

Remote Sensing, Fall 2025

Lab 5: Feature Extraction

Lab goals

Satellite images like air photos can be used for manual interpretation, but because they are digital, we can use image processing techniques to semi-automatically extract vector features. The specific goal in this week's lab is to create vectors for 2-3 class features which you can clearly identify and reduce to a manageable number of polygons.

There are five main steps:

- Generate a clean layer containing the desired features –a bitmap or raster channel from THR or Ratio-Index-Transform or Classification
- SIEVE as needed to create a manageable number (sieve works only on raster channels)
- Generate vectors (raster to vector):
RAS2POLY or BIT2POLY or EXPOLRAS
- Smooth vectors – SMBOYLE or SMMCMASTER
- Examine and clean attribute table - calculate area stats (in Catalyst or GIS)

Features to extract:

- 1. Water (twice for PG and for Bowron Lakes)
- 2. forest fire – Bowron Lakes

1. Start Catalyst and Load/open the PG 2023 image ... (one last time)

Extract water from the PG 2023 multispectral image

For water, you should have an “almost ready to go” water layer from NDWI in lab 4.

If you don't have NDWI, you can quickly run it again: $(\text{Green} - \text{NIR}) / (\text{Green} + \text{NIR})$

.. or copy pg2023ndwi from *L:\GEOG357\labs2025* (if I remembered to put it there)

You could also use a NIR/Red or NIR/Blue ratio, or classification, and then threshold.

2. Create the water bitmap

Load the file and display bands 6-5-4; now add the NDWI layer

Layer – Add -> Grayscale and select the NDWI layer, finish

Examine this layer; query some values in the water. You can use right-click -> numerical values to display a matrix of DNs around your cursor:

Make sure its in the middle of water, so the matrix is not catching land pixels.

Determine the minimum value for water and apply this in the Threshold tool (THR).

It should be somewhere around 0, so all land is <0 .. no need to be precise

Tick the NDWI channel and run first to viewer (output).

If it looks good, run again and save output to your PG2023 pix file.

3. Vectorise the bitmap to create water outlines: BITPOLY

tools-> algorithm library → BIT2POLY

Input: the bitmap layer number (2 ?)

Output: viewer and save to file

Params: smooth should be checked RUN

If you can't see your new vector lines e.g. if they are blue, you can right-click on the new polygon layer in the display listing and change the colour

Your .pix file should now include both bitmap and vector layers. Check by switching to the 'files' tab and see the listings for this file. Switch back to the 'maps' tab.

4. polygon attribute tables

You can't sieve a bitmap to remove wee bits, only a raster, but note that we could later remove small polygons either in Catalyst or GIS.

right-click on the new polygon layer label -> pick **Attribute Manager**

The areas may be in square metres as default with UTM coordinates, we can convert to hectares or square kilometres to reduce 'scientific notation' - we will select **hectares**

Right-click on the Area column heading, select Table definition, change decimal places to 2 and display units to Hectares. Apply OK

Deselect Area heading – click on it

Layer-> Save as -> pick your PG 2023 pix file and the Polygon Layer

Layer-save as again and this time scan down a few lines to the ArcGIS shapefile, and save as shapefile .. you could name it something like water2023.shp and save in your folder. This can be directly opened in ArcGIS or QGIS – unlike the layer stored in the .pix file (in PCI format).

In the attribute table you should see the polygons listed in order of area and by clicking in the left column, it will highlight that feature. The top 3 should be the Nechako/Fraser (one polygon) and Tabor and Swampy Lakes .. the rest get harder to see due to size. Ferguson Lake should be #4.

Click in the top left column (blank to the left of 'ShapeID', and you should see a summary of stats for the water polygons, including total area (sum) for the polygons.

Q1: What is the area of each of the two largest lakes (hectares) – which lake is larger ?

Q2. how many water bodies are in this layer now and what is their total area (km²)

Done with PG for now and maybe all the labs. Start a new project – 2 options

File -> New project (discard old one) OR if you think you may just need to return before end of lab, first save as .. e.g. lab5a You shouldn't need this as its goodbye PG and hello Mountains.

5. Polygon layers for Bowron Lakes

Copy **bowron2024aug1.pix** from *L:\GEOG357\labs2025* and also **bowron2024pan.pix**

In Focus open your copies of the multispectral and the PAN file

Display the standard bands 654 in RGB - the PAN will open in grayscale

The image is ~ 51 x 39 km – slightly larger than the PG image; Path 47, row23

You can see the famous Bowron Lakes canoe circuit, the parallel ridges covered by numerous avalanche slopes, and a recent fire just below the centre of the image, along with a larger one in the SW corner. These fires caused the evacuation of Well/Barkerville to the NW of the image in late July 2024. The larger fire appears 'more red' suggesting the one inside the park happened first and has had more time to 'cool off' (also evident in the thermal bands). In the circuit, Isaac Lake is on the east side and Lanezi Lake on the south side.

There are also a few pesky clouds which will slightly impact the extraction of the water layer.

Note the Landsat 9 bands (same as Landsat 8, but with the two thermal bands which I didn't include in the PG dataset); it also has the band 1 for water/aerosols (not on Landsat 4-7).

a. Water – lakes

Repeat the process we used on PG2023 to extract lakes/water, but now for Bowron2024

Start with the NDWI layer, which I've created for you – display in gray scale.

THR: The minimum threshold should be the same as in the PG image. Run first to display; if happy, run again and save the bitmap to file – your BOWRON multispectral file.

BIT2POLY: repeat process done with the PG scene

Polygon attributes: Change units to square kilometres instead of hectares and repeat Q1 from the PG image but for Bowron Lakes (in kms):

Q3a: What is the area of each of the two largest lakes – which lake is larger ?

Q3b. how many water bodies are in this layer and what is their total area (km²)

b. Bowron Lakes: the fires

Use the Normalised Difference Burn 'Ratio' Index (NDBR) to highlight the fires:

$$\text{NDBR} = (\text{NIR} - \text{SWIR2}) / (\text{NIR} + \text{SWIR2})$$

Raster Calculator: double-click on bands and single click on operators to make your formula

Run first to display only, review the image and DN's – are the DN's in the burn(s) lower than everywhere else – I think it's going to be below a 'maximum' of 0 -all other features are +ve.

Note down your approx. min/max for the burns.

When happy, run again and save to your Bowron Multispectral file, and now we'll use:

EXPOLRAS: This algorithm tool goes beyond BIT2POLY incorporating multiple steps to extract and refine features by thresholding, sieving and vectorizing all in one operation.

Tools → Algorithm Librarian -> **EXPOLRAS**

Input: your NDBR channel

Output: to viewer and your Bowron pix file

Params:

Threshold Minimum: input your value here

Maximum: 0 (?)

Minimum Area: 11 – this is the sieve operation (1 hectare or greater)

Compactness could be interesting given the general shape of our feature, but we'll leave it as is

Go to log tab and Run ... it should be successful 😊 but check

You now have a polygon layer for the wildfires, but not yet smoothed

We will use a more sophisticated algorithm to smooth this unsmoothed layer, written by Dr. Ray Boyle, U. Saskatchewan. It is called SMBOYLE and is found in the Algorithm Library.

Smoothing – run **SMBOYLE** – input your unsmoothed vector layer, output to Viewer and save to your Bowron MS .pix file. Accept the default parameters.

Q4a. How many smoothing tools are in the Catalyst Algorithm Library (they start with SM...)

4b. Which one does the help suggest is preferred with satellite imagery and why ?

Right-click on the polygon label in the 'maps' tab and open the **Attribute manager**. convert units to hectares, and review the total. Save the vector segment to a shapefile (e.g. wildfires.shp)

Add the Bowron Lakes Park boundary shapefile:

Layer-> add-> vector and browse to **L:/GEOG357/shapefiles/bowron-utm.shp**

[remember to do the final click on the VEC link in the bottom window]

Now loaded, right-click -> save as -> (format) Arcview shapefile in your folder as your own copy

Last year we did avalanche slopes: the fire(s) should be much easier. One can use the park boundary to 'mask' between wildfires in / outside the park, as we did last year for avalanche slopes (see figure)

Note: if you had a classification, as in Lab 3, you could just threshold that layer you want by inputting the class number as maximum and minimum in tool THR e.g, class = 1 for coniferous forest in the PG2023 file.



6. Edge-enhancing Filters: FED / FSHARP

The tools include a number of filters – some for smoothing, others for the opposite. They all sample a window of DN's e.g. 3x3 or 7x7 and perform either averaging or difference results. Software such as Photoshop may have similar operations

Edge filters may in some cases serve to highlight feature boundaries almost like vectors.

Find this tool: FED

Input channel is your NDWI, Output – viewer-grayscale (just to the screen), keep parameter defaults (3 x 3) and run. It may take a while Be patient.

Wow! it seems to nail the water edges, the wildfire and avalanche slopes edges may be visible.

Check the DN values on edges and within the lakes

Now run it again using the NBDR channel – is that any different for the burn edges?

Now have a look at the effects of filter: FSHARP (no, it's not music)

As before, pick your NDWI channel for input, viewer-grayscale, params: default, run

Set the filter size to 5x5 pixels and view the result again – v. sharp !

Try it again inputting the NDBR

Hmmm ... seems we could sharpen up bands 4,5,6 and create a sharper colour composite – almost like pansharping when you don't have a separate PAN band ?

Q5a: describe briefly how/why do the edge filters pick out water so cleanly

5b. why does water itself have such low DN values in the FED results ?

Please submit your answers as .TXT or .PDF by Friday-Sunday