# ESM 215 Exercise 3 Quantifying Landscape Pattern

The purpose of this exercise is to introduce you to commonly applied metrics of landscape pattern using the landscape analysis package Fragstats. [FRAGSTATS](http://www.umass.edu/landeco/research/fragstats/fragstats.html) is a spatial pattern analysis program for categorical maps developed and maintained by Kevin McGarigal and Barbara Marks. The software is useful for quantifying composition and configuration of landscapes. [Here](https://www.umass.edu/landeco/research/fragstats/documents/fragstats_documents.html) is the pdf version of the FRAGSTATS manual, which is also available through the program GUI.

In this exercise we will apply FRAGSTATS to compare land cover patterns on 3 landscapes defined by different geologic substrates in northern Santa Barbara County. You will be analyzing the same region in northern Santa Barbara County that you examined for Exercise 2. Here we will focus on 3 landscapes that differ in geological substrate, degree of agricultural development, and degree of urbanization. These landscapes will be delineated using the geologic map as the “Tile Grid” in fragstats.

In additions to comparing metrics for different landscapes, you will test the sensitivity of landscape metrics to the neighbor rule (4- vs 8-). You will also evaluate the impact of roads on measures of landscape fragmentation.

**Input data**

*(All data should be in the ‘data’ directory you copied last week to your local drive. You will use files from this same directory for this exercise.)*

**sy\_veg15.tif**   - Also used in Exercise 2. This is a 28m raster depicting vegetation/land cover map and was produced (mainly) from Landsat Thematic Mapper satellite imagery. California Wildlife Habitat Types are shown here. [Here](http://frap.fire.ca.gov/data/statewide/FGDC_metadata/fveg15_1.xml) is a description of the data. A table associating the grid value with CWHR types is provided in a csv format used by fragstats as **syveg15\_classes.fcd**. This file is also available as an excel file of the same name.

**sy\_veg15rd.tif**   -This is the same raster as **sy\_veg15** *except it includes roads in Class 0*. Roads are not distinguished by road type (e.g., interstate, state, local).

**sy\_geolpol.tif –** derived from the same statewide geologic map used in exercise 2, but here each separate area of a particular geologic unit is assigned a unique value, resulting in 22 uniquely numbered areas. *Be sure you are using the correct raster, as other files in the same directory have similar names*. We will analyze 3 landscapes:

1. Landscape 14 is the unit most converted to intensive agriculture, Los Alamos Valley floor, Quaternary alluvial fill.
2. Landscape 18 (grid ID=18) is the most extensive unit and also the unit most affected by urban development. This landscape encompasses western Burton Mesa, which is underlain by the Quaternary non-marine Orcutt Sandstone. (*This will be our case study landscape in upcoming exercises*).
3. Landscape 22 (grid ID=22) is the least developed unit in terms of agricultural or urban development. This area encompasses the eastern Purisima Hills and is underlain by Careaga sandstone;

**Running FRAGSTATS**

1. Start -> fragstats (type “fragstats” into the search window)
2. Start a new analysis by hitting the **New** button in the upper left on the Menu Bar.
3. There are two tabs in the upper left below the Menu Bar, “Input Layers” and “Analysis Parameters.” Begin with the Input Layers tab.
4. Add layer **sy\_veg15.tif** by hitting the Add Layer button. In the Data Type Selection window, select GeoTiff grid as the data type and then and browse to the file in the Dataset name field. Hit OK.
5. Browse to the class descriptors file **syveg15\_classes.fcd** and load it in the Common Tables field.
6. Now go to the Analysis Parameters tab. Working from the top to bottom of menu options:
   1. Use the 8-cell neighborhood rule.
   2. Click on “Automatically Save Results” and then specific a path and filename in your personal work area. It can be helpful to make a subfolder named save\_results to store your results from here on. To specify the filename, because we are first using the 8-cell neighborhood rule, at the end of the path you can type something like “8cellneighborresults”. (For example, your path might look like: [\\babylon\mesm\yourname\Classes\ESM215\Exercise3\save\_results\8cellneighborresults](file://babylon/mesm/yourname/Classes/ESM215/Exercise3/save_results/8cellneighborresults))
   3. Under Sampling Strategy, we will analyze every cell in the **sy\_veg15.tif** raster. Under Exhaustive Sampling, turn on “User provided tiles” and click “Class metrics” and “Landscape metrics.” Browse to **sy\_geolpol.tif** to identify it as the tiling layer. This setting will analyze class and landscape properties separately for each geologic area. We will not analyze individual patches within landscapes.
7. Now select Class and Landscape Metrics for the analysis. These will be on the right side of the window.
   1. In Patch Metrics (red button), de-select all in all 5 tabs (Area – Edge, Shape, Core area, Contrast, and Aggregation). (We are not analyzing individual patches).
   2. In Class metrics (yellow button), under the Area-Edge tab, select Total Area, Percentage of Landscape, Edge Density, Mean Patch Area and Coefficient of Variation in Patch Area.
   3. In Landscape Metrics (blue button),
      1. under the Area-Edge tab pick Total Area, Total Edge and Edge Density
      2. Under the Shape tab, pick PAFRAC.
      3. Under the Diversity tab pick Patch Richness, Patch Richness Density and SHEI.
8. Hit Run (the green arrow in the Menu Bar). If all looks OK in the Activity Log window, hit Proceed.
9. You can do a cursory examination of the fragstats outputs using the Results (green data sheet button) in fragstats. You can also access the Results using the upper left menu: Analysis > View results. The csv output tables are easier to work with using excel.
10. Re-run the model with the same settings except under Analysis Parameters change the 8-neighbor rule to the 4-neighbor rule. Be sure to change the file name in step 6b (maybe something like “4cellneighborresults” this time).
11. Repeat steps 4-11 substituting **sy\_veg15rd.tif** for **sy\_veg15.tif,** using only the 8-neighbor rule. You can remove the previous layer (**sy\_veg15.tif**) by selecting and clicking Remove Layer. Be sure to change the file name in step 6 (maybe include “rd” in the title this time).

**Questions**

1. Based on the landcover map that does not include roads (subveg15.tif), compare landscapes 14, 18 and 22 for the following variables:
   1. Using the 4-neighbor rule, compare landscape edge density (ED), patch richness (PR), patch richness density (PRD), and Shannon evenness index (SHEI). Do the same for the 8-neighbor rule. How do landscape patterns differ between these agricultural, urbanizing and rural landscapes?
   2. How does choice of 4-neighbor vs. 8-neighbor affect landscape-level results for ED, PR, PRD, and SHEI?
   3. Using the 4-neighbor rule for specific classes, compare edge densities for agricultural (14), urbanizing (18) and rural landscapes (22) for natural vegetation (grassland, coastal scrub, oak woodland) versus cultivated agricultural classes (orchard, vineyard, cropland).
2. Compare results for the landcover maps with and without roads. Specifically:
   1. How does including roads affect Patch density, Edge density, and SHEI in the three landscapes?
3. Briefly discuss potential applications of the metrics used here to conservation planning, land use planning, or another application area of interest to you.