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) for a heron rookery, as well as 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:

- Create data layers and heads-up digitize (with snapping) to add new features
- Create attribute tables
- Add / edit data within attribute tables
- Create buffers using (fixed, multiple and variable widths)
- Create a map layout.

DATA

General Set-up

- Copy the "Lab2" folder from the course folder on the G:\ drive to your U:\ drive.
- Start ArcGIS and create a new map document. Add all the existing data layers in your Lab2 folder to your map document
    - Save the new map document in the Lab2 folder on **your** U: drive as **Buffer.mxd**
- Next, click File, then Document properties, then Data Source Options, ensure that **Store relative pathnames** … is selected (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)
        - Datum: _____; Projection: _____

- Next explore the data layers
    - Note that some layers are not visible. Rearrange the order so all layers can be viewed.
    - Rename data layers as follows:
        - Logroad → Gravel Roads
        - Secroad → Paved Roads
        - Legal → VIU Forest Boundary
        - OGMA → Old Forest
        - WTP → Wildlife Tree Patch
        - ESA → Env. Sensitive Areas
    - Adjust the colours of the layers so they make sense to you
        - Lakes and Streams – blue
        - VIU Forest – hollow with a purple line, width = 1.5
        - Paved Road – "Highway Ramp" (red)
        - Gravel Road – "Automobile Tunnel" (medium gray)
        - Contours – light-medium brown (Tecate Dust: row 7 column 4)
        - Forest – Apple Dust (row 7, column 6) with gray line color and 50% transparency
        - Symbolize the other layers as required

    - Take a quick look in the attribute tables to see what data is available.

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.

- Turn off from view all fields except for Forest_ID (the easiest way is to double-click the layer, select the Fields tab, clear all fields and then turn on only the Forest_ID).

A simplified table already exists. Rather than retyping in this data you will simply join this (outside) source table to our destination table (the Forest data layer).

- Join the ForestCover table to the attribute table of the data layer using Forest_ID (Note – If you missed adding this table during set-up you'll need to do it now).

Now explore the data. Note the following:

- AREA is in hectares (ha) – 1 ha equates to a football field or soccer pitch
- NPF_DESCR – is non-productive forest, the <null> entries indicate that it is actually forest; however, you will notice some "swamp" entries
- Major and Minor indicate the significance of tree species – codes are as follows:
  - **Fd** is Douglas-fir
  - **Hw** is western hemlock
  - **Cw** is western red cedar
  - **Pl** is lodgepole pine
  - **Pw** is white pine
  - **Dr** is red alder
  - **Mb** is big-leaf maple
- AGE in years should be obvious
- HT is tree height in metres
- The last columns indicate % of each tree species

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

- Right-click on the HT field and choose properties
- Click the numeric (…) button
- Reduce number of decimal places to 1
- Click OK twice

- Classify the Forest layer according to age
  - Use 5 classes
  - Natural breaks

  Take note of where the older forest stands are located.

- Classify the Forest layer according to height
  - Use 5 classes
  - Natural breaks

  Compare the difference between the two. Explain the difference!

Create New Data – Neighbours

There are two cleared areas immediately adjacent to the VIU Forest: the Wastelands Motocross and Wood Waste Dump (has gravel roads running through it).

- Create a new polygon layer named **Neighbours**. Set the coordinate system (datum/projection) to be the same as the data frame of your map document.
- Use the air photo as a guide and 'heads-up digitize' the two cleared areas
- Add a text field to the attribute table called "Name". Enter the names for each polygon.
- Symbolize with a light rose colour

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	420740	5451076	Fd	36.3	32.3
2	420773	5451078	Fd	33.0	30.4
3	420760	5451054	Fd	39.5	38.4
4	420733	5451039	Bg	35.2	32.1
5	420788	5451011	Fd	31.3	29.7
6	420799	5451033	Bg	38.3	33.6

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

- **Create table**: Open ArcCatalog and make a folder connection to your Lab2 folder. 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

  - Now delete the unnecessary "Field1"

- **Enter data**: Start editing (if necessary, activate the Editor toolbar). 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"
    - Click the Edit button and set the datum and projection of the new data layer to be 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)
- Oops – the coordinate for point 6 is incorrect, change the easting to **420950** – what happened to the location of the tree?

Save your map document! Note, save periodically, especially after you've done some significant work.

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 the names provided. ** Failure to do so will result in loss of marks! ***

**** Check if the Buffer Wizard is listed under the Tools menu. If not, follow the instructions below**.

How to add the Buffer Wizard to the Tools menu

1. Click the Tools menu and click Customize.
2. Click the Commands tab.
3. Click Tools in the Categories list.
4. Click on the Buffer Wizard icon in the Commands list and drag it to the Tools menu on the Main menu. The Tools menu will open and you can drop the Buffer Wizard into the menu at any position. Alternatively, you can choose to place the Buffer Wizard on any of the other menus or toolbars.
5. Click Close on the Customize dialog box.

Buffer the Nests
Next, you will explore buffering. First, examine the option of dissolving (vs. not dissolving) the inner boundaries of the buffer features.

- Use the *Buffer Wizard* to buffer *Nest Events*:
    - specify a 50 metre width
    - ensure "dissolve yes" is selected (graphic looks like "Mickey Mouse")
    - before clicking Finish, browse to your Lab2 folder and name the output shapefile layer "**Buffer_Dissolve_Yes**".

    - After the buffer is completed, it is added to the top of the TOC. Drag it down to the top most polygon layer (i.e. just under point and line layers)

- Use the *Buffer Wizard* and create a second buffer around the nests
    - specify a 50 metre width
    - ensure "dissolve no" is selected (graphic looks like a part of the Olympic circles)
    - before clicking Finish, browse to your Lab2 folder and name the layer "**Buffer_Dissolve_No**".

    - After the buffer is completed it is added to the top of the TOC. Drag it down to the top most polygon layer (i.e. under point and line layers)

    - 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)

Can you think of a situation in which you would use each method?

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" with 2 rings, each 50 metres wide. You will need to consider which dissolve option is best. Save the buffer layer in your **Lab2** folder and name the layer "**HeronBuffer**".

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. There are 2 classes of streams:
    S6 = small streams that contain no fish
    UC = unclassified streams (yet to be surveyed/ fish inventory not known)

The S6 streams actually do not require a reserve zone; however, for this exercise we will create a 20 metre special management zone. Note the value of **20** in the "**Buffer**" field. Since unclassified essentially means we do not yet know the fish value, we should default to a moderate protection level for fish streams – i.e. protect the stream until it is proven to not contain fish. Thus, at the planning stage, we will enter a conservative buffer width of 30 metres for all the unclassified streams. Note there are many records with the UC classification. You could edit them one at a time … or you could do it all at once. To

accomplish this you first select all the records with a class of "UC", then use the field calculator and enter the value of "30":

- Use ***Select by Attributes*** and select all records with a class of UC
- Right click on the **Buffer** field (this is a numeric field where buffer width is stored)
    - Select Field Calculator
    - Click "Yes" to ignore the warning (which essentially states you cannot undo this edit)
    - In the "big white box" type **30**
    - Click OK

Now comes the Buffer …

- Since we wish to buffer all streams, click the Clear Selected Features button

- Buffer the Streams layer:
    - based on a distance from an attribute – use the "Buffer" field (remember map distance units are meters)
    - Save the buffer layer in your **Lab2** folder and name the layer "StreamBuffer".

Save your map document.

The last analysis is to create a buffer around a popular hiking trail that goes up Mount Benson. Open the Trails attribute table. Select the last 2 trails (FID 30 and 31). Create a special management zone along this trail that is 60 metres wide (i.e. 30 metres on each side). Name the layer "TrailBuffer".

Map Layout

Create a map layout that displays the Nests, Streams, Trails, Lakes, Forest, Paved Roads, Gravel Roads, Neighbours, HeronBuffer, TrailBuffer and StreamBuffer layers. No other layers should be displayed.

- Apply the map template: LandscapeClassic.mxt
- Symbology for the layers should be as previously stated, except
    - The buffer layers 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 – Special Mgmt Areas".
- Double click the text below the scale bar and enter your name – set the text size to 36.
- Move the legend as required.
- Eliminate the data frame background colour (currently it is blue).

Set the scale to 1:15,000.

Export your map as a **.jpeg** file to your **U** drive. Include your surname as part of the filename (e.g. *lastname*_lab2.jpg), and email your JPEG to doug.corrin@viu.ca

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