Lab 7: Vegetation Landscapes Report

Purpose

The purpose of this lab is use some of the skills learned in the earlier labs (summarization, overlays, joins, etc.) to conduct a GIS analysis examining landscape change using the Oregon Egoregion dataset, a hierarchical landscape classification framework, to examine the loss of Oak Savanna (as represented by Oak-containing vegetation types). The Ecoregions dataset has multiple classifications of landscape type that become more granular with increasing scale. The historic vegetation dataset was created from General Land Office records and other information, and includes a classification for Oak savanna and other oak-containing classifications. The modern vegetation dataset we will use contains a different landscape classification scheme than the historic vegetation representation, and lists a set of vegetation associations containing Oak. We will determine which Ecoregion has experienced the greatest proportionate loss of Oak vegetation types. We will then examine the persistence of historic oak vegetation areas in the ecosystem with the greatest loss.

Prerequisites

This exercise builds on skills practiced in Labs 1-6.

References & Links

- ArcGIS Desktop: Calculate Field examples.
    - https://desktop.arcgis.com/en/arcmap/latest/manage-data/tables/calculate-field-examples.htm
- ArcGIS Desktop: Clip.
    - https://desktop.arcgis.com/en/arcmap/latest/tools/analysis-toolbox/clip.htm
- ArcGIS Desktop: Intersect.
    - https://desktop.arcgis.com/en/arcmap/latest/tools/coverage-toolbox/intersect.htm
- ArcGIS Desktop: Summary Statistics.
    - https://desktop.arcgis.com/en/arcmap/latest/tools/analysis-toolbox/summary-statistics.htm
- ArcGIS Desktop: Joining attributes in one table to another.

    - https://desktop.arcgis.com/en/arcmap/latest/manage-data/tables/joining-attributes-in-one-table-to-another.htm
- Oregon Spatial Data Library
    - http://spatialdata.oregonexplorer.info/geoportal/

To Turn In

- Single-page map in Portable Document Format (PDF).
- Flow chart, hand-drawn hard copy, or, optionally, digital.
- A short report (3-4 pages) describing the GIS analysis conducted and the conclusions you found.

Put a copy of each document:

1. Inside the `Lab#` subfolder in your student folder. It's simplest to just complete the original documents here.
2. Uploaded to the class Canvas site as listed under the lab assignment.

Submit the documents at your earliest convenience before the start of the next lab.

Steps

For best results, read through all instructions before starting the lab.

Part 1 - Map Instructions

Reminder: Save often! it is a good idea to save frequently. You may even want to Save As and give sequential file names so that you could revert to a previous version if you make a mistake that you cannot undo or if the ArcMap document gets corrupted.

1.1 - Data

Create a new Lab7 folder, and download spatial datasets there.

Discover and download the datasets via the link provided. Be sure to note the data source, in order to provide citations on your map. **Take a few minutes to read the narrative description of the metadata to understand the content of each layer.** This exercise will ask you to describe the analysis methods and the data results. Understanding the data will aid you both in the description portion of the exercise and in the analytic steps described.

1. Open a web browser, and navigate to the Oregon Spatial Data Library.

2. Browse or search for the following datasets:
    a. *Oregon Historic Vegetation*
    b. *Oregon Ecoregions*
    c. *Oregon Actual Vegetation Map - 1992*
3. Download them to your lab folder, and extract their contents.

Additionally, as part of your map design you should locate additional data layers to provide context. For example, you may want to use Oregon and adjacent state boundaries, county boundaries, rivers, roads, cities, etc. for that purpose. You've been introduced to a numbers of good resources for these purposes: Oregon Spatial Data Explorer, UO MAP Library Learning Commons, and Natural Earth Data to name a few. Use your judgment and what you've been shown in class to choose helpful data layers for your map.

1.2 Creation of a Flow chart

Make a flow chart of the steps listed below. Do this by hand on a piece of paper. Use ellipses for datasets, and rectangles for operations (selection, clip, etc). Use arrows to connect these elements together to describe the analysis, labeling the elements as appropriate. Note that you might need to make more than one draft, and that reading the lab in its entirety first will aid your understanding and thus your ability to construct the flow chart.

General Flowchart Steps

1. Intersect Oregon Ecoregions with historic and current vegetation.
2. Calculate the proportion of historic and current Oak vegetation type in each ecoregion
3. Identify the ecoregion with the largest proportionate loss of Oak vegetation types
4. Intersect historic and current vegetation for the identified ecoregion
5. Identify areas historically having oak in their species composition and currently having oak in their species composition within this ecoregion.
6. Calculate the proportion of area formerly Oak species to current Oak species area

As should be apparent, these steps are broadly stated, with many actions implied. These broad steps are detailed below with the specific operations. As you revise your flow chart, you can add this more granular level of detail to more precisely record your actions. You must submit this more granular flow chart.

1.3 GIS Analysis & Processing

Environment Settings

Output file formats are determined in part by the workspace environment (directory, file GDB, Enterprise GDB) they are written to. By setting your workspace environment to your *Lab 7* folder, you can ensure you write output datasets to your class folder, ensuring their retention and output format (shapefile). Go to

Geoprocessing>>Environments>>Workspace>>Current Workspace & Scratch Workspace

In the current and scratch workspace cells, type or paste your lab seven path. You can also navigate by clicking on the folder icon.

General Flowchart Step 1: Intersect Oregon Ecoregions with historic (and then current) vegetation.

The object of the analysis is to describe the amount of change in a particular ecoregion type between that recorded in the historic dataset and that recorded in the 'modern' dataset. See the metadata on the Spatial Data Library website: "Ecoregions denote areas of general similarity in ecosystems and in the type quality, and quantity of environmental resources." We will intersect the ecoregions with the historic and current vegetation polygons (in turn) to create a datasets we can summarize. The instructions are written with the historic vegetation referenced. Repeat them a second time for the current vegetation.

Read Intersect from ArcMap documentation.

Before we intersect the datasets, let's make life a little easier by opening the properties of the ecoregions and the historic data set (in turn), and turning off some fields. This will result in a more compact output table that will be easier to examine. Open the Fields tab and turn off unwanted fields. The fields we wish to retain for the Ecoregions are the level 3 and 4 names ("NAME", "LEV3_NAME"). Leave the object-id field checked as well ("FID"). Close the properties dialogue.

To intersect the Oregon Ecoregions with historic vegetation, choose *Geoprocessing>>Intersect* or open the intersect tool from the *Analysis Tools>>Overlay* toolset in *Arc Toolbox.* Fill out the dialogue. The order in which the data sets are entered into the list determines the output ofield order, but has no other relevant consequence. Name your output something meaningful without spaces, using mixed case or underscores to add readability to your file name.

General Flowchart Step 2: Calculate vegetation area and proportion of ecoregion area by vegetation class

Open the attribute table of the resultant dataset and examine the results. Note that there is no area field on the output dataset. Add an appropriately-named area field and calculate the polygon area.

1. Open the attribute table.
2. Under *Table Options* (the button on the attribute table that looks like a paper with holes & lines in it), choose Add Field.
3. Provide a short name for the field; shapefiles are limited to 10 character names. Tip: you may want to include the units in your field name, so you can better remember them later, e.g. area_sqmi/area_sqkm.
4. Choose an appropriate attribute data type to store the area values for the polygons. Remember, Float and Double are names for decimal number attribute types.
5. After creating the field, scroll to the right end of the attribute table, which is where new fields are added.
6. Right-click on the name of the new field, and choose Calculate Geometry.
7. You should receive a warning that you're calculating attribute values outside an 'edit session'. Read the warning to understand its point, but go ahead and choose Yes.
8. Choose Area as the property, and specify your desired units (I recommend square miles or kilometers, or you'll be dealing with very large numbers).

Tip: You can rearrange (in ArcMap) the order of fields by clicking on the field name in the table and dragging it to the right or left of other fields columns. Additionally, you can 'freeze' (or 'unfreeze') a column in a visible place, or 'turn a field off' by right-clicking on a field name in the table and choosing the corresponding option. Turning a field back 'on' can be done via Layer Properties -> Fields.

Now we can summarize the area of each vegetation polygon in each ecoregion of a particular level. We could use the dissolve tool if we wanted output geometry, but in this case, a table will do.

Read Summary Statistics in ArcMap documentation.

Open Analysis tools>>Statistics>>Summary Statistics from Arc Toolbox.

Fill in the dialogue.

1. The statistic we are after is the sum of the area; Choose area from the drop-down menu.
2. Note the dialogue will display a red X by a selected attribute to summarize until the statistic type is chosen. Take a moment to look at the statistic types available.Choose “SUM”.
3. We want to tabulate the area *aggregating by* a couple of attributes. These are known as case fields in this context. The ecoregion level we are interested in at this point in the analysis is level three. The other attribute we are interested in is the vegetation type. The order of the case fields does not functionally matter, but entering them in the order described will make for a more readable table. Enter the two case fields.
4. Be sure to give the output a meaningful name.

Examine the resultant table: *How many rows are there? What does this mean in terms of the relationship between the input classes in the two datasets*? We now need to perform a calculation and a selection to be able to determine which ecoregion had the greatest *proportion* of Oak vegetation types.

Add a field called Proportion *to the summary table just created, giving it a type capable of holding a percentile (decimal) value.*

In order to calculate the *proportion* of Oak vegetation types in each level 3 ecoregion, we’ll need the total area for that ecoregion. To get that, we can summarize the table we are working with by the level 3 ecoregions.

Use the *Summary Statistics* tool again in a similar manner to the operation described above to produce total area by level 3 ecoregion (you will only have one case field, the level 3 name). Note one can also right-click on the “Lev3_NAME” field from the table view and choose *Summarize*. This tool is similar to *Summary Statistics*, but does not have the case field option, which we do not need for this step. Give the output table an appropriate name, like Total area by Ecoregion.

Join the total area by ecoregion table from this operation on to the first table produced, summarizing area by ecoregion and vegetation type.

Read Joining attributes in one table to another from the ArcMap documentation site.

1. With the first table (more rows and containing the vegetation classes) active, choose *joins and relates>>join* from the menu at the top left corner of the table view.

2. Note that the dialogue will autofill. These choices may be correct, but they may not. The parent table is assumed from the context in which the dialogue was initiated (active table), choose lev3_Name as the answer to item 1, the field whose values will be used for the join.
3. If the table in item 2 is the second table you created containing the total area per ecoregion, the item should have auto filled to the name of the join field desired. If not, adjust the settings to choose the second table you created and the matching join field for level 3 name. Note this is a M-1 join.
4. Leave the type of join (keep all records) as-is.
5. Click *Validate Join* and view the results. *What does this mean?*

Tip: When reading ArcMap documentation pages, notice that there is a hierarchy of the documentation contents on the left side of the page. Other pages under the same section heading may also be helpful in understanding what the tools do and how to use them; or perhaps have information for related tools and operations. For example, the section with the above page also has one titled *Esssentials of joining tables* which may be useful in better understanding the join operations.

View the resultant table. Note that the values for the second table repeat for every instance of that join field value in the parent table. We are now ready to calculate proportions.

1. Right-click on the field you added called *Proportion*.
2. Choose Calculate Field, accepting the out-of-editing warning.
3. Divide the area for each vegetation type (SUM_…) by the total area for that ecoregion (SUM_SUM_…). Your expression should look something like `ecoregion_x_historicVegetation.SUM_SqMi] / [ecoregion_toalArea.Sum_SUM_Sq]`
4. To assure yourself this is correct, select one ecoregion type (*Select by Attributes*), view only those records using the *view selected records* icon at the bottom of the table view, and right-click on the *Proportion* field and choose *Statistics*. The sum of the values should be one (1). Note the shape of the histogram.

Tip: To remove a joined attribute table, right-click on the layer with the join, and look under `Joins and Relates -> Join -> Remove Join(s)` for the table in question.

We have now calculated the proportion of historic vegetation classes within each level 3 ecoregion.

General Flowchart Step 3: Identify the ecoregion with the largest proportionate loss of Oak vegetation types

Now, to find that ecoregion that has the greatest historic proportion of Oak vegetation loss, we need to summarize a subset of the records containing oak vegetation types. Do his once for each of the two tables created above.

1. Use the *Select by Attributes* tool to select only rows containing vegetation type containing Oak, restricting the table view to the selected records, as above. Use the in statement ('Field in (value1, value2, value3)') to restrict the records
2. **Save this query statement to an expression file (.exp) with an appropriate name, e.g. "CurrentOakVegetationTypes.exp"**
3. Right-click on the lev3_NAME field, and choose summarize.
4. In the resulting dialogue, expand the area and proportion field options, and choose to sum; give the output an appropriate name.
5. Examine the resulting table

When processing the historic data, add a field called PropLoss to the table, with a decimal data type.

Once this is done for historic and current vegetation, with the historic table active, join the current vegetation table, and calculate the proportion of loss (historic proportion - current proportion). You can remove the join when the calculation is complete. Examine the historic vegetation table representing proportion historic Oak vegetation types and propornate loss. *In what ecoregion did the most loss occur?*

General Flowchart Step 4: Intersect historic and current vegetation for the identified ecoregion

Now that we have identified the ecoregion with the greatest loss of Oak vegetation types, we can take a closer, and slightly different look at the loss in the identified ecoregion. The steps below are written at the level of the tool without describing the specific inputs in detail.

1. Make sure to clear any selections present (clear selection icon or *Selection>>Clear Selected Features*)
2. Use the *Select by Attributes* tool to Select the identified ecoregion from the Level 3 names of the ecoregions dataset
3. Export this to an appropriately-named dataset (e.g. "WillametteValley.shp)
4. With first the historic, and then the current, vegetation datasets as the input data layers, and the exported ecoregion feature class as the clip feature, use the *Clip* tool to clip the vegetation datasets to the ecoregion

5. With the clipped feature classes as input, use the *Intersect* tool to intersect the two vegetation feature classes. Use an appropriate output file name.

General Flowchart Step 5: Identify areas historically having oak in their species composition and currently having oak in their species composition within this ecoregion.

Using the selection queries we saved in the steps above, we will construct a new selection query to identify the areas historically containing oak Vegetation and currently containing Oak Vegetation. We will store this selection in an added field called RemainOak. We will then summarize the table to produce the **final** table showing the data elements to calculate persistent Oak vegetation areas.

Use the *Add Field* tool to add a field called RemainOak. Use the *Select by Attributes* tool to construct a query identifying polygons historically with Oak vegetation and currently with Oak vegetation.

1. With the feature class table produced by intersecting the clipped vegetation datasets open, add a field of integer type called RemainOak
2. Open the *Select by Attributes* tool
3. Click the *Load* button and navigate to your expression files, choose the historic one
4. Select all the text and copy it to your clipboard.
5. Choose *Load* again and load the other query you saved
6. Insert your cursor at the beginning of the loaded query, and paste in the text from the first query.
7. Type a space, the word “and”, and another space
8. Verify the query
9. Right-click on the RemainOak field and calculate (ignore the warning) the value of the selected records to 1.

General Flowchart Step 6: Calculate the proportion of area formerly Oak species to current Oak species area

We can now make the final table of the analysis by summarizing the selected records on the RemainOak field, suming area. We then add a field to store the proportion remaining, and calculate that value.

1. To create the summary table, right-click on the RemainOak field and choose summarize; sum the area field; give the output an appropriate name
2. Add a field to the resultant table called proportion, with a Double type
3. Right-click on the summary area field, and choose statistics; copy the sum of the area (i.e. total area for the dataset)

4. Right click on the added *Proportion* field; choose calculate field.
5. In the resultant dialogue, enter a formula to divide the area field by the total area you copied from the statistics dialogue, e.g. `[SUM_SqMi/(your copied total value)]`

In the row with the value 1 for RemainOak has the proportion of areas that were recorded as Oak historically, and are recorded as Oak in the current vegetation data set (and conversely for the other row).

1.3 Map and Data Graphics

The products of this lab will be a one-page map layout to accompany a short document. The map layout can be designed with your choice of paper size and orientation (landscape or portrait). You may choose to include additional maps, data graphics, or tables in your layout or short document as needed to illustrate the narrative.

- Be sure to include all necessary map elements as discussed in lectures 10 and 11.
- We also discussed controlling factors on map design, visual variables, thematic symbolization types, visual hierarchy, and things to do for better maps. Take your newfound knowledge from those lectures and the readings, and apply them to creating a map layout that communicates the analysis you performed and the document it accompanies.
- Tip: I highly recommend working on any color schemes using the ColorBrewer web app.
    - When changing a color in ArcMap, you'll see the option below the color picker for *More Colors*. A *Color Selector* will appear with prompts for the red, green, and blue (RGB) values to mix into the color. You can switch the ColorBrewer colors from HEX to RGB to see the numbers you can enter in the *Color Selector*.
- Use a main map and one or more insets for context or detail (make sure the scale differential is worth it--don't use an inset with a scale close to that of the main map.
- In one data frame, symbolize the level 3 ecoregions by the proportion of loss of Oak vegetation types.
- In one data frame, symbolize the Willamette Valley Ecoregion identifying areas remaining in Oak vegetation types
- Use charts as desired (optional) to support the map layout or in the write-up, below

Make a PDF copy of your map.

1. Filename: Lab7_Vegetation Landscapes Report.
2. Take a look at your exported PDF through a PDF viewing application or a web browser. Always look at your output! Both common and unusual errors slip past creators when they don't look at their outputs.

Part 2 - Write-up

Flow chart

Now that you've completed the GIS analysis portion of the lab, reflect across the drafts of flow charts you made. Make a fresh, clean flow chart by hand or using model builder or an application--*at your own risk of time investment*. Diagram the steps as described at the beginning of the lab. As an additional element, draw boxes to group the elements that comprise the General Flowchart Steps. Print your name on the paper and turn in separately in lab when the lab is due. If you complete the diagram in digital format, feel free to turn it in with your map and write-up.

Report

In contrast to previous weeks, you will write a short report instead of answering questions provided here. The report should be 3-4 pages double-spaced; we will not read more than four pages when evaluating the work: limit yourself appropriately.Your report should be organized in a way that is easy to follow, *avoids excessive technical detail and jargon* (or defines any jargon used), and uses complete sentences.

The content should also describe the GIS analysis conducted (enumerated or narrated list of steps) and the results of that analysis.

1. Describe the degree of change represented at the ecoregion-scale. *How location-specific is the degree of change represented?*
2. Describe the degree of change represented within the identified ecoregion. *How location-specific is the degree of change represented?*
3. Describe any considerations you may have of the appropriateness of the analysis? How accurate are the representations of change in 1 and 2, immediately above, in terms of representing change in Oak vegetation types. *How do the different classification schemes affect the analysis?*