Proportion of focal habitat in boundary with natural edge interface	$SI\text{-}BO_{NN}$	0,176	0,163	0,171	0,174	0,180	0,172	0,175	0,176	0,005	0,009	0,004	0,003
	Proportion of focal habitat in boundary with artificial edge interface	$SI\text{-}BO_{OTHER}$	0,107	0,125	0,090	0,091	0,109	0,126	0,084	0,100	0,002	0,001	-0,006	0,009
	Proportion of focal habitat in islet with natural edge interface	$SI\text{-}IS_{NN}$	0,003	0,003	0,003	0,005	0,003	0,003	0,005	0,003	0,000	0,000	0,001	-0,002
	Proportion of focal habitat in islet with artificial edge interface	$SI\text{-}IS_{OTHER}$	0,014	0,036	0,013	0,012	0,014	0,033	0,012	0,011	0,000	-0,002	-0,001	-0,001
	Proportion of focal habitat in linear feature with natural edge interface	$SI\text{-}LI_{NN}$	0,024	0,028	0,027	0,029	0,022	0,029	0,032	0,023	-0,002	0,001	0,005	-0,006
	Proportion of focal habitat in linear feature with artificial edge interface	$SI\text{-}LI_{OTHER}$	0,081	0,147	0,069	0,063	0,081	0,140	0,071	0,065	0,000	-0,007	0,002	0,001

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Conclusion

- **Robust** and **scalable** method for calculating landscape fragmentation indicators
- **Existing national spatial datasets** was used
  - no need for additional data collection
  - enables monitoring forest ecosystem condition through **time** (in Finland, suitable data time series from 2009, 2011, 2013, 2015, 2017)
- **Can be applied for any EAA** – municipality, protected area, region, country…
- Everything was implemented with **free open-source software**, but the process could be further automatized with R or Python
- Further work: definition of **reference level values** for the indicators (upper and lower levels), connectivity and other indicators that could be extracted from existing data?

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