Landscape Ecology (FES542) Assignment #3

Landscape Metrics

Due: Due Tuesday, November 2nd, 12 pm (on Canvas)

Needed for this lab:

- R version 3.6.1 or RStudio Version 1.2.1335
- Raster (.tiff) files (classified Landsat TM) for 10, 10 km^2 Oregon landscapes (land1… land10)
- Raster file for landscape surrounding Corvallis
- A variety of packages listed in the R scripts associated with this lab

All files (including landscape data and R scripts) can be found on Canvas under "pages" https://oregonstate.instructure.com/courses/1759220/pages/landscape-metrics-lab

Data are also available on: available on T:\Teach\Classes\FES542-LandscapeEcol/LEGIS. **Please download to a separate folder where files cannot be altered by others.**

1. Landscape Composition Metrics (after Gergel & Turner 2002)(**6 points total**)

For the hypothetical early-settlement and late-settlement landscapes (Fig. 1) calculate by hand: (a) the proportion (pi) of the landscape occupied by each cover type, (b) dominance (D), (c) Shannon evenness (SHEI).

$$(1)\ pi = \frac{\text{Total number of cells in category i}}{\text{Total number of cells in the landscape}}$$

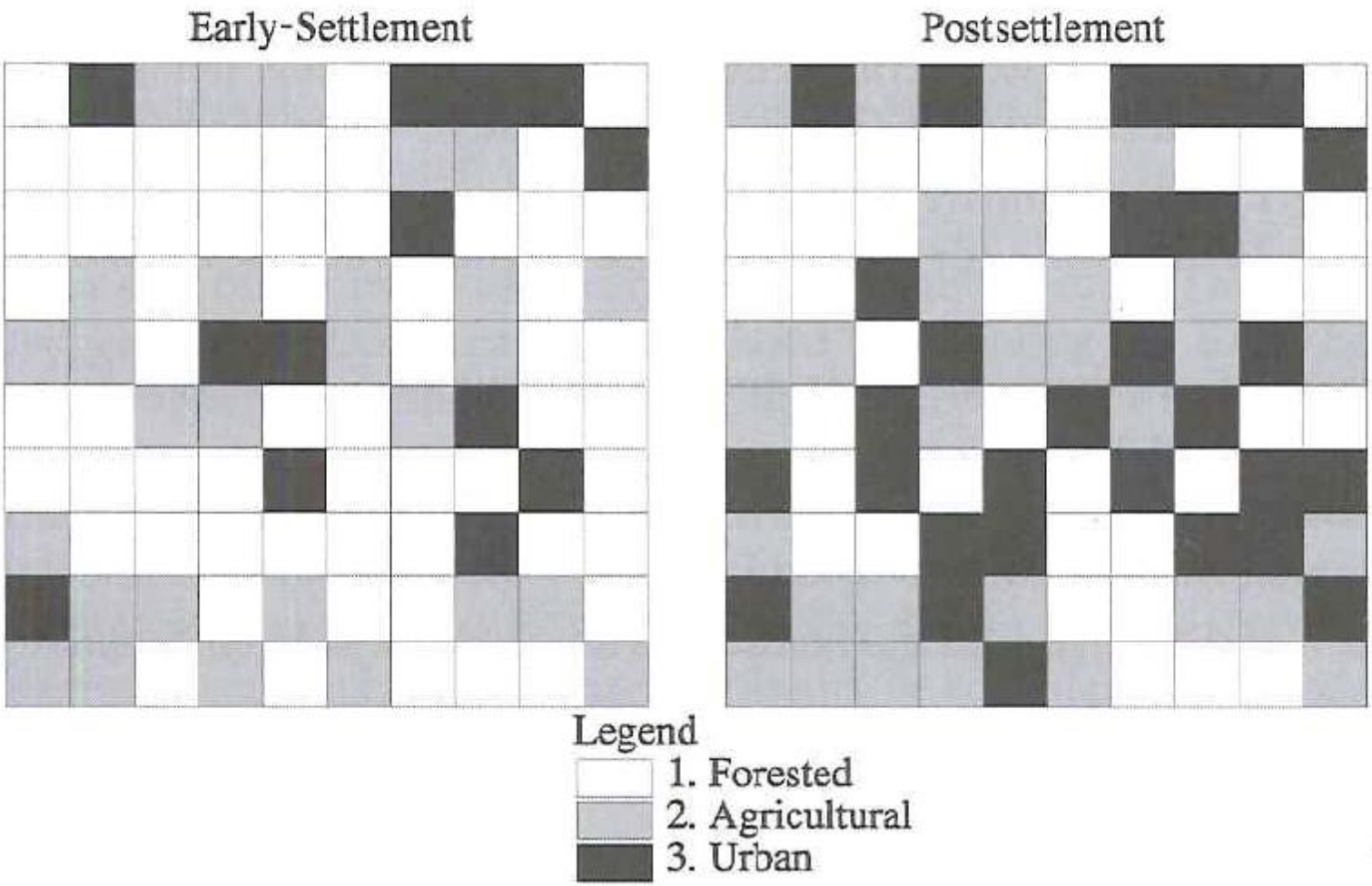
$$(2)\ D = \frac{\ln(S) + \Sigma\,[p_i * \ln(p_i)]}{\ln(S)}$$

$$(3)\ SHEI = \frac{-\Sigma\,[pi * \ln(p_i)]}{\ln(S)}$$

S = number of cover types, p_i = proportion of ith covertype, ln = natural log function

a) How would you interpret/ describe the changes in landscape between the two time periods? (**1 point**)
b) Explain the relationship between dominance and Shannon evenness.(**1 point**)
c) If you were conducting an analysis of a real landscape, would you report both D and SHEI? Why or why not? (**1 point**)
d) To compare D or SHEI across two or more landscapes does S need to be the same for each landscape in the comparison? Why or why not? (**1 point**)
e) Is there an upper and lower limit of S beyond which D and SHEI will not work? (**1 point**)
f) What is one drawback to using D or SHEI as metrics to monitor landscape change? (**1 point**)

Simulated Landscapes



2. Using Fragstats in R (package 'landscapemetrics'): automated landscape composition and configuration metrics

R package for Fragstats: https://cran.r-project.org/web/packages/landscapemetrics/landscapemetrics.pdf

Details on Fragstats (the original software): https://www.umass.edu/landeco/research/fragstats/fragstats.html

Landscape-level metrics (11 points total)

Researchers often require characterizing whole landscapes, or sample landscapes quantitatively. Such instances include efforts to measure landscape change over time, or to examine how landscapes with different structure potentially influence animal movement, demography or distributions. This section of the lab will introduce you to the tools used for this sort of analysis. You will use Fragstats, implemented in R, to quantify 10 real landscapes in Oregon and then compare metrics for these landscapes to determine how various commonly used metrics behave (or misbehave as the case may be).

Follow the detailed instructions in the R script "**Landscape_scale_metrics_code_students.R**" to produce the following:

1. A 10-panel figure of the landscapes to be analyzed. (**2 points**)
2. A pairwise correlation plot showing relationships between the six landscape-scale metrics used: (1) edge density, (2) mean core area, (3) Shannon's diversity index, (4) number of patches, (5) Euclidean nearest neighbor distance, (6) log of mean core area (**2 points**)

Questions:

(a) Which landscape has the most forest? Which has the most cultivated land? (**1 point**)

(b) Which, in your view, is the most fragmented landscape? What is your justification for this? (**2 points**)

(c) After looking at the pairwise correlations, what issues might there be with including all of these variables as predictors of species response to fragmentation. How might you deal with this issue? (**2 points**)

(d) Why do you think these metrics are so highly correlated? (**1 point**)

(e) Which landscape would you choose as a protected area? Explain your choice in a short paragraph. (**1 point**)

Class-level metrics (6 points total)

It is also commonly of interest to quantify aspects of a single class of land cover within and across landscapes. For instance, if a particular type of forest is of conservation concern, one might like to know the mean patch size for that class, the total area of that class, and how much edge there is. As above, these metrics can be used as predictors in species distribution models, or as criteria to select protected areas.

Follow the detailed instructions in the R script "**Class_scale_metrics_code_students.R**" to produce the following:

(f) For one class (forest), plot the pairwise relationships between the three metrics (1) core area index,

(2) class area, (3) edge density. What do you notice about these relationships? (**1 point**)

(g) Assuming edge density is a good metric for fragmentation, which landscape contains the least fragmented forest? Accounting for the amount of forest in the landscape, which landscape has the least fragmented forest? Justify your approach and answer. (**2 points**)

(h) For all classes combined, plot the pairwise relationships between the three metrics. What do you notice in this case? (**1 point**)

(f) Plot the smoothed relationship between class area and edge density (using 'geom_smooth' in ggplot). Provide an ecological (and mechanistic) explanation for this relationship. (**1 point**)

(g) Which do you think will be more useful in your research, class or landscape-level metrics? Why? (**1 point**)

3. Focal Patch Metrics (6 points total)

Frequently in landscape ecology, it is useful to know attributes of particular patches within in a landscape. This is the case if you have adopted a 'focal patch' sampling design (see Fahrig 2003 from reading list). In this section of the lab, you will learn to do some basic GIS/spatial operations in R that allow you to measure focal patch statistics.

As above, the data you are working with are rasters with different different 'habitat' types. Your objective is to generate metrics on (1) the size of focal habitat patches, and (2) the amount of habitat in the surrounding landscape. These attributes are popular for assessing the influence of fragmentation on species distributions and survival (see Bender et al. 1998, Betts et al. 2006, Betts et al. 2014). It is critical that you understand what you are doing in this section particularly, so please look at these examples of where a focal patch approach has been used.

The single landscape layer necessary for this section is found on Canvas (https://oregonstate.instructure.com/courses/1759220/pages/landscape-metrics-lab) and T:\Teach\Classes\FES542-LandscapeEcol/LEGIS

Processing steps: (see R script "Focal_patch_metrics.R" for details)

In this section, you will learn how to calculate focal patch area, the total amount of habitat in at a particular spatial extent, and observe relationships between these variables. All empirical studies in landscape ecology require the placement of some sort of sampling locations across a landscape. This next section will show you how to do this for a random sampling design. You will also design a new study to reduce any problems you observe in the random design.

(a) Create a map with habitat amount (in this case forest) at 1000 m (show this in your assignment) (**1 point**)
(b) Generate a second map with habitat patches (show this in your assignment). (**1 point**)

(c) Plot the relationship between amount of forest amount (1000 m extent) and log (patch size). What do you observe? Why might this relationship be problematic in landscape ecology research? (**2 points**)

(d) Design a new study (N=50, not randomized) that removes, as much as possible, the problem you observed in (c). Plot the relationship between forest at 1000 m and log (patch size) in this new study. (**1 point**)

5. **(Bonus) Provide one benefit or drawback to using a 'landscape' vs. 'focal patch' approach to landscape metrics (in one paragraph). (1 point)**

Total = 28 points (+ 1 bonus)

References

Gergel, S.E. & Turner, M.G. 2002. Learning Landscape Ecology. Springer.

Hesselbarth, M.L. et al. 2019. landscapemetrics: an open-source R tool to calculate landscape metrics. Ecography https://doi.org/10.1111/ecog.04617