Landscape and Fragmentation Analysis

- Patch Analyst
- Patch Analyst (Grid)

Landscape Ecology

- Study of landscape patterns

- Interaction among patches within a landscape

- Dynamics and change in landscape patterns over time

- Flows of energy, nutrients, and species among landscape elements

Landscape - a mosaic of patches

Patches can represent.....

- Cover types

- Habitat types

- Structural stages of cover types

- Urban development

- Physiographic features

...etc

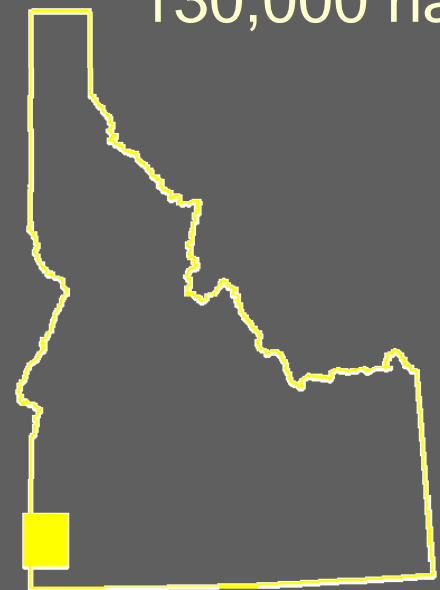Landsat 5 imagery, July 1992

Hurry Back Creek

Current Creek

Smith Creek

Red Canyon Creek

116° W Long, 43° N Lat
Elevation 800-2500 m
Precip. 250 – 1000 mm

130,000 ha

Succession in a Western Juniper Community

Grassland after fire

Mountain big sagebrush steppe

Stand initiation juniper (Phase 1)

Open young juniper (Phase 2)

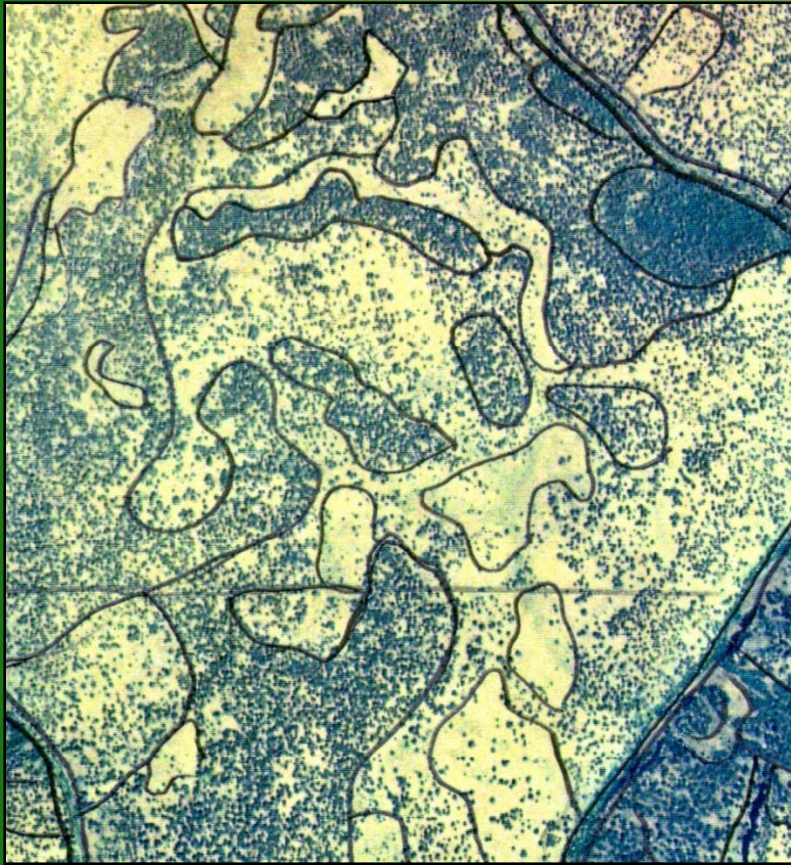Young multistory juniper (Phase 3)

Mature juniper woodland

From Air Photo to
GIS Vegetation Layer
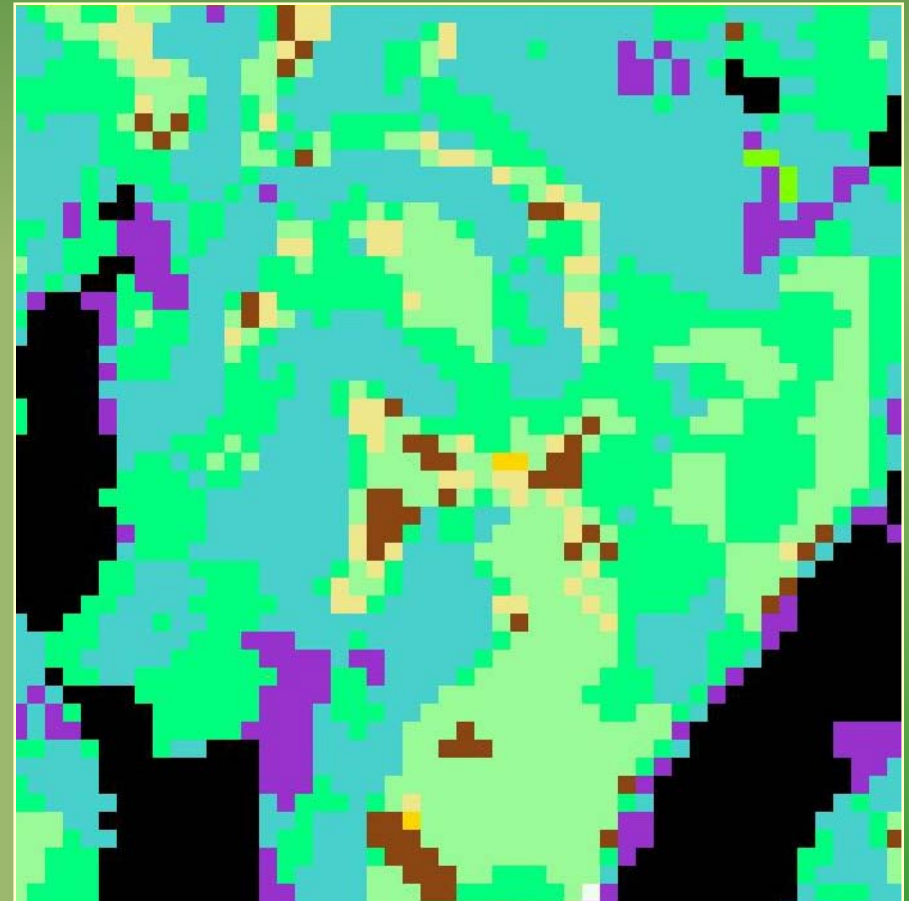
From Satellite Image to
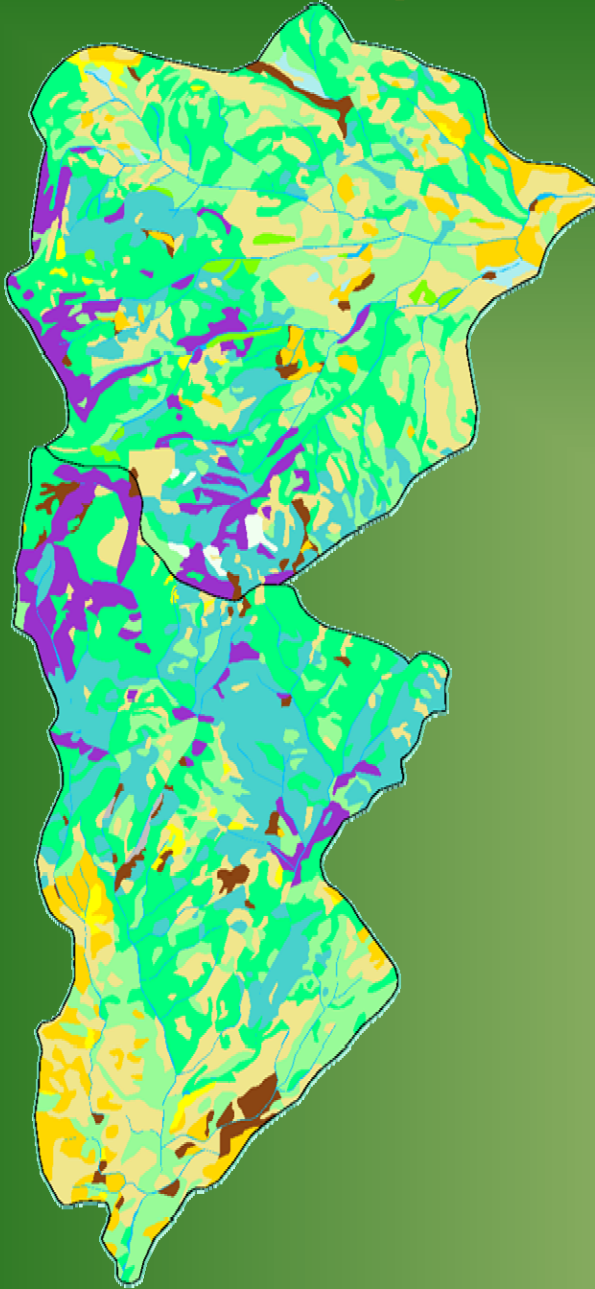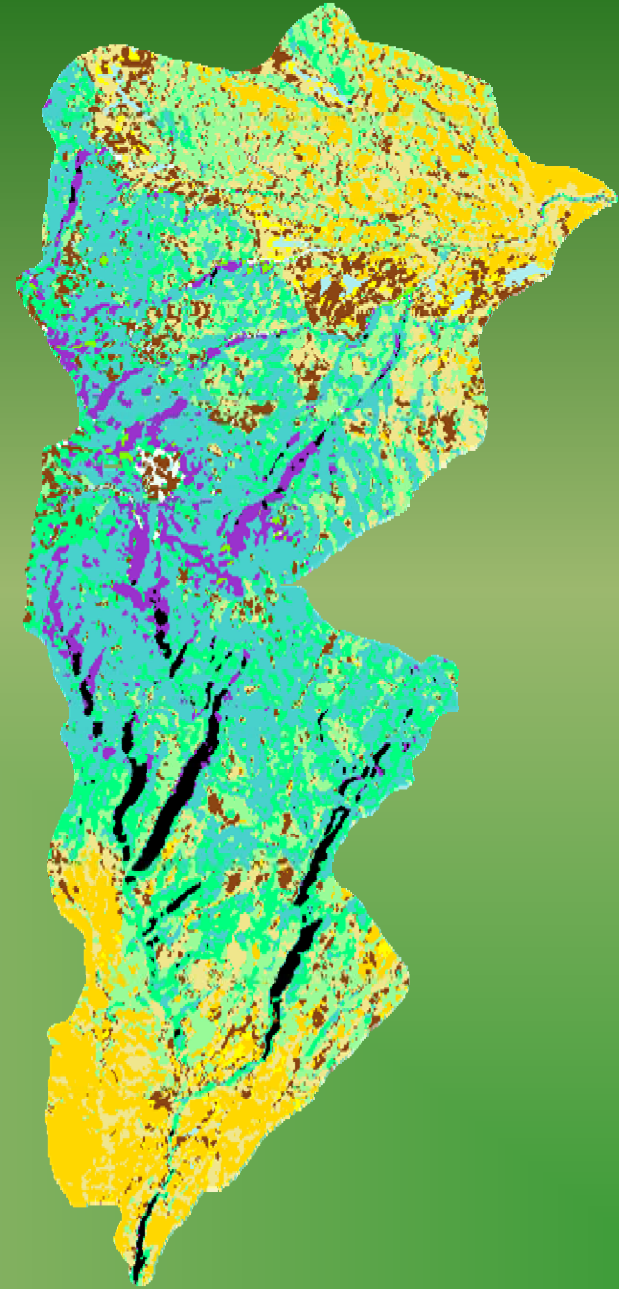## GIS Vegetation Layer

Photo interpretation

Satellite data

Landscape Characteristics

- Patch size and Edge density
- Patch richness
- Shape
- Patch diversity
- Patch evenness
- Spatial distribution / Interspersion
- Nearest neighbor / Proximity
- Core area metrics

Landscape and Fragmentation Analysis Software

- Fragstats 3.3
  - GUI interface
  - Works with many input formats including ArcGIS Grids (rasters)
  - Landscape, Class and Patch analyses
  - Allows the user to select output metrics
  - Moving window analysis
  - Batch processing

http://www.umass.edu/landeco/research/fragstats/fragstats.htm

Landscape Metrics

Mean Shape Index

Nearest neighbor

Shannon's Diversity Index

Mean Patch Size

Edge Density

Core Area Density

?

Evenness

Contagion

Proximity Index

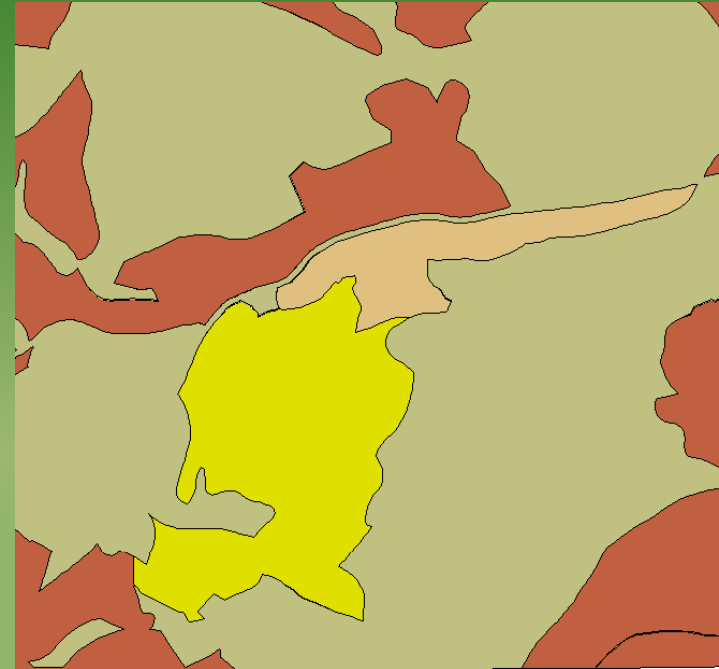Patch Size Standard Deviation

Interspersion Juxtaposition

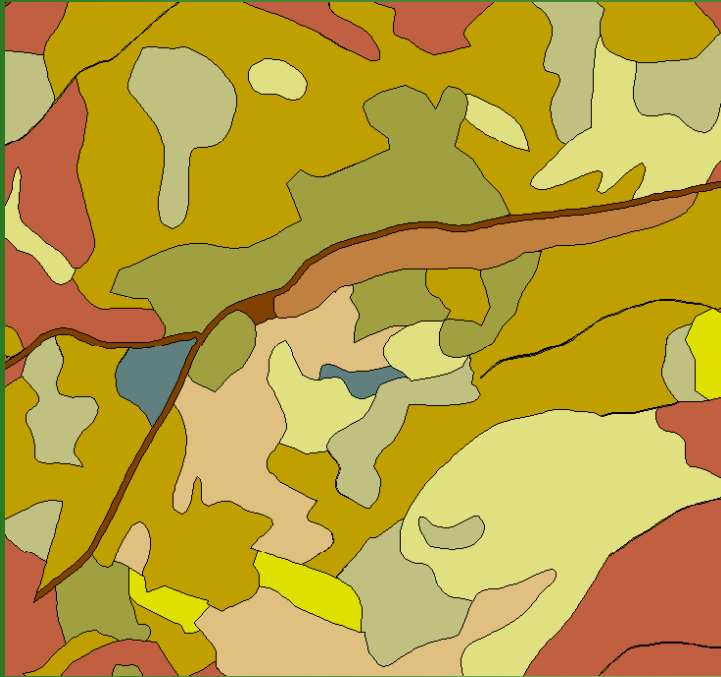Patch Richness

Patch Size
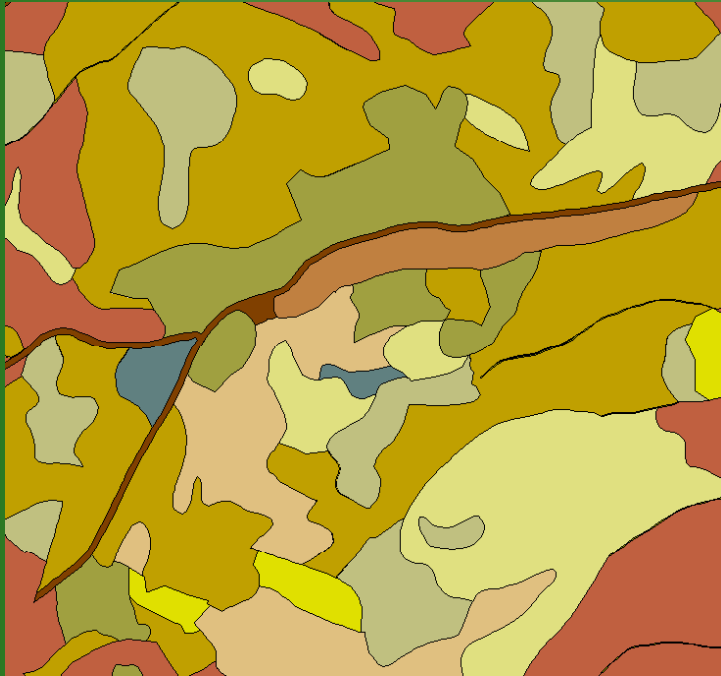
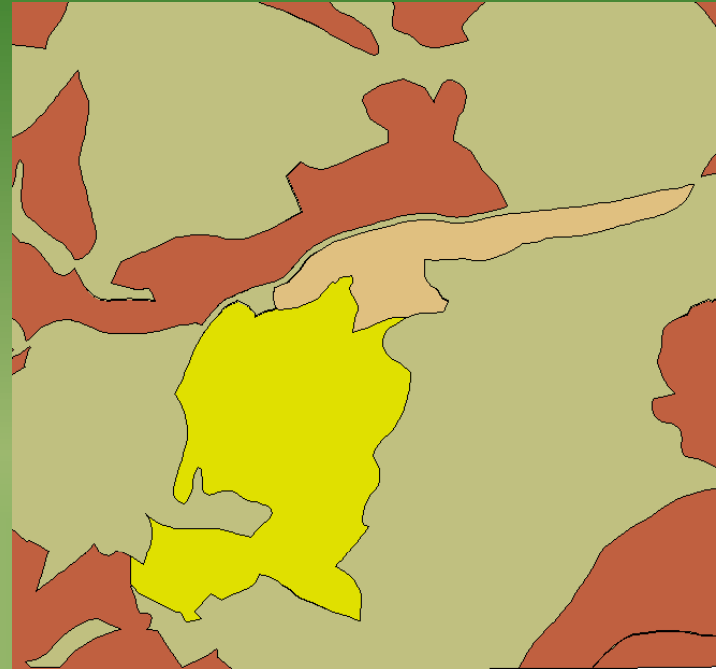MPS = 8.5 ha
MedPS = 4.0 ha
PSSD = 13.1 ha

MPS = 30.3 ha
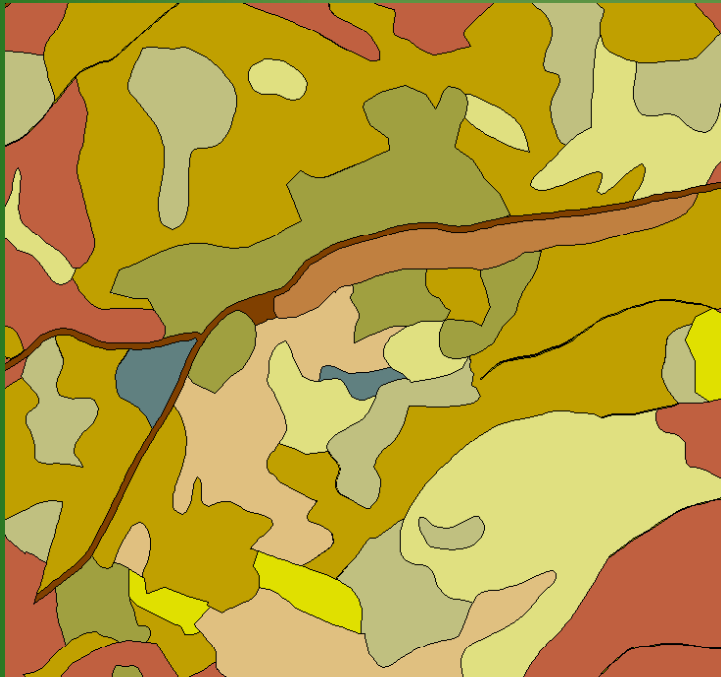MedPS = 4.0 ha
PSSD = 74.7 ha

Edge Density

TE = 104 km
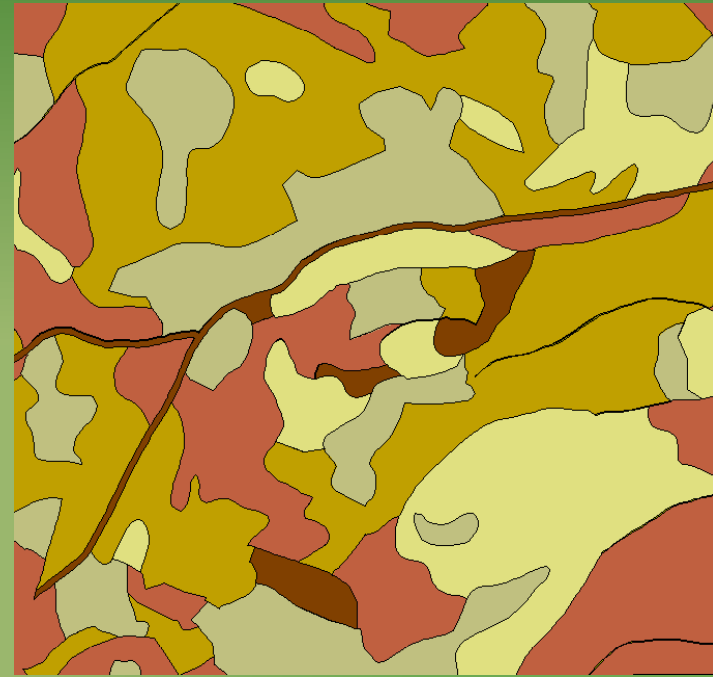ED − 0.019 m/m²

TE = 56 km
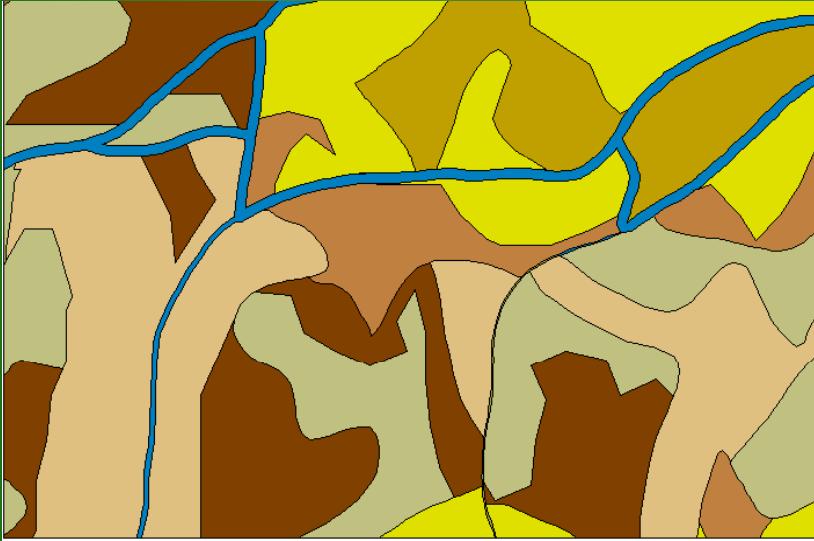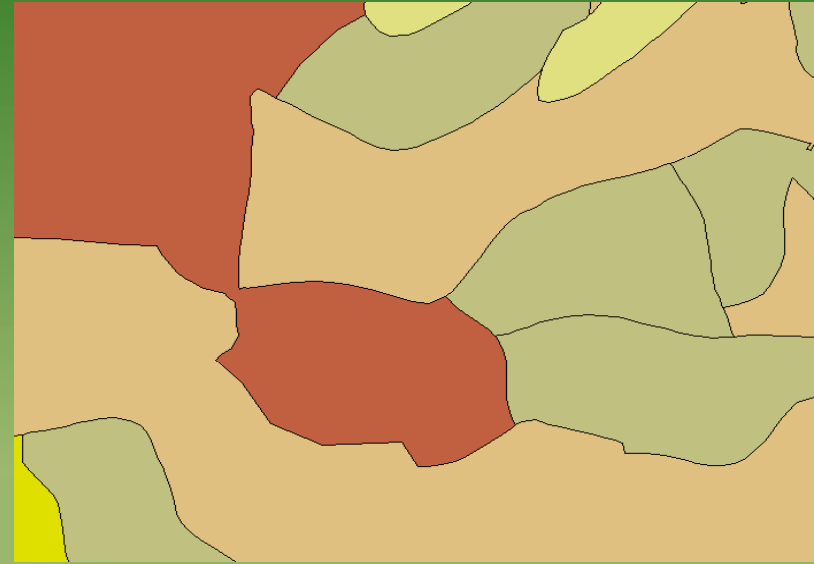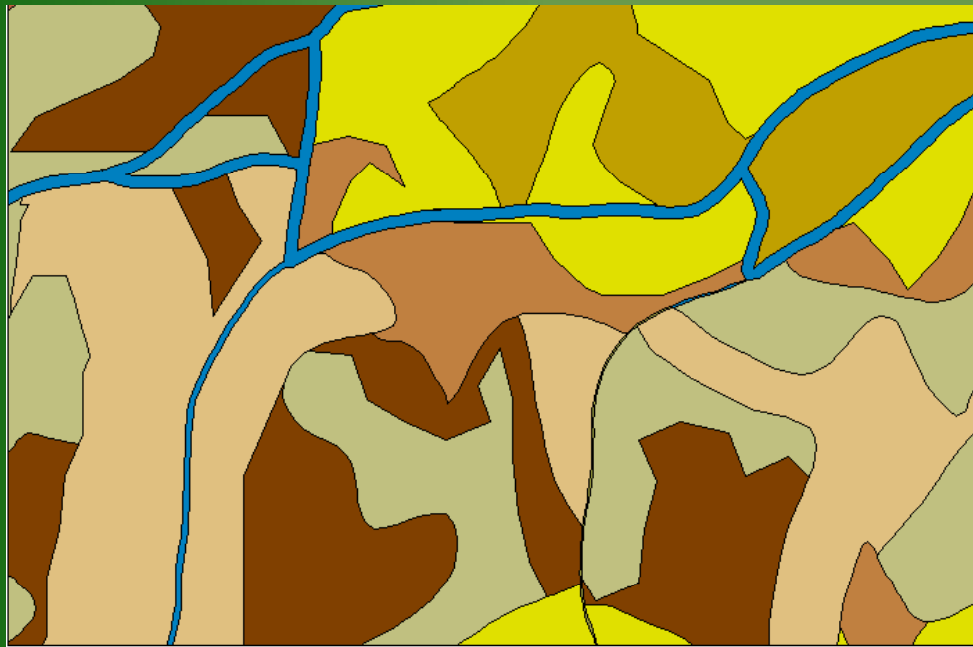ED = 0.010 m/ m²

Patch Richness

PR = 12

PR = 5

Patch Shape

MSI = 1.93
AWMSI = 1.74
MPAR = 4419 m/ha

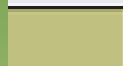MSI = 1.26
AWMSI = 1.41
MPAR = 1147 m/ha

Mean Shape Index is 1 when all patches are circular and increases as the patches become more irregular.

Patch Shape by class

	MSI	MPAR m/ha
	1.22	2846
	1.31	627
	1.38	335
	1.52	209
	2.00	1429
	3.04	26813 *slivers*
	7.77	1128
	7.25	6632
	1.44	361
	1.40	298

Patch Diversity and Evenness
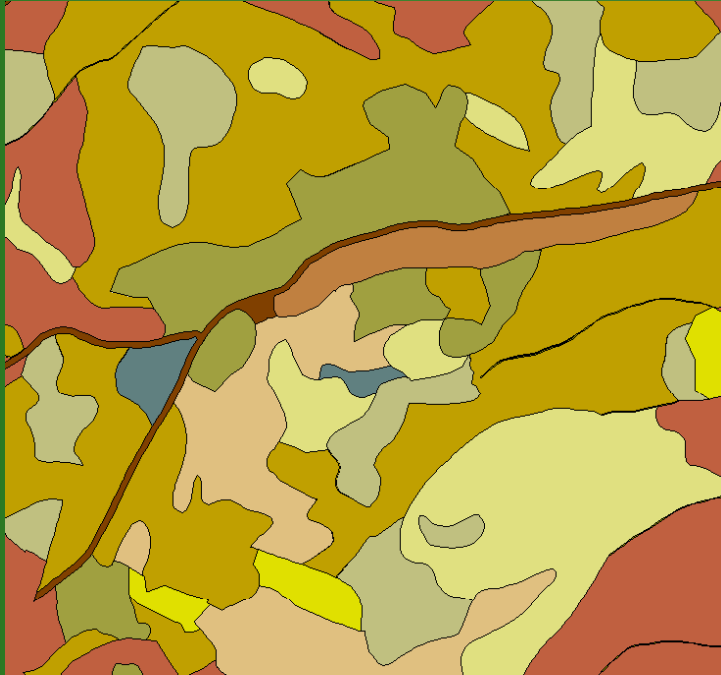
SDI = 2.16
SEI = 0.94
PR = 12

SDI = 1.66
SEI = 0.94
PR = 5

Diversity varies with Patch Richness while Evenness is independent of Patch Richness.

Patch Diversity and Evenness

SDI = 2.33
SEI = 0.94
PR = 12
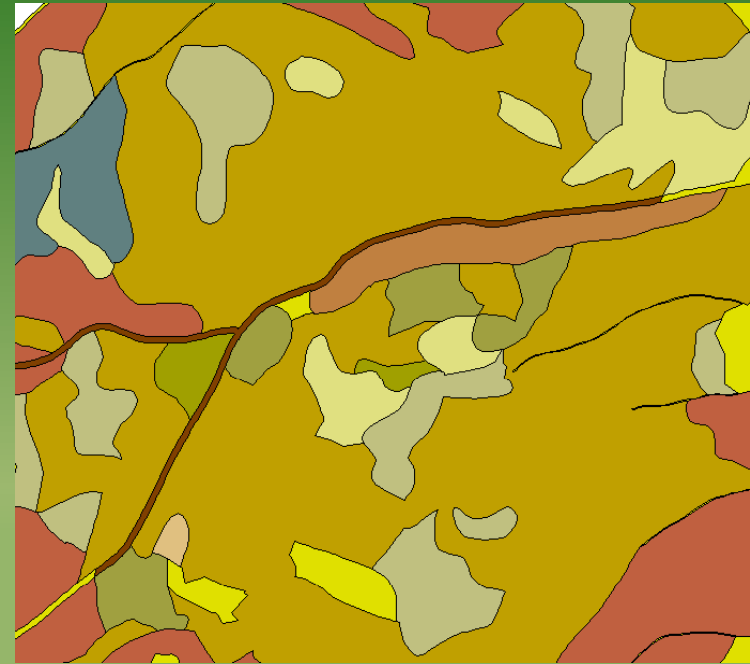
SDI = 2.00
SEI = 0.81
PR = 12

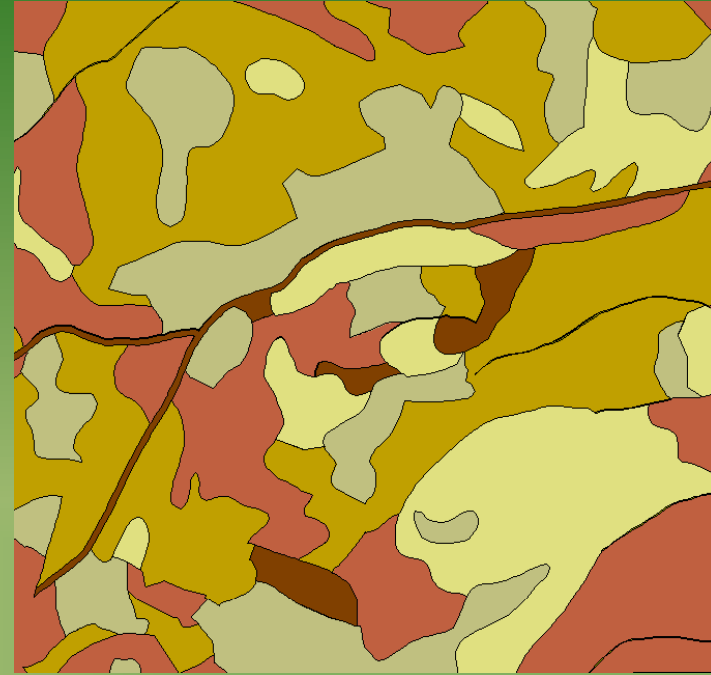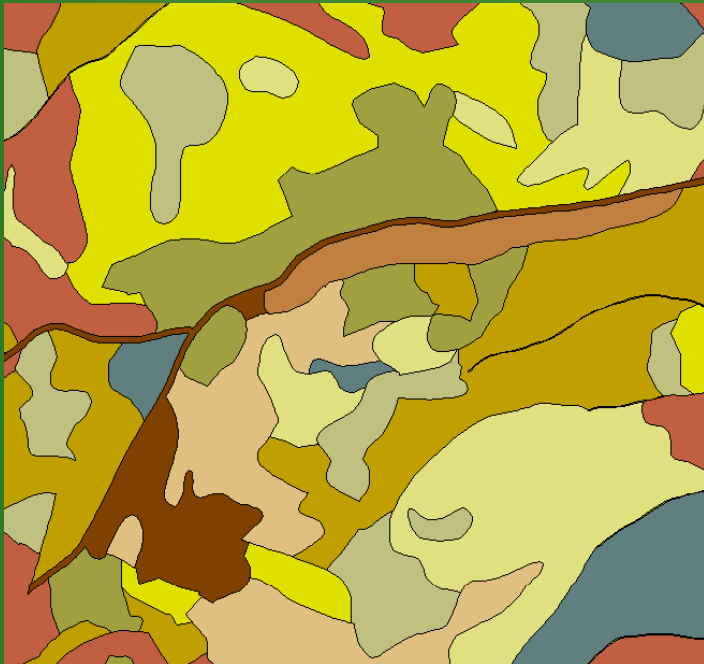*Shannon's Diversity and Evenness Index both reflect the relative distribution in area between patch types. Spatial distribution is not accounted for.*

Patch Isolation / Fragmentation
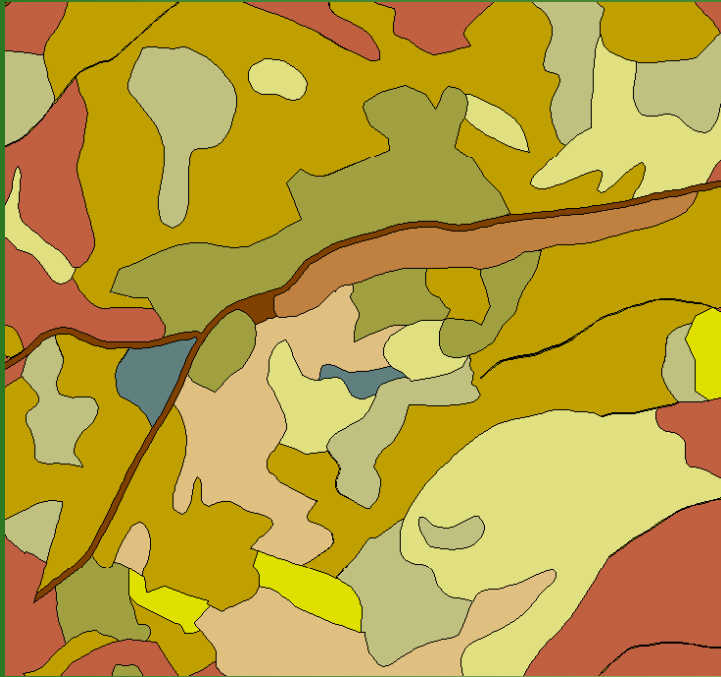
MNN = 96.3
MPI = 86.0
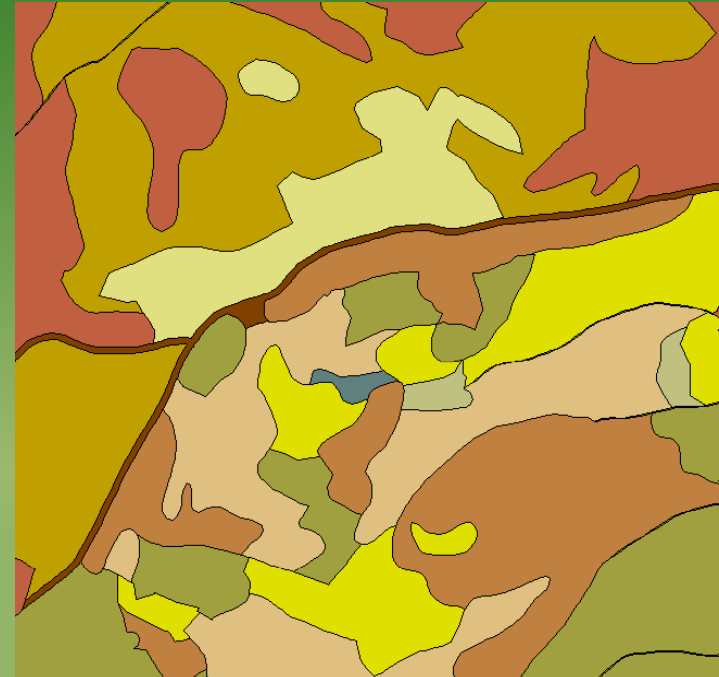
MNN = 71.4
MPI = 49.5

Mean Nearest Neighbor Index is the average of the shortest distances between patches of the same type within the landscape.

Interspersion Juxtaposition Index
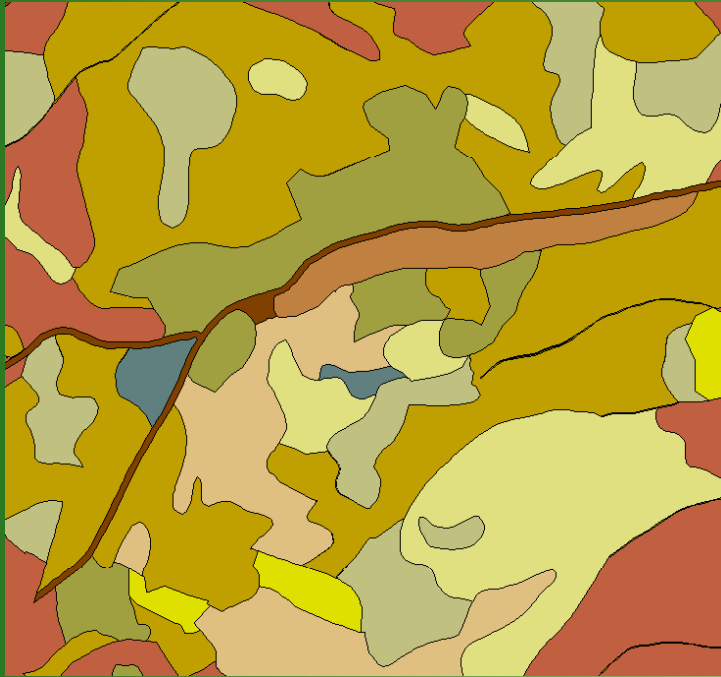
IJI = 75.5
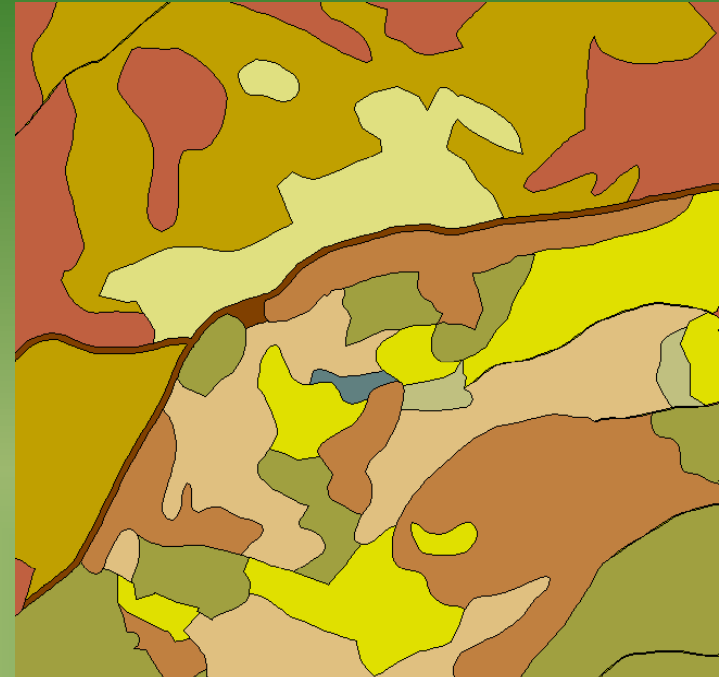
IJI = 69.1

IJI measures patch adjacency. IJI approaches 100 when all patch types are equally adjacent to each other.

Landscape Levels

Landscape –metrics are computed for the entire landscape.

Class – metrics are computed by landscape class (e.g. cover types or habitat types)

Patch – metrics are computed for each patch. A limited number of metrics are available.

Patch Analyst Statistics Summary

Shape Metrics
Mean Shape Index
Area Weighted Mean Shape Index
Mean Perimeter-Area Ratio
Mean Patch Fractal Dimension
Area Weighted Mean Patch Fractal
Dimension

Area Metrics
Class Area
Total Landscape Area

Patch Density & Size Metrics
No. of Patches
Mean Patch Size
Median Patch Size
Patch Size Coefficient of Variation
Patch Size Standard Deviation

Diversity & Interspersion Metrics
Mean Nearest Neighbor Distance
Mean Proximity Index
Interspersion Juxtaposition Index
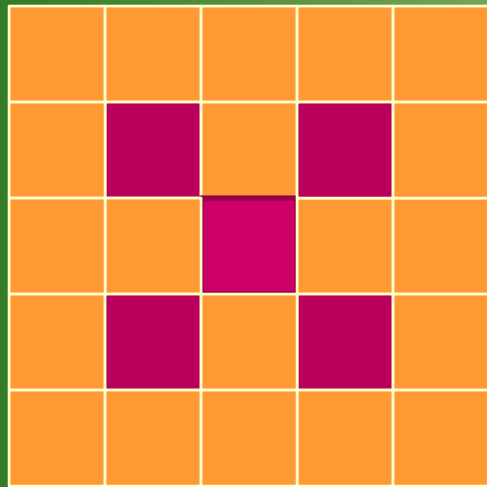Shannon's Diversity Index
Shannon's Evenness Index

Edge Metrics
Total Edge
Mean Patch Edge
Contrasted Weighted Edge

Fragstats User Interface

Connectivity Rules

4-cell rule
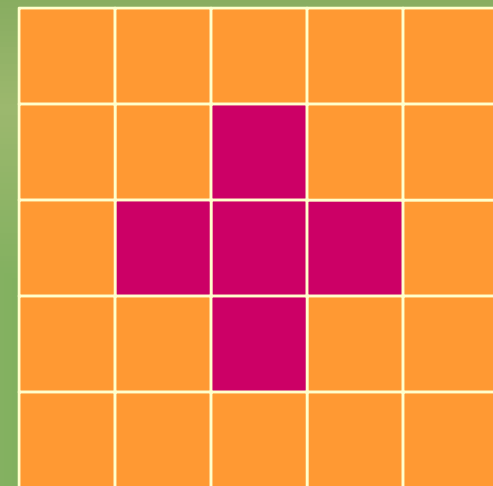
8-cell rule

Moving Window Analysis
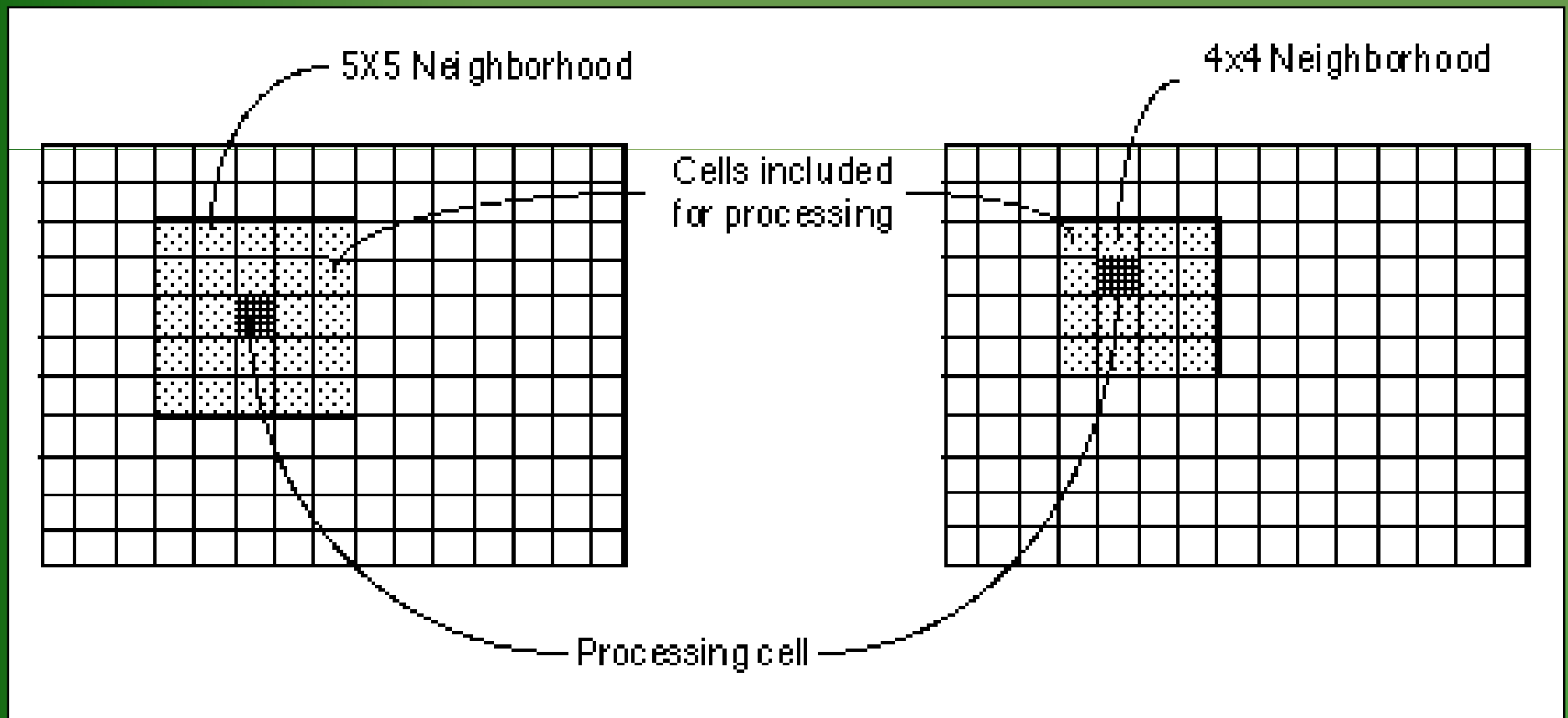
Moving Window Analysis
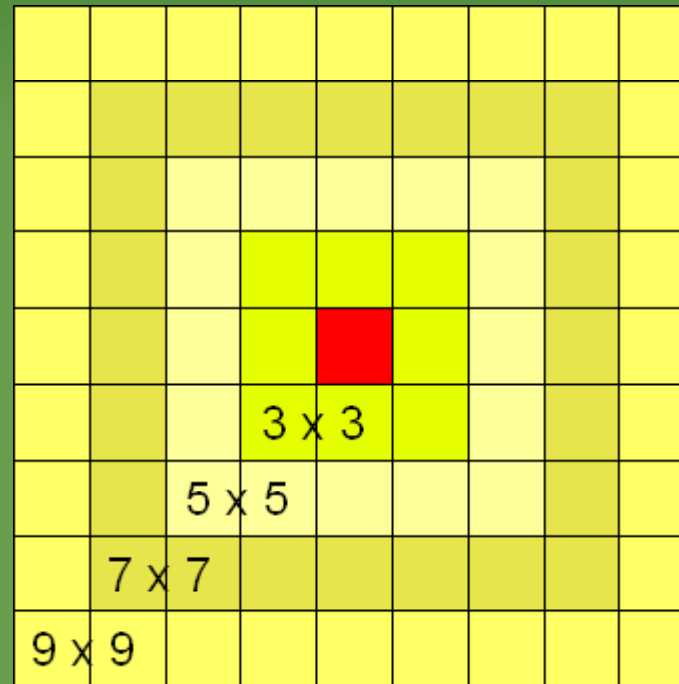
A circular or square moving window moves across the input grid and selected metrics are calculated for the center cell of the window

Shrub cover
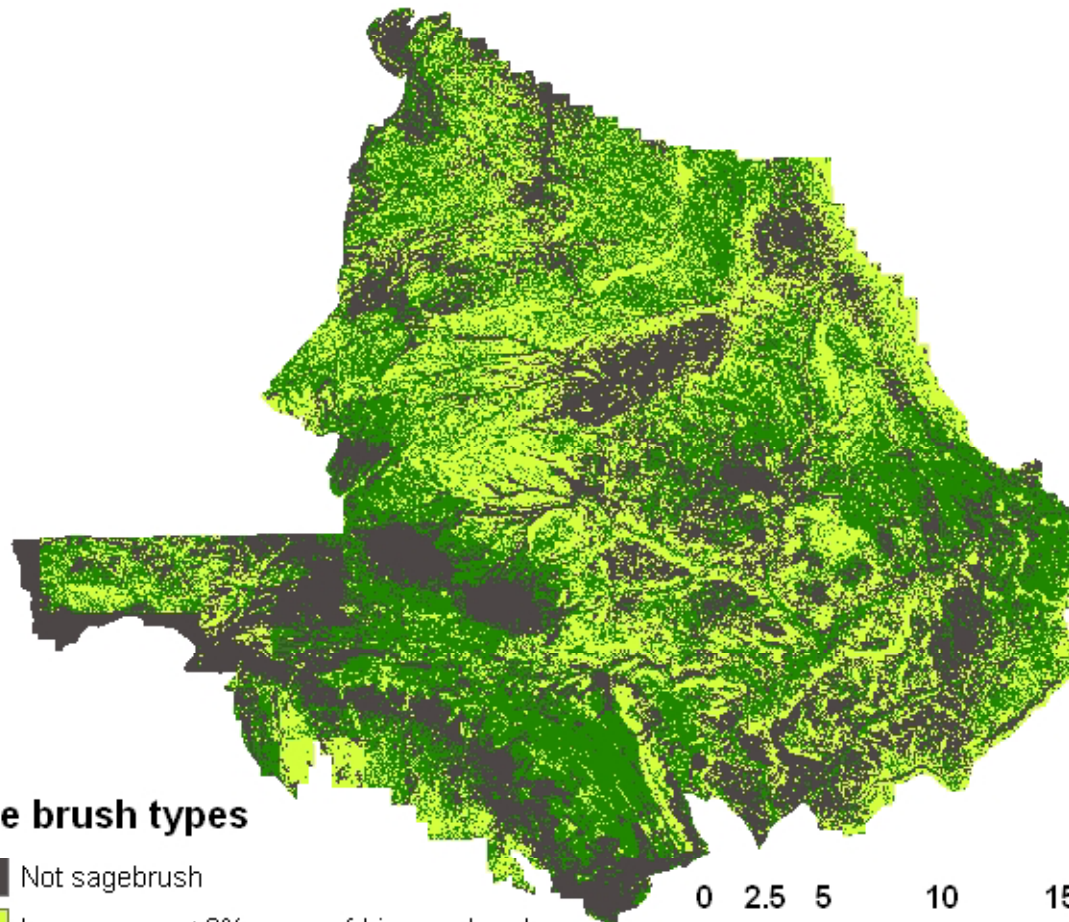
Sage brush types

- ⬛ Not sagebrush
- 🟨 Low sage or < 8% cover of big sagebrush
- 🟩 > 8% big sagebrush cover

0 2.5 5 10 15 Miles

Landscape scale habitat characteristics

Do animals use areas of high or low shrub cover?

Does the amount of 'edge' between low and high cover areas affect habitat selection?

Are areas within home ranges homogeneous or heterogeneous with respect to shrub cover?

Does patch size matter?

etc…………………

Comparison of areas with medium/high sagebrush cover within 100 m (top) and 1 km (bottom)

EB_95_fixedkernel

Medium and High Big Sage

% per hectare

High : 100

Low : 0.265252

EB_95_fixedkernel

Sagebrush cover %
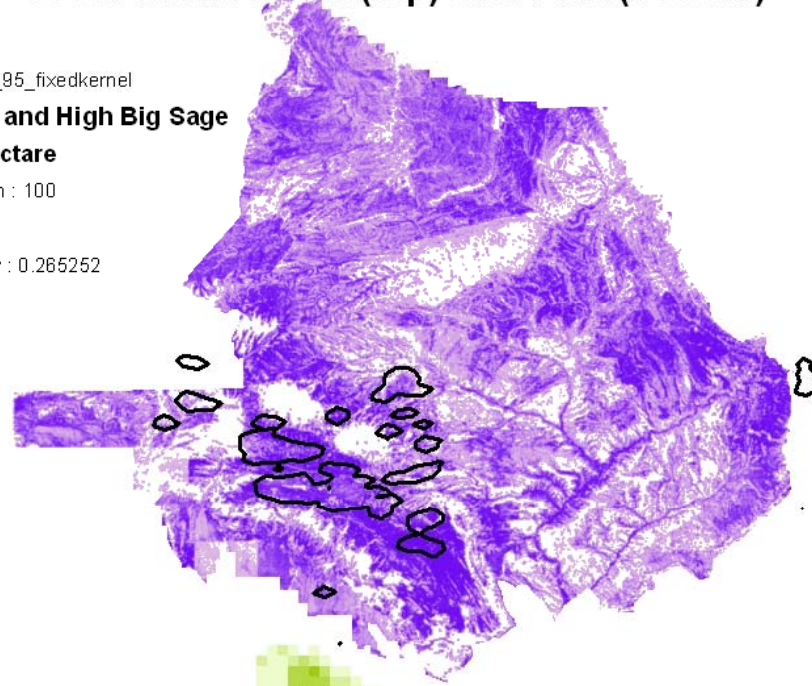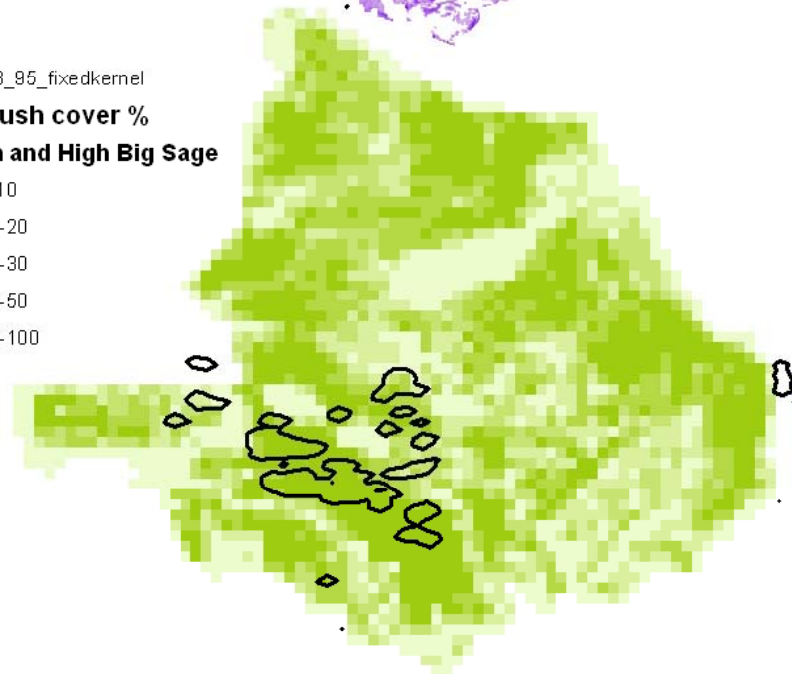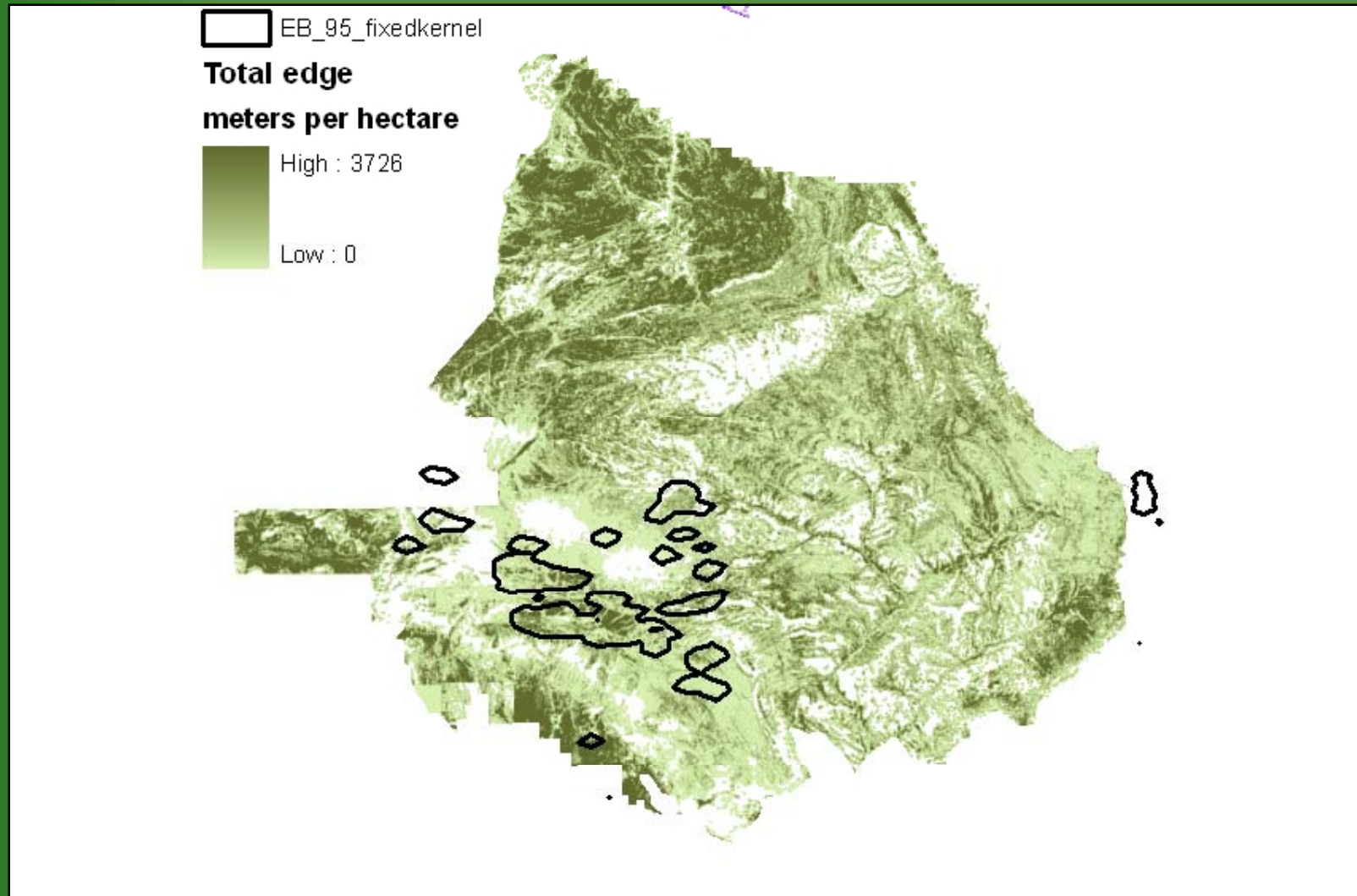
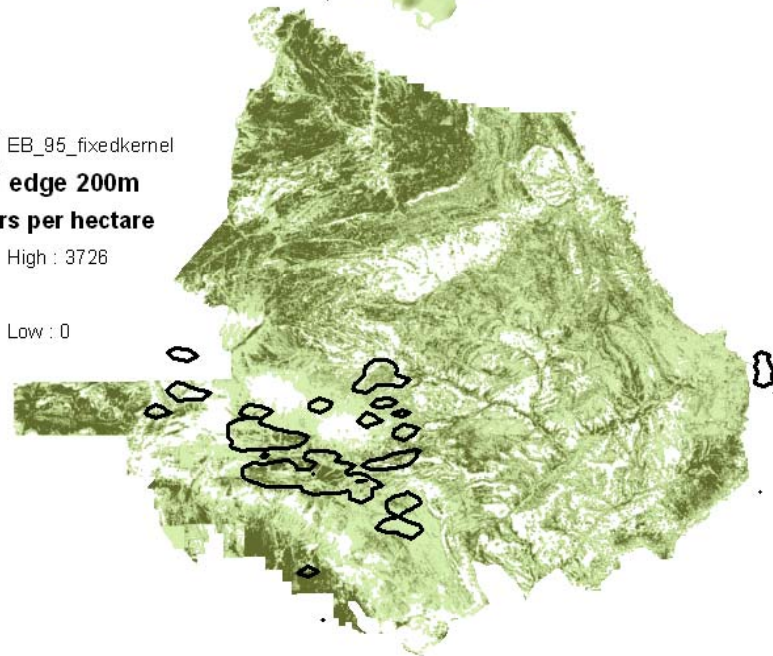**Medium and High Big Sage**

0-10

10-20

20-30

30-50

50-100

Total edge within a 100 m radius circular moving window

Comparison of total edge between areas of
low and medium/high sagebrush cover
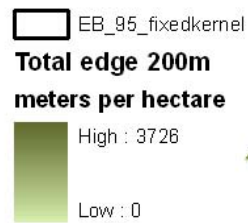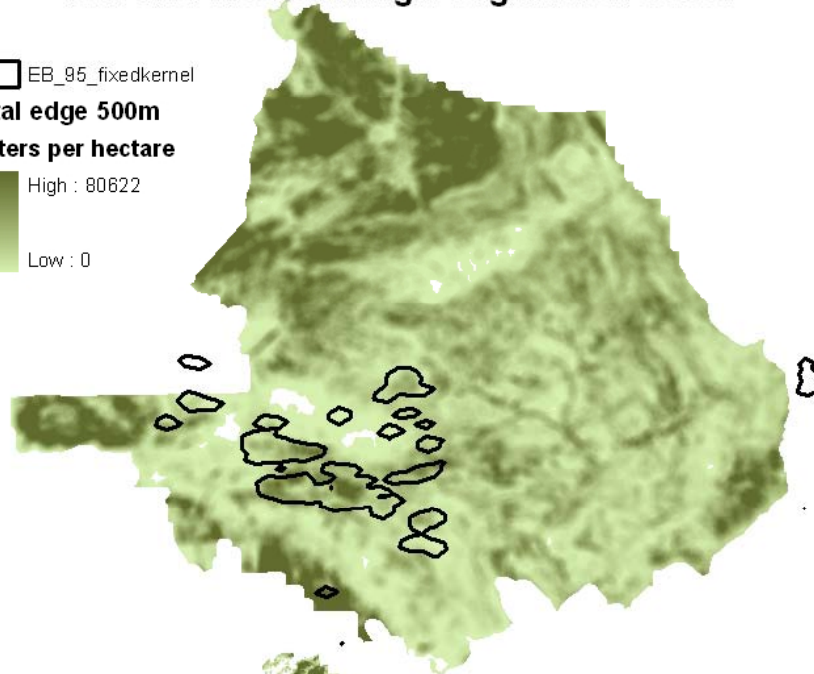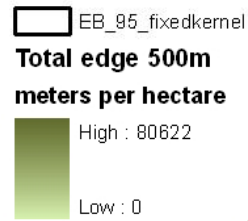
Batch Processing Possible!!

Batch File.--If Batch mode is selected, then FRAGSTATS will run the batch file specified in the Input File text box and produce output for all of the landscapes designated in the batch file. See Step 4 on Working with Batch Files for details on building a suitable batch file. If Batch mode is selected, then the Input Data Type (see below) and Grid Attributes (see below) will become inactive (grayed out in the interface) because these parameters will be specified uniquely for each input landscape in the batch file.

Further reading….

Cushman S.A., K. McGarigal, M.C. Neel, 2008. Parsimony in landscape metrics: Strength, universality, and consistency, Ecological Indicators 8:691–703.

De Beer Y. and R.J. van Aarde, 2008. Do landscape heterogeneity and water distribution explain aspects of elephant home range in southern Africa's arid savannas?, Journal of Arid Environments

Grainger1 M., R. van Aarde1, and I. Whyte, 2005. Landscape heterogeneity and the use of space by elephants in the Kruger National Park, South Africa, African Journal of Ecology

Herrera, L.P. P. Laterra, N.O. Maceira, K. D. Zelaya, and G.A. Martı´nez, 2009. Fragmentation Status of Tall-Tussock Grassland Relicts in the Flooding Pampa, Argentina, Rangeland Ecology and Management .

Kong F. and N.Nakagoshi, 2006. Spatial-temporal gradient analysis of urban green spaces in Jinan, China, Landscape and Urban Planning.

Arjan J. H. Meddens, Andrew T. Hudak, Jeffrey S. Evans, William A. Gould and Grizelle Gonza´lez, 2008. Characterizing Forest Fragments in Boreal, Temperate, and Tropical Ecosystem, Ambio.