

Lab 5 – Tables and Attributes

We are studying the harvest of timber products from Douglas Fir-Western Hemlock-Western Red Cedar forests (*DFCH*) in Coos County, Oregon. In order to protect Riparian habitats (areas around bodies of water) from effluent and excessive sediment runoff, ODFW mandates a 20-foot buffer zone, meaning that no trees within 20 feet of fish-bearing streams can be harvested. However, a proposal by a subcommittee of the Oregon Board of Forestry would increase the stream buffer zone to 90 feet, resulting in a significant loss in harvestable timber.

Our task is to estimate the potential profit losses due to the change in stream buffer zone using geospatial techniques. We will be using vector GIS data in our analyses that has been gathered from the Oregon Geospatial Enterprise Data Office's Spatial Data Library (<http://www.oregon.gov/DAS/CIO/GEO/pages/alphalist.aspx>). We will be using an array of vector geoprocessing tools, including Buffer, Dissolve, Intersect, Symmetrical Difference, and Clip. In addition, we will be filtering our data via SQL Attribute queries.

The data include:

- Forest Types: [forestland.shp](#)
- Hydrography: [Hydrography_Statewide_Streams_Fp.gdb](#)
- Oregon Counties: [orcntypoly2015.shp](#)
- Timber Classification: [timber.shp](#)

Using the data provided, we must determine the steps required to process the data and calculate the potential profit loss. Begin by noting that the data are for the entire state of Oregon.

1. Because we are only interested in profit loss in Coos County, we need to subset the data. We will query the Oregon County Boundary data ([orcntypoly2015](#)) to obtain only Coos County Boundary.
2. Using the Coos County Boundary, we will clip all other data to our area of interest (Coos County). Think of this like a cookie cutter – our Coos County Boundary is the cookie cutter. We will **Clip** each of the following: Forest Types, Hydrography, and Timber Harvest Classification data to obtain only data that is in Coos County.
3. Next, since we are only interested in Douglas Fir-Western Red Cedar-Western Hemlock forests, we will use query the [forestland.shp](#) data to select only Douglas Fir-Western Red Cedar-Western Hemlock forests.
4. Next, we need to find areas that are eligible for timber harvest. We will query [timber.shp](#) to select only areas that have harvestable timber (merchantable timber).

5. Notice that both the [forestland.shp](#) and [timber.shp](#) are made up of several individual polygons. These are called “multipolygon” datasets. To simplify subsequent analysis steps we will **Dissolve** each of the queried Forest Types and Timber Classification. This **Dissolve** step converts the multipolygon data to a single polygon, reducing the number of features to one.
6. Once the features have been dissolved into single polygons, we can perform **Overlay Analysis** to select only areas that have harvestable Douglas Fir-Western Red Cedar-Western Hemlock. For the overlay analysis, we will use the **Intersect** tool, which retains a polygon for **ONLY** areas shared by both the [forestland.shp](#) and [timber.shp](#).
7. Now that we know what areas of Coos County contain harvestable timber of our choice, we need to identify perennial fish-bearing streams in the County. To make this selection we will query [hydrography_clip.shp](#) to select only perennial fish-bearing streams.
8. With our identified perennial fish-bearing streams, we can then use the **Clip** tool to select only streams in the areas of harvestable DFCH forests.
9. With our selection, we can now apply the stream **Buffers**. For our analysis we need to create two buffers: a **20ft buffer** and a **90ft buffer**. Remember, the 20ft buffer represents current ODFW regulations, and the 90ft buffer represents the proposed change in stream buffer regulations.
10. To calculate the loss in timber harvest we must calculate the difference between the two buffers. Using our 20ft and 90ft buffer polygons we will apply the **Symmetrical Difference** operation, resulting in a 70ft polygon that resembles two parallel lines. This represents the area of DFCH forest that would become ineligible for harvest due to new regulations.
11. Now that we have a polygon that represents timber loss, we can take advantage of GIS and calculate, in understandable terms, the area of timber loss in square feet or acres.
12. To proceed with our calculation, we will edit the shapefile to add two Fields: one that will contain the total area, and another that will contain the final Value of timber loss.
13. We will then use the **Calculate Geometry** function to quickly and easily calculate the area in Acres.
14. With our area calculation, we can then determine the total value of timber harvest loss. To calculate the profit loss, we are assuming that each acre of DFCH forest is worth \$4,000. Keep in mind that there are better estimates that can be calculated, but for sake of simplicity, we are using \$4,000. With this estimate, we can calculate the estimated loss by multiplying the value per acre by the number of acres. (Value per Acre * Total Acres).

Exercise Instructions

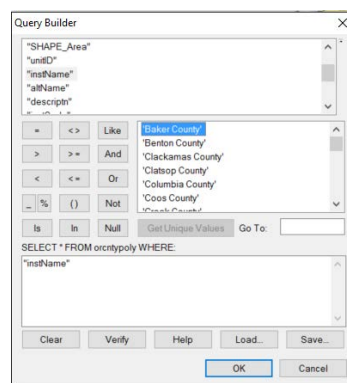
1. Download and extract the course data

Notice that there are several folders. Take note of the “**_working**” folder. As you perform these analysis steps, you will generate new data. It is important that you save all generated datasets in this folder so that you can easily keep track of them.

2. Open a **new** ArcMap document and use Folder Connections to connect to the Lab 5 – Attribute Tables folder you downloaded. The four provided datasets: [forestland.shp](#), [orcntypoly.shp](#), [timber.shp](#), and [Hydrography_Statewide_Streams_fp](#). Loading these datasets may take time, especially the Hydrography dataset. This data contains every single stream for the entire state of Oregon, so you may need to be patient in processing and displaying this data.

3. **Query orcntypoly.shp**

- a. Use SQL to query (also called filter) the Oregon Counties data to select only Coos County.
- b. Go Layer Properties (right-click > Properties) and click on the **Definition Query** tab.
- c. Click the **Query Builder** button. Notice that the top section of the menu contains text in quotes. Each one of these is a field in the attribute table. Locate and **double-click** the “**instName**” field. Double-clicking on this field name should populate the bottom section of the query builder screen. With the field selected, single-click on **Get Unique Values**. Notice that this populates the right section with county names in Oregon.



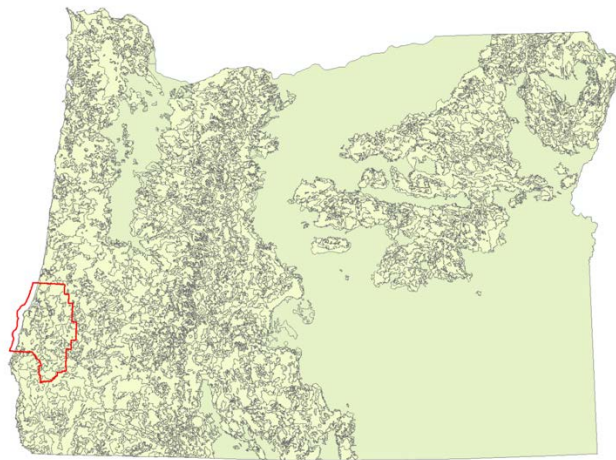
- d. The SQL language uses algebraic expressions to query (select and/or filter) data. Our objective here is to select only Coos County, so our expression will look like this:

"instName" = 'Coos County'

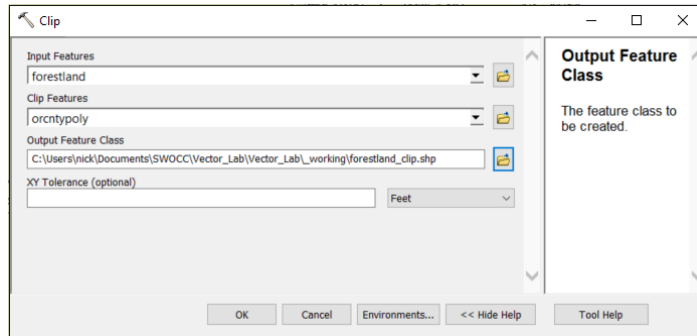
- e. Complete the expression. Single-click the equals button (=) and double-click the Coos County record. Make sure that your expression matches the expression above. Clicking the "Verify" button will check your expression to make sure there is not an error. It is always a good idea to check this before trying to move forward. Click OK to close the windows and close the Layer Properties window.
- f. Deselect all layers in the Table of Contents except for *orcntypoly*. You should only see Coos County.

4. *Clip data to Coos County*

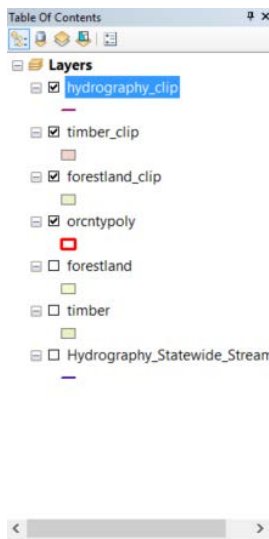
- a. In the Table of Contents, select all other layers to make them all visible. Reorder the layer so that your *orcntypoly* layer is on top and visible. Double-click the color chip and change the appearance of this layer. I recommend changing the Fill Color to No color and making the outline thicker and a bright color so you can easily see it. Your map should look similar to this: ****screenshot2****



- b. In the top menu, click Geoprocessing > Arc Toolbox. With the toolbox open, click **Analysis Tools -> Extract -> Clip**.
- c. With the Clip window open, populate the following fields:
 - i. Input: *forestland*
 - ii. Clip Features: *orcntypoly*
 - iii. Output Feature Class: **Save as** *forestland_clip* in your *_working* folder.
 - iv. The clip window should look like this:



- v. Click OK. Once the tool has finished you should end up with *forestland_clip* in the Table of Contents. Deselect all layers except *orcntypoly* and *forestland_clip* to verify that your new data has been clipped to Coos County.
- d. Repeat this procedure for *timber* and *Hydrography_Statewide_Streams_Fp*. Always use *orcntypoly* as your Clip Features and make sure you save the other files in the working folder with “_clip” at the end of the file name. This will ensure that you are able to find the data and you’ll know what the data are when you see the filenames. Note that the Hydrography dataset should take substantially longer than the others to Clip. Be patient.
- e. Similar to Step 5.c.v., make sure the layers have all successfully clipped to Coos County.
 - i. When the clips have completed, your Table of Contents should look similar to this:



5. Query forestland & timber

- a. Before querying the data, go ahead and remove the original datasets for the entire state of Oregon from ArcMap. Once removed, you should only have the datasets for Coos County.
- b. In the Table of Contents, deselect all layers but the clipped timber and forestland data. Toggle on/off the data layers to get a feel for how they relate to one another.
- c. Similar to subsetting Coos County from [orcntypoly](#), we will query both the [forestland](#) and [timber](#) data.
- d. For the timber layer, navigate to **Properties** -> **Definition Query**. Click on the **Query Builder**.
 - i. In the top section, find and double-click "TYPE" to enter it into the expression window. Click the equals button (=) to add it to the expression. Click Get Unique Values and double-click "Merchantable Timber" to add it to the expression. Your final expression should look like this:

"TYPE" = 'Merchantable Timber'

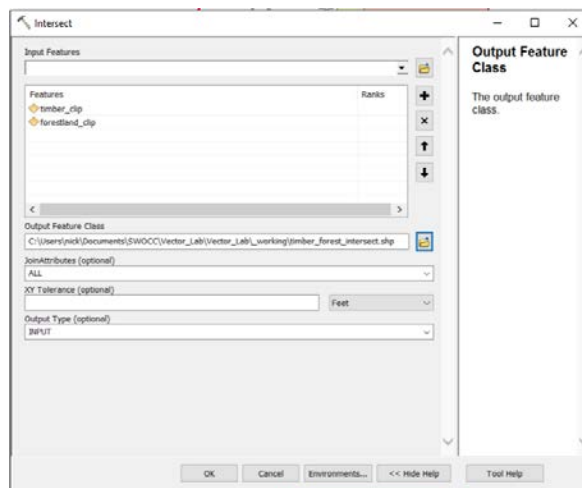
- ii. Verify that your expression is valid, click OK, and close the Properties Window. Notice that the [timber](#) dataset has changed.
- e. For the forestland layer, navigate to **Properties** -> **Definition Query**. Click on the Query Builder.
 - i. In the top section, find and double-click "NUMBER" to enter it into the expression window. Click the equals button (=) to add it to the expression. Click Get Unique Values and double-click 512 to add it to the expression. Your final expression should look like this

"NUMBER" = 512

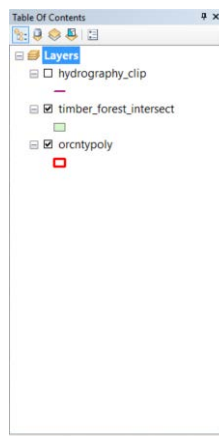
- ii. Notice that in previous expressions the Value has been in quotes. This is because that value is a string of text. In this case, the value (512) is an integer. Since it is not text it will not be encased in quotes. Verify that the expression is valid, click OK, and close the Properties Window.

6. Overlay Analysis: Intersect timber & forestland

- a. Now that we have subset the data to include just Harvestable Timber and Douglas Fir-Western Red Cedar-Western Hemlock Forests, we need to intersect them to locate areas that contain both. In the top menu, click Geoprocessing > Arc Toolbox. With the toolbox open, click Analysis Tools > Overlay > Intersect.
- b. With the intersect window open, populate the following:
 - i. Input Features: [timber_clip](#) & [forestland_clip](#).
 - ii. Output Feature Class: **Save as** [timber_forest_intersect](#) to your `_working` folder.
 - iii. The intersect window should look like this:



- iv. Click **OK**. Once the tool has finished you should see [timber_forest_intersect](#) in the Table of Contents. You can now remove the two layers used to generate [timber_forest_intersect](#). Once removed, your Table of Contents should look similar to this:



7. Query hydrography_clip

- a. Just like other times we've queried data, navigate to the **Layer Properties** -> **Definition Query** -> **Query Builder**.
 - i. In the top section, find and select "Fishpres". Add the equals sign (=) to the expression and click Get Unique Values. Since we are adding streams that contain fish, select 'Fish' and add it to the expression.
 - ii. To this point, your equation should look like this:

"Fishpres" = 'Fish'

- iii. But, we want to subset the data for streams that contain and **AND** are perennial (year-round streams). So, we need to add a second argument to the expression.
- iv. Click "And" to add it to the equation. The AND operator will allow us to say the following: Select fish-bearing streams AND perennial streams.
- v. In the top section, find and select "Duration" to add it to the expression. Add the equals operator (=) and click Get Unique Values. Add 'Perennial' to the expression.
- vi. Your final expression should look like this:

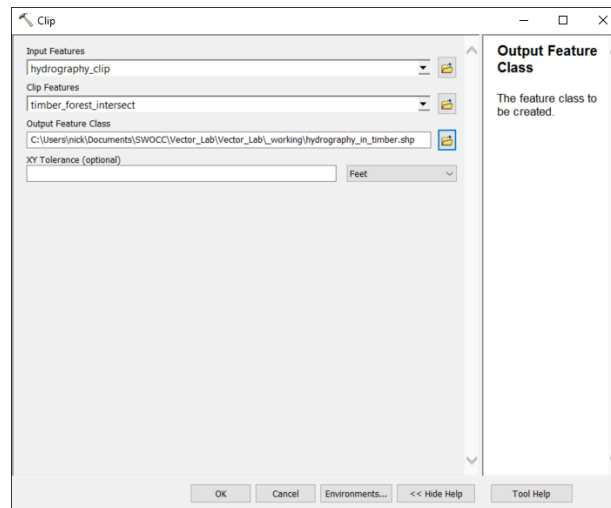
"Fishpres" = 'Fish' AND "Duration" = 'Perennial'

- vii. There are many different operators (AND, LIKE, NOT, OR) that can be used together to query data. These logic operators are important to understand, so be sure to reference the venn-diagram when necessary to see how they relate to one another. Click OK, close the Layer Properties window, and watch as the number of streams changes. It appears that we've eliminated all but the most important streams in Coos County.

8. Clip hydrography_clip to timber_forest_intersect

- a. At this point we have identified the forest areas of choice and the streams of choice. But, we still have streams for the entirety of Coos County. Because we are only interested in streams in the selected timber areas, we must **Clip** the data.
- b. In the top menu, click **Geoprocessing** -> **Arc Toolbox**. With the toolbox open, click **Analysis Tools** -> **Extract** -> **Clip**.
- c. With the Clip window open, populate the following fields:

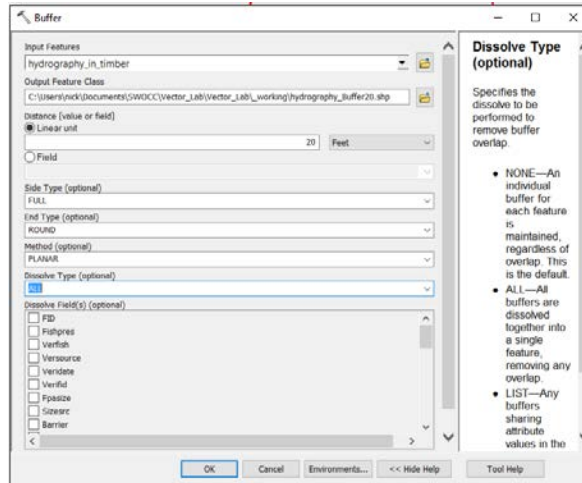
- i. Input: [hydrography_clip](#)
- ii. Clip Features: [timber_forest_intersect](#)
- iii. Output Feature Class: **Save as** [hydrography_in_timber](#) in your `_working` folder.
- iv. The clip window should look like this:



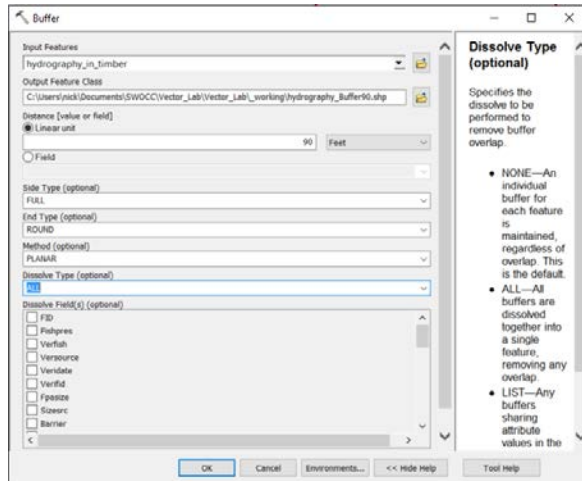
- v. Click OK. Once the tool has finished you should end up with [hydrography_in_timber](#) in the Table of Contents. Deselect [hydrography_clip](#) to verify that your new data has been clipped to timber areas of choice.

9. Generate 20 and 90 foot Buffers

- a. One of the most common GIS operations, the Buffer tool allows you to create a polygon based on the proximity to other data.
- b. With **ArcToolbox** open, click **Analysis Tools** -> **Proximity** -> **Buffer**.
- c. With the Buffer window open, populate the following fields:
 - i. Input Features: [hydrography_in_timber](#)
 - ii. Output Feature Class: **Save as** [hydrography_Buffer20](#) in your `_working` folder.
 - iii. Distance: 20 Feet
 - iv. Dissolve Type: ALL
 - v. The Dissolve window should look like this:



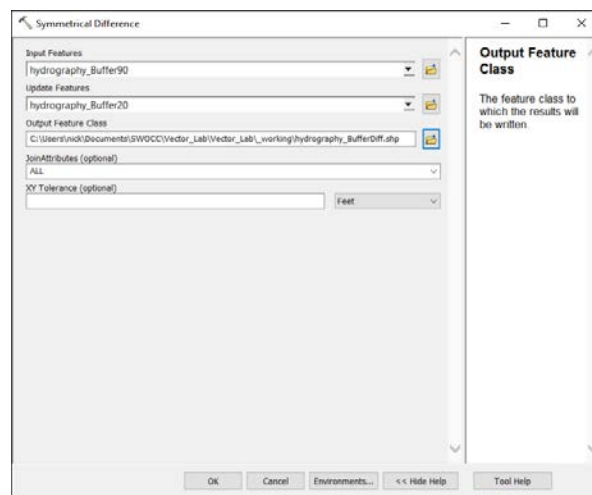
- vi. Click **OK**. Once the tool has finished you should end up with *hydrography_Buffer20* in your Table of Contents. From a distance it looks just like the existing hydrography layer, but if you zoom in you will see that the Buffer layer appears wider than the stream layer.
- d. Generate another buffer. This time you will generate a 90-foot buffer, so adjust the distance and file names accordingly. Follow the same protocol as before and your Buffer window should look like this:



- e. Once generated, sort the layers in the Table of Contents, such that they are as follows:
 - i. *Hydrography_in_timber*
 - ii. *Hydrography_Buffer20*
 - iii. *Hydrography_Buffer90*
- f. When sorted in this manner, you should be able to zoom in very close and see the original hydrography as well as each of the Buffers.

10. Perform Symmetrical Difference on the Buffers


- a. Another common GIS analysis operation, *Symmetrical Difference* is an *Overlay* function that removes any overlapping areas of a feature.
- b. With *ArcToolbox* open, click *Analysis Tools* -> *Overlay* -> *Symmetrical Difference*.
- c. With the *Symmetrical Difference* window open, populate the following fields:
 - i. Input Features: [hydrography_Buffer90](#)
 - ii. Update Features: [hydrography_Buffer20](#)
 - iii. Output Feature Class: **Save as** [hydrography_BufferDiff](#)
 - iv. The *Symmetrical Difference* should look like this:



- v. Click **OK**. Once the tool has finished you should end up with [hydrography_BufferDiff](#) in your Table of Contents. If you deselect all but this layer and zoom in you will see the results of the *Symmetrical Difference*. Toggle on/off the buffer layers and the results of the *Symmetrical Difference* to see how they relate.
- vi. With this step complete we now have the area in question isolated. All we have to do now is calculate the total area and then multiply it by the timber value per acre.

11. Add Fields, Calculate Geometry, and perform a Field Calculation.

- a. Begin by deselecting all but the [orcntypoly](#) and [hydrography_BufferDiff](#) layers.
- b. Navigate to the Attribute Table of [hydrography_BufferDiff](#). Notice that there isn't much in the attribute table. Here we will add a field and perform the calculations.

- c. Click the top-left button inside the Attribute Table . Click on **Add Field**. In the Add Field window, populate the following:
- Name: Area
 - Type: Double
 - Precision: 0
 - Scale: 0
- d. Once added, you will see the field in the Attribute Table. Right-click on the newly added Area Field and select Calculate Geometry. A warning will pop-up, to which you should click Yes.
- e. The default values are all fine, except you should change the Units to **Acres US [ac]**.
- f. You will be warned again, and again you should click Yes.
- g. Now notice that the field has a value. All of the GIS work completed to this point has been done so that we can generate this value.
- h. Add another Field. For this field, populate the following:
- Name: Value
 - Type: Double
 - Precision: 0
 - Scale: 0
- i. Once added, you will see the field in the Attribute Table. Right-click on the newly added Value field and select Field Calculator. A warning will pop-up, to which you should click Yes.
- j. In this window, click the **Python** radio button. Type 4000 and click OK.
- k. Add another Field. For this field, populate the following:
- Name: ProfitLoss
 - Type: Double
 - Precision: 0
 - Scale: 0
- l. Right-click the ProfitLoss field and go to **Field Calculator**.
- m. In this window, click the **Python** radio button. For the expression, double-click Area, click multiply (* - an asterisk) and double click Value. The final expression should look like this:

`!Area! * !Value!`

- n. Click **OK**, and view the result. Notice that the formatting isn't appropriate for currency, and since this is ProfitLoss, we ideally want it to be formatted as currency.
- o. Right-click ProfitLoss in the Attribute table and navigate to Field Properties. Click on **Numeric (...)** and click **Currency** in the Category field. Click **OK** twice and notice that the format is more suited for currency.

Q1. What is the total area for the final buffer?

Q2. What is the total Profit Lost for DFCH forest types in Coos Bay in the event of an increase in stream buffer size from 20-feet to 90-feet?

Submit the following:

- 1. Responses to the final two questions.**
- 2. A basic map with the following:**
 - a. Coos County Boundary**
 - b. The final buffer polygon**
 - c. The polygon of harvestable DFCH forest**

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