

ArcGIS

Buffer Analysis

OVERVIEW: The Analytical Process

Lab exercises that we undertake should follow a structured problem-solving approach:

1. **Issue:** understand the issue to be resolved (e.g. constraint mapping problem)
2. **Learning Objectives:** understand the learning objectives (i.e. typically understand the generic GIS tools used to solve the issue and gain some proficiency with the software)
3. **Data:** know what data you need and understand what you have:
 - a. assemble the data
 - i. create (or open an existing) map document
 - ii. ensure all the map layers are present
 - b. explore the data (i.e. understand what you have)
 - c. alter symbology to make it more readily understandable
4. **Analysis:**
 - a. determine the analyses required (i.e. make a plan what needs to be done)
 - b. conduct the analyses (i.e. execute the plan)
5. **Interpret Results:** be sure you understand all new map data that you create – if it doesn't make sense then stop and think (and possibly redo that step)
6. **Communicate Results:** make a map layout that clearly communicates your results.

THE ISSUE

The issue at hand is to update the VIU Forest database to include

- adjacent clearings, and
- reserves (buffers) around heron nests and along streams and a popular hiking trail

Background

The VIU Forest has two adjacent clearings: a motocross pit and a wood waste dump. These need to be added to the GIS database. Also, forestry workers have discovered the presence of a heron rookery (i.e. a collection of wildlife trees with heron nests). You need to map these wildlife trees, and then create a 'multiple width buffer' around the trees – the inner buffer will be a reserve (no logging) and the outer buffer will be a special management zone.

Your next analysis is to create riparian buffer zones on the streams. Each section of stream (i.e. stream reach) will be buffered according to its importance to fish habitat – i.e. more important reaches will have a larger buffer. In order to create this 'variable width buffer' you will:

- Enter data in the stream attribute table for buffer width, and then
- Buffer the streams using this data from the table.

Then you will create a buffer around the hiking trail that goes from Witchcraft Lake, through a portion of the VIU Forest up to the top of Mount Benson.

Finally, you will create a map layout that clearly communicates these management zones.

LEARNING OBJECTIVES

You will further develop the following ArcGIS skill sets

- Set *relative pathnames* for saving data
 - Create data layers and heads-up digitize (with snapping) to add new features
 - Create database attribute tables
 - Add / edit data within attribute tables
 - Create a map based on a table of coordinates
 - Create buffers using (fixed, multiple and variable widths)
 - Create a map layout.
-

DATA

General Set-up

- Copy the “VIU_Woodlot2012” folder from the course folder on the G:\ drive to your U:\ drive. This folder contains the VIUwoodlot.gdb (geodatabase) – this file contains the map layers for the woodlot.

Create map document and add our data

Remember the geodatabase is the source data whereas the map document controls how the data appears.

- Start ArcMap and create a new map document (use the Blank Map template).
- Add all the data layers contained in the VIUwoodlot.gdb. You may need to “connect” to VIU_Woodlot2012.
- Save the new map document in the VIUForest2012 folder on **your** U: drive as **YourSurnameForest.mxd** (e.g. CorrinForest.mxd)
- Next, click File, then Map Document Properties, ensure that **Store relative pathnames to data sources ...** is selected (now if you copy this map document to another location it will ‘look for’ data within the same folder)

Explore and Symbolize the Data Layers

- First, examine the *data frame*
 - Rename the data frame from layers to **VIU Forest**
 - Check the map and display units are set to metres
 - Check the coordinate system (datum and projection) of the data frame (VIU Forest) - ** If it is not set to NAD_1983 conduct the following:
 - Click the **Predefined** folder, then **Projected Coordinate Systems**, then **UTM**, then **NAD 1983**, then **NAD 1983 UTM Zone 10** and click **Apply**

Group map layers with a similar theme.

- Click once on *RoadsAnno*, then hold down the Ctrl button and click *Signage*, *Gates* and *Roads*
- Right click on *Roads*, select Group
- Rename the new group to “**Roads**”

- Next create the following groups:
 - **Water** – contains *Culverts*, *Sump*, *Water_Bodies* and *Water_Courses*
 - **BioSolids** – contains *Application_Trails*, *Application_Areas*, and *Pits*
 - **Openings** – contains *Commercial_Thinning*, *Opening_Falling_Boundaries* and *Openings_SU*
 - **Legal** – contains *GPS_Surveys* and *Woodlot0020*
 - **Harest Restrictions** – contains *Recreation_Features*, *Research_Plots*, *ESA_to_merge_with_sesecosyst*, *Non_Productive*, *OGMA*, *Parks*, *Sensitive_Ecosystem_Inventory*, *Visual_Quality_Objective* and *Wildlife_Tree_Patch*

Adjust the order of the layers (top to bottom):

1. Roads
2. Water
3. Contours
4. Harvest Restrictions
5. BioSolids
6. Openings
7. Forest Cover
8. Legal

Note, you might find it necessary to alter the order of the layers at a later time, but for now use this order.

Adjust symbology

- Water bodies blue – blue
- Contours – light-medium brown (Tecate Dust: row 7 column 4)
- Woodlot0020 – hollow with a purple line, width = 1.5
- Forest_Cover – Apple Dust (row 7, column 6) with gray line color and 50% transparency
- Visual Quality Objective – 10% Simple Hatch (so we can see through it)
- Roads – use **Categories – Unique values** and use the **Value Field Surface**, then click Add All Values button,
 - double click symbol next to *gravel* and choose **Existing Road Needs Repair**
 - double click symbol next to *pavement* and choose **Freeway** and adjust width to 1.5
- Symbolize the other layers as you see fit (but not garishly ugly)

Take a closer look at the Forest Layer

You will note for the Forest attribute table there are a multitude of fields, most of which make no sense to us.

- Double-click the Forest_Cover layer, select the Fields tab, clear all fields except for the following
 - Forest_POL

- Forest_SPC
- **Forest_S_1** through to **Forest_S_9** (these are species composition)
- Forest_STA
- LabelPoly (these next ones are at the bottom)
- LabelSpp
- LabelCode
- Year
- Shape_Area

Note that some of the data entries for Shape_Area have excessive decimal places – only one place is needed.

- Right-click on the Shape_Area field and choose properties
- Click the numeric (...) button and reduce number of decimal places to 1

Calculate Area

The *Shape_Area* field is the area of the polygons in square metres. A more useful measure would be hectares:

- Add a field called Hectares
- Right-click on Hectares and choose Calculate Geometry, click Yes to allow edit session
- In the next box ensure that Area and Hectares are selected and press OK
- As before, reduce the number of decimal places to 1 plus ensure that **Pad with zeros** is selected (this will ensure a value of exactly 5 ha is displayed as 5.0 instead of 5)
- You can now hide *Shape_Area* from view

Classify the Forest_Cover layer according to age (use field: Forest_STA)

- Use 5 classes
- Use colour ramp that ranges from green to blue (as it makes the classes more obvious)
- **Natural breaks**
- Save as a layer file as **AgeNatBrk.lyr** to the VIU_Woodlot2012folder
- Add the layer file to the map document and rename it **Age Natural Break**
- Classify the Forest layer according to age
 - Maintain the same colour ramp
 - Use 5 classes
 - **Equal Interval**
 - Save as a layer file as **AgeEqInt.lyr** to the VIU_Woodlot2012folder
 - Add the layer file to the map document and rename it **Age Equal Interval**
- Classify the Forest layer according to age
 - Maintain the same colour ramp
 - Use 5 classes
 - **Quantile**
 - Save as a layer file as **AgeQuant.lyr** to the VIU_Woodlot2012folder

- Add the layer file to the map document and rename it **Age Quantile**
- Create a group called **Forest Age** and put the 3 layer files just created into that group
 - Compare the 3 layers
 - Open a Word document and write a brief paragraph that explains the differences between the way in which the layers are coloured. You will need to address how each method works and the nature of the data (i.e. forest age on our woodlot). You should also paste in jpg's of the 3 layers to aid with your explanation.
- **Resymbolize Forest_Cover so that it is once again a single colour**
 - Use Apple Dust (row 7, column 6) with gray line color and 50% transparency

Create a Point Layer from Coordinates

The locations of heron nests were determined using GPS and are given in the following table:

NestID	Easting	Northing	TreeCode	HTm	DIAcm
1	420772	5451373	Fd	36.3	32.3
2	420800	5451356	Fd	33.0	30.4
3	420843	5451360	Fd	39.5	38.4
4	420897	5451440	Bg	35.2	32.1
5	420892	5451351	Fd	31.3	29.7
6	420772	5451226	Bg	38.3	33.6

Note: Fd = Douglas-fir and Bg = Grand Fir; HTm = height (m); DIAcm = diameter (cm)

- **Create table:** Open ArcCatalog and, if necessary, make a folder connection to your VIU_Woodlot2012folder. Right click on the folder and select *New* then *dBase Table*.
 - Rename the table *Nests.dbf*.
 - Close ArcCatalog (otherwise you may have trouble editing the table in the next step).
- **Add Fields:** Return to ArcMap and add the *Nests* data table to your map document.
 - Open the table and add the necessary fields (refer to text below to decide field type and precision/scale if it is Float or Double)

Remember:

- Text – for a mix of characters (letters and/or numbers)
- Short integer – up to 4 digits (**NO** need to define precision)
- Long Integer – up to 9 digits (**NO** need to define precision)
- Float – real number; up to 7 digits
 - precision = # of digits
 - scale = # of decimal places
 - e.g. prec=5, scale=2 can store 123.45
 - e.g. prec.=7, scale=3 can store 1234.567
- Double – real numbers; for 8+ digits
 - Precision and scale as before

- Do not touch “OID” as it is a required field, but you can now delete the unnecessary “Field1”

- **Enter data:** Enter the values from the table above. Stop and save edits, then close the *Nests* table.

The next step is to create a map layer showing these point locations.

- Right click on the *Nests* data table and select *Display XY Data*
 - Make sure your “Easting” is selected for the “X Field” and your “Northing” is selected for the “Y Field”
 - Confirm the datum and projection for the new data layer is the same as the data frame (you determined this earlier)
 - Click **OK**
- “Nest Events” is added to the TOC – change the symbology to “star 3” with a size of 10 and the colour red.
- The trees are located in the NE corner of the VIU Forest – zoom into this area to get a better view (a scale of 1:10,000 will do nicely)

Save your map document! Note, save periodically, especially after you’ve done some significant work – you know ... when you get that warm feeling of satisfaction.

ANALYSIS & INTERPRETATION (you should interpret all new data layers as you create them)

**** When conducting analysis new layers will be created ** Be sure to save the new layers with names provided ** Failure to do so will result in loss of marks *****

Buffer the Nests

Next, you will explore buffering. **Buffer** is in the **Toolbox** under *Analysis* and then *Proximity*.

- Conduct a buffer and specify the following:
 - Input Features: **Nest Events**
 - Output Feature Class: use the browse (folder) button and navigate to your working directory (i.e. U:\VIU_Woodlot2012) and name the file **BufferDissolveNo**
 - Distance: **50** metres
 - Dissolve Type: **None**
 - After the buffer is completed, it is added to the TOC.
- Conduct the buffer a second time with the exceptions of
 - Filename for output feature class is **BufferDissolveYes**
 - Dissolve Type: **All**
 - All else is the same
- Group both layers into a new group called **My Buffers**
 - Compare the 2 buffer layers
 - First compare visually
 - Second, examine each attribute table – you should be able to explain the difference (it’s a good test question)

Let's look at another buffering option — multiple rings. You want to create a 50 metre reserve that encircles the patch of wildlife trees. This area will become a reserve zone and will not be logged. Additionally you want a second buffer that extends 50 metres from this reserve zone. In this second buffer, up to 40% of the trees will be harvested in order to create a windfirm forest around the reserve.

- Buffer the nests again, but this time choose **Multi Ring Buffer** from the toolbox
 - Input Features: **Nest Events**
 - Output Feature Class: use the browse (folder) button and navigate to your working directory (i.e. U:\VIU_Woodlot2012) and name the file **HeronBuffer**
 - For distance type in 50, then press the + button, then type 100 and press the + button again
- Dissolve Option: **All**
- Drag this layer into the **My Buffers** group

Save your map document.

Buffer the Streams

We will buffer streams in order to protect water quality and fisheries values. As stated before, some streams have greater value than others; for example, a stream that supports salmon should receive greater protection than an intermittent stream that does not contain any fish.

- Open the table for Streams and take note of the data fields. In the table are the following classes of streams:
 - S2 = large stream with fish
 - S3 = medium stream with fish
 - S5 = medium stream with no fish
 - S6 = small streams with no fish
 - UC & UN = unclassified streams (yet to be surveyed/ fish inventory not known)

We will create buffers that represent a special management area called a Riparian Management Area (RMA). The distances are as follows:

- S2 = 50m
- S3 = 40m
- S5 = 30m
- S6 = 20m.
- UC & UN streams will default to the S2 distance of 50m

You will note that the values in the Buffer field are inconsistent. You will now rectify this.

- Use **Select by Attributes** and select all records with a class of S2
- Right click on the **Buffer** field (this is a numeric field where buffer width is stored)
 - Select Field Calculator
 - In the “big white box” type **50**

- Click OK
- Follow the same procedure and “fix the values” for the other reach classes (i.e. S3, S5, S6, UC & UN)
- Clear the selection or your buffer won’t function properly
- **Buffer the Streams layer:**
 - Use the appropriate input feature
 - Name the output feature class **StreamBuffers** (be sure it is saved to your working directory)
 - Use Field instead of Linear Unit and choose the appropriate field from the list
 - Ensure that the dissolve is “on”
 - Don’t worry about Dissolve Fields
- Drag the new **StreamBuffers** into the **My Buffers** group

Map Layout

Create a map layout that displays the Nest Events, Water_Courses, Water_Bodies, Forest_Cover, HeronBuffer, and StreamBuffer layers. No other layers should be displayed. Also note that polygon layers should not cover line or point layers; reorder the map layers if need be.

- Apply the map template: LandscapeClassic.mxd (on the Traditional Layouts tab)
- Use a scale of 1:40,000
- Eliminate the data frame background colour (currently it is blue)
- Symbology for the layers should be as previously stated, except
 - The StreamBuffers layer should be symbolized using a “10% crosshatch” pattern (scroll down in the Symbol Selector) with a dark-green colour for both the fill and outline (set the outline width to 1.0 pt.).
- Give your map a title of “VIU Forest – My Buffers”.
- Double click the text below the scale bar and enter your name – set the text size to 36.
- Move the map elements (legend, north arrow, scale bar, your bar) as required to compose a good layout

Export your map as a **.jpeg** file to your **U** drive. Include your surname as part of the filename, and email your JPEG plus your paragraph description of the classification schemes for forest age to doug.corrin@viu.ca

Save your map document for the final time and exit ArcMap.