# LAB 9: Buffering and Overlay in QGIS

**What You'll Learn:** to apply the concepts of buffering and overlay, two common cartographic operations. You should read the sections on buffering and overlay in Chapter 9 in the GIS Fundamentals textbook.

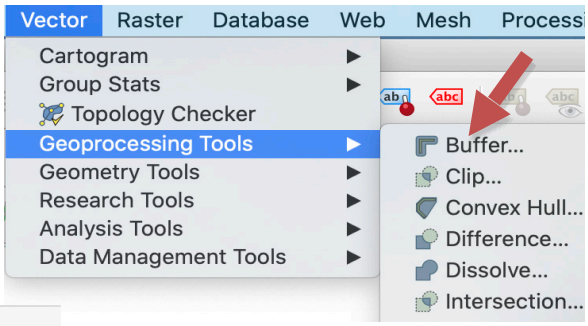
**Data**: All data are in \L9 subdirectory, including lakes.shp, roads.shp, and public lands in public_Hugo.shp. All distance units are meters.

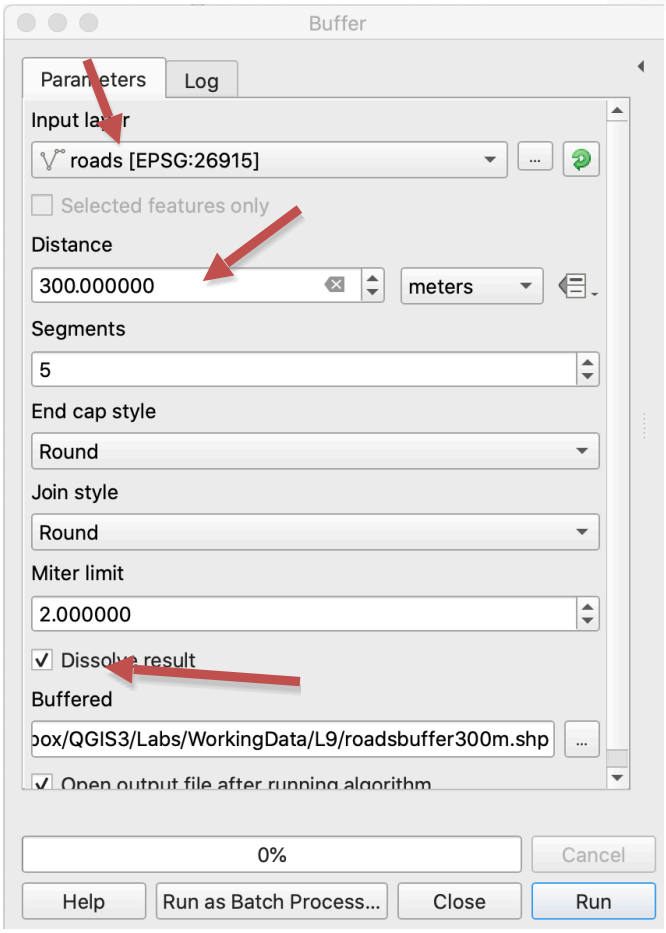
**What You'll Produce:** Two maps, of 1) lake buffers, and 2) suitable recreation areas on private land.

## Part 1: Buffering in QGIS

Create a new QGIS project and add the roads.shp data layer.

Left click Vector on the top tool bar and then Geoprocessing Tools -> Buffer. (Video: Buffer)



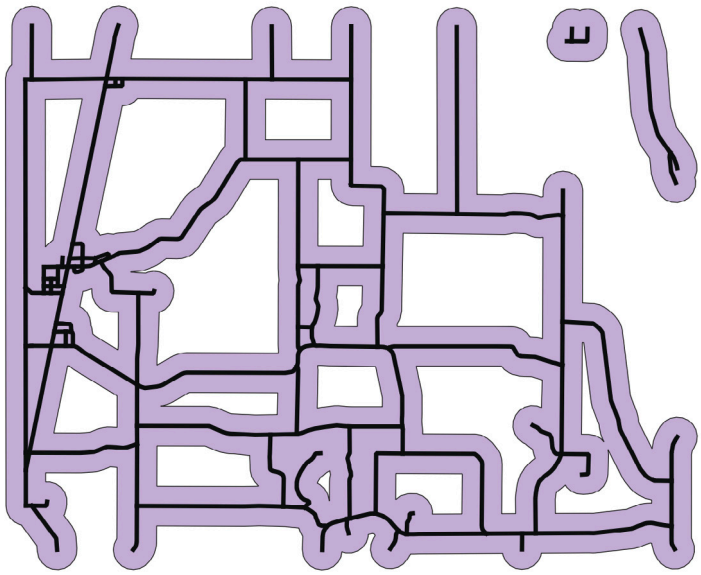




There are options to specify the input feature layer, the buffer distance and units, and the output.

Specify "Dissolve results" because otherwise the tool generates multiple, overlapping polygons.

Use the parameters shown at left and add the result to your project when finished.

The buffer layer should look something like that on the right, here re-arranged to show the roads on top, and the buffer in purple below.



Redo this buffer, but this time; leave the default **Dissolve buffer results** UNCHECKED. Make sure to open and view the attribute table associated with each buffer layer.

How do the results differ? When would this be important? After inspecting, remove the undissolved layer.

**Creating a Variable Distance Buffer**

The second exercise will buffer the *Lakes.shp* layer using a variable distance buffer (Video: Variable Distance Buffer).

The buffer distances are:

- A buffer distance of 50 meters for lakes with size class 1
- A buffer distance of 150 meters for lakes with size class 2
- A buffer distance of 500 meters for lakes with size class 3

There are three main steps:

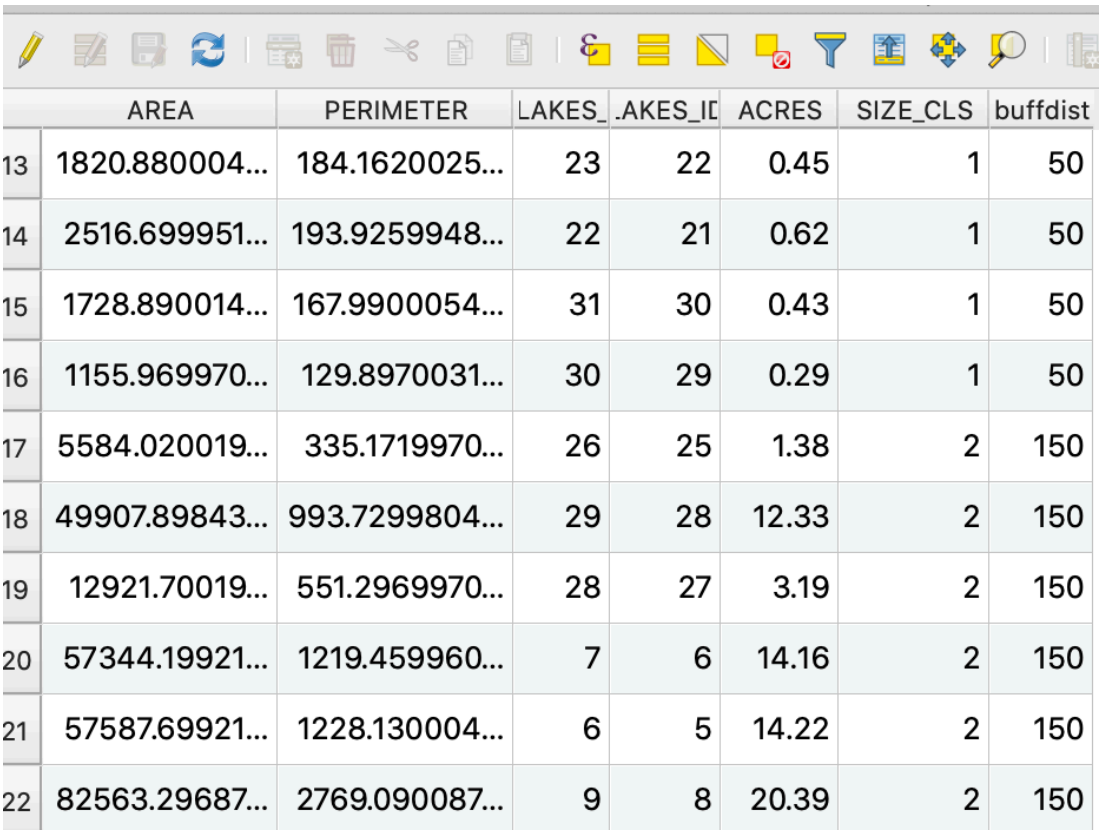
- Open the lakes attribute table and insert a field to hold the variable buffer distance.
- Select by Attributes to assign values for the variable buffer distance (refer to Labs 7 and 8 if you don't remember the details on selecting and editing values in a table).
- Apply the buffer operation.

For this exercise, specifically you should:

- Make sure the *Lakes.shp* is in your project, and open its attribute table. You may manually select by sorting/shift clicking, or by using a selection condition to select the lakes with size class 1.
- Toggle Edit, and use the Field Calculator to create a new whole number (integer) field named something like buffdist, with a value of 50.
  Make sure that you have the option checked for only updating selected features, near the upper left of the tool. Apply the calculation.
- Select those features with Size_CLS of 2, and use the Field Calculator to Update an Existing Field, assigning 150 to the buffdist variable.
- Repeat the select/assign process for lakes with Size_CLS 3, assigning a buffdist of 500.

- Unselect any selected polygons or the buffer will only be applied to those selected (e.g., before switching out of the table, click on the Unselect all to clear the selected features. If you forget here, you can unselect from the main QGIS menu). Save your edits and toggled off editing mode.

Check that your table is correct, e.g., similar to the example figure below. Note that the last two columns, SIZE_CLS and buffdist, change in concert, with a larger buffer distance appearing for larger size classes.



| | AREA | PERIMETER | LAKES_ | .AKES_ID | ACRES | SIZE_CLS | buffdist |
|---|---|---|---|---|---|---|---|
| 13 | 1820.880004... | 184.1620025... | 23 | 22 | 0.45 | 1 | 50 |
| 14 | 2516.699951... | 193.9259948... | 22 | 21 | 0.62 | 1 | 50 |
| 15 | 1728.890014... | 167.9900054... | 31 | 30 | 0.43 | 1 | 50 |
| 16 | 1155.969970... | 129.8970031... | 30 | 29 | 0.29 | 1 | 50 |
| 17 | 5584.020019... | 335.1719970... | 26 | 25 | 1.38 | 2 | 150 |
| 18 | 49907.89843... | 993.7299804... | 29 | 28 | 12.33 | 2 | 150 |
| 19 | 12921.70019... | 551.2969970... | 28 | 27 | 3.19 | 2 | 150 |
| 20 | 57344.19921... | 1219.459960... | 7 | 6 | 14.16 | 2 | 150 |
| 21 | 57587.69921... | 1228.130004... | 6 | 5 | 14.22 | 2 | 150 |
| 22 | 82563.29687... | 2769.090087... | 9 | 8 | 20.39 | 2 | 150 |

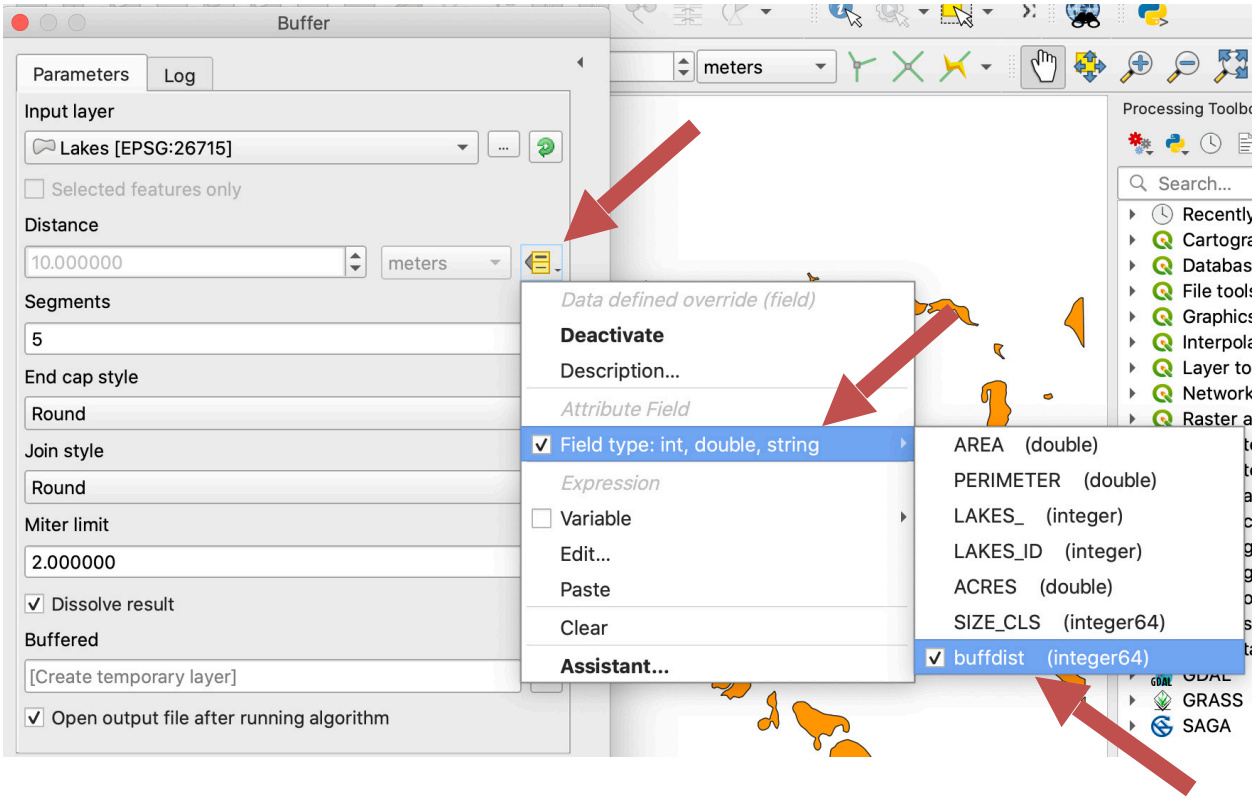
Now create the variable distance buffer (read the section on variable distance buffers in Chapter 9 in the text if you aren't sure of this concept).

Use the same buffer tool as we introduced previously (Vector->Geoprocessing->Buffer).

Specify the same input data layer as before, Lakes.shp, and also make sure to click the check box to Dissolve the result (figure below).

We specify a variable distance buffer through an option box, accessed by clicking on a small box at the far right of the distance/units option (see arrow below).

This allows us to open a sequence of dropdowns, here we choose field, and then buffdist as the variable that contains the buffer distance (see figure below).




We may specify an output, something like VarBuffLakes, and run the tool.

This should create a layer similar to that at right. Note the buffers are larger for the larger lakes, as per our specified buffer distance variable.

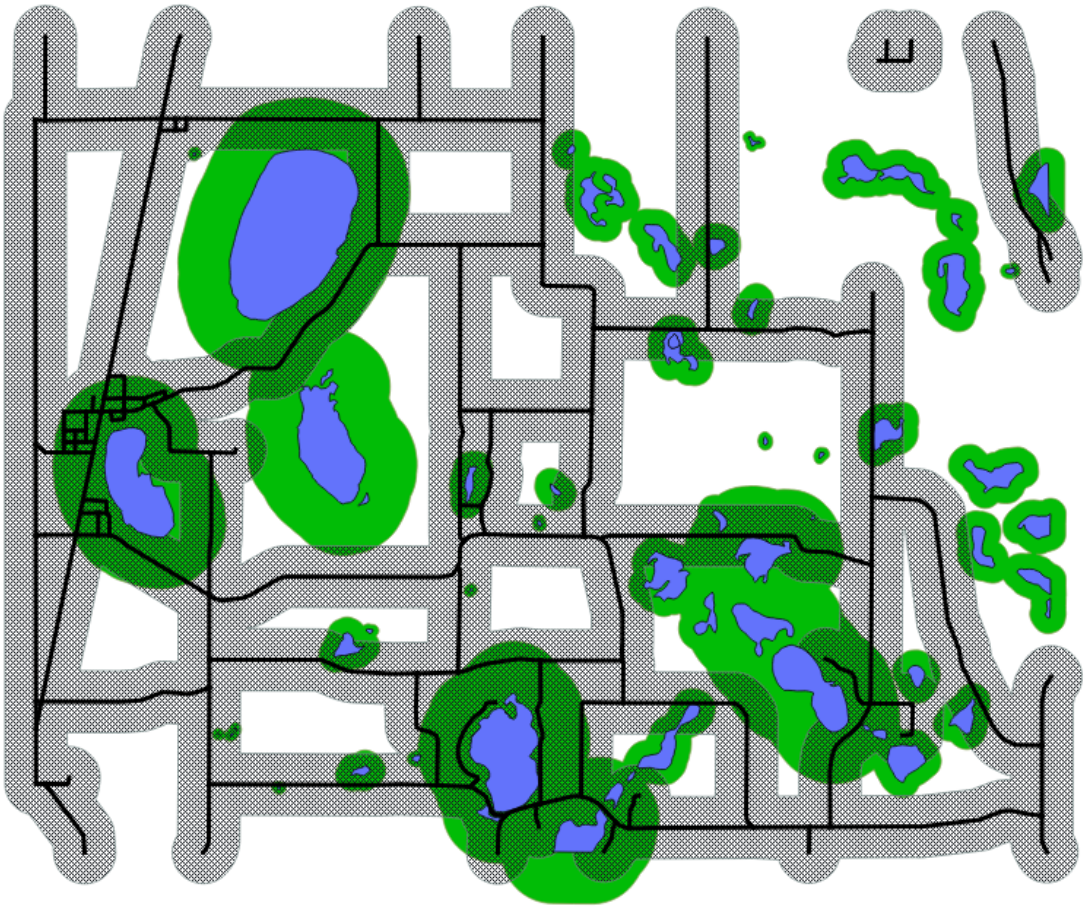
Arrange the roads, dissolved fixed distance road buffer, lakes, and variable distance lake buffer layers so that you can see all three, as in the figure below.

Create and export a layout with the roads, lakes, and their buffers, as in the

view shown here. Make sure the order is as shown here, so you may see most of each layer. The order is, from the top, 1) roads, 2) road buffer, 3) lakes, 4) lake buffer.

Your data view should look something like the figure below.

Create a layout with the four data layers as below, and label each layer with descriptive text in the TOC/legend, and include a scale bar, north arrow, and title.



## Part Two: Overlay in QGIS

Our goal in this exercise is to find potential campgrounds for a State Park. A campground needs to be close to lakes. However, these will be drive in sites that must also be close roads. The final map will show locations that are both within 50, 150 or 500 meters of a lake (depending on the size of the lake) and within 300 meters of a road.

We have already created our starting Layers. These are the variable distance lakes buffer and the fixed distance roads buffer from the previous exercises.

Here we need to modify input layers prior to overlay so that we may easily interpret the results after overlay.

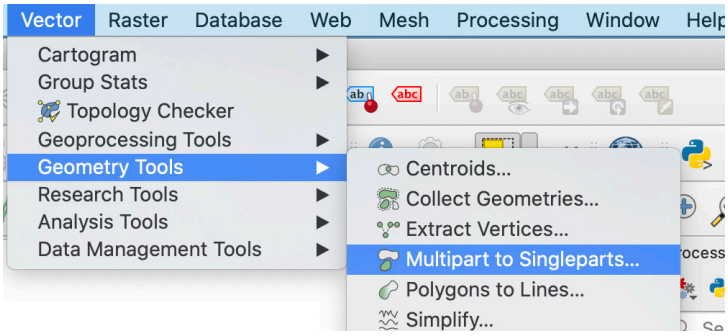
First, we must turn the buffer output to single part features. Buffer returns multipart features, which means there may be multiple polygons for a single row.

Open the attribute table for VarBuffLake, you should see just one row, while the layer obviously has many polygons.

To convert this multipart layer to single parts, use

Vector->Geometry Tools-> Multipart to Singleparts

The tool window isn't shown, because it is rather simple, with an input and output file.




After running the tool, open the table for the output. Note that there are now multiple entries, one for each polygon.

Also note that the buffdist is now wrong, it has a value of 50 for all the polygons (or perhaps one of the other values, 150 or 500 is repeated, the one it saves appears somewhat random), even though the medium and large sized lakes had different buffer distances. That's because the individual data are lost, and buffer only records the values for one polygon in the multipart feature. It copies those values to the singlepart features you create, but they're usually not relevant or correct for all individual polygons. In this case, we don't need the buffdist variable any more, so we could delete it.

You should also delete the now all irrelevant other columns, like Lakes_, Lakes_ID, Acres, SIZE_CLS, and buffdist, as they are only correct for one of the polygons, and not the other 26.

Our overall goals require we identify areas that are inside the lake buffers. We create a new item (column) in the lakes buffer table (here insd_lbuf), with a value of 1 for all the lake buffer polygons.

Refer to previous labs if you forget how to add a column. When you are done, you should have an attribute table for the lakes buffer that looks similar to the figure at right.

| | AREA | PERIMETER | insd_lbuf |
|---|---|---|---|
| 1 | 3343.629882... | 349.856994... | 1 |
| 2 | 3343.629882... | 349.856994... | 1 |
| 3 | 3343.629882... | 349.856994... | 1 |
| 4 | 3343.629882... | 349.856994... | 1 |
| 5 | 3343.629882... | 349.856994... | 1 |
| 6 | 3343.629882... | 349.856994... | 1 |

Do the same for the road buffer layer. Add a new attribute named something like insd_rbuf, and assign it a value of 1 to indicate it is inside the road buffer.

Remember to save and toggle off editing for each layer when complete.

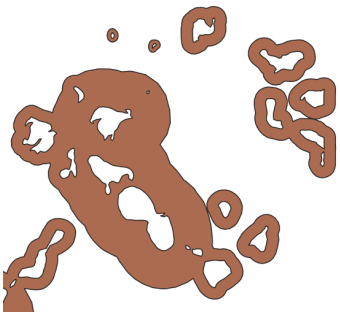
We don't worry about assigning a value for areas outside of buffers because of the way a vector data model views the vector world. Areas outside of polygons do not have a boundary nor a record in the attribute table associated with them. We cannot assign a value for these "outside" areas in each input layer, because there is nothing to attach the value to.

Before we overlay the two layers with the "Union" command, we need one more preparation step. The lake buffers layer we created has buffered areas that include the lake as well as the land near shore. Campsites will be on dry ground, so we will use the ***Difference*** tool to remove the lake from the lake buffer layer.

Open the Vector→Geoprocessing Tools→ Difference

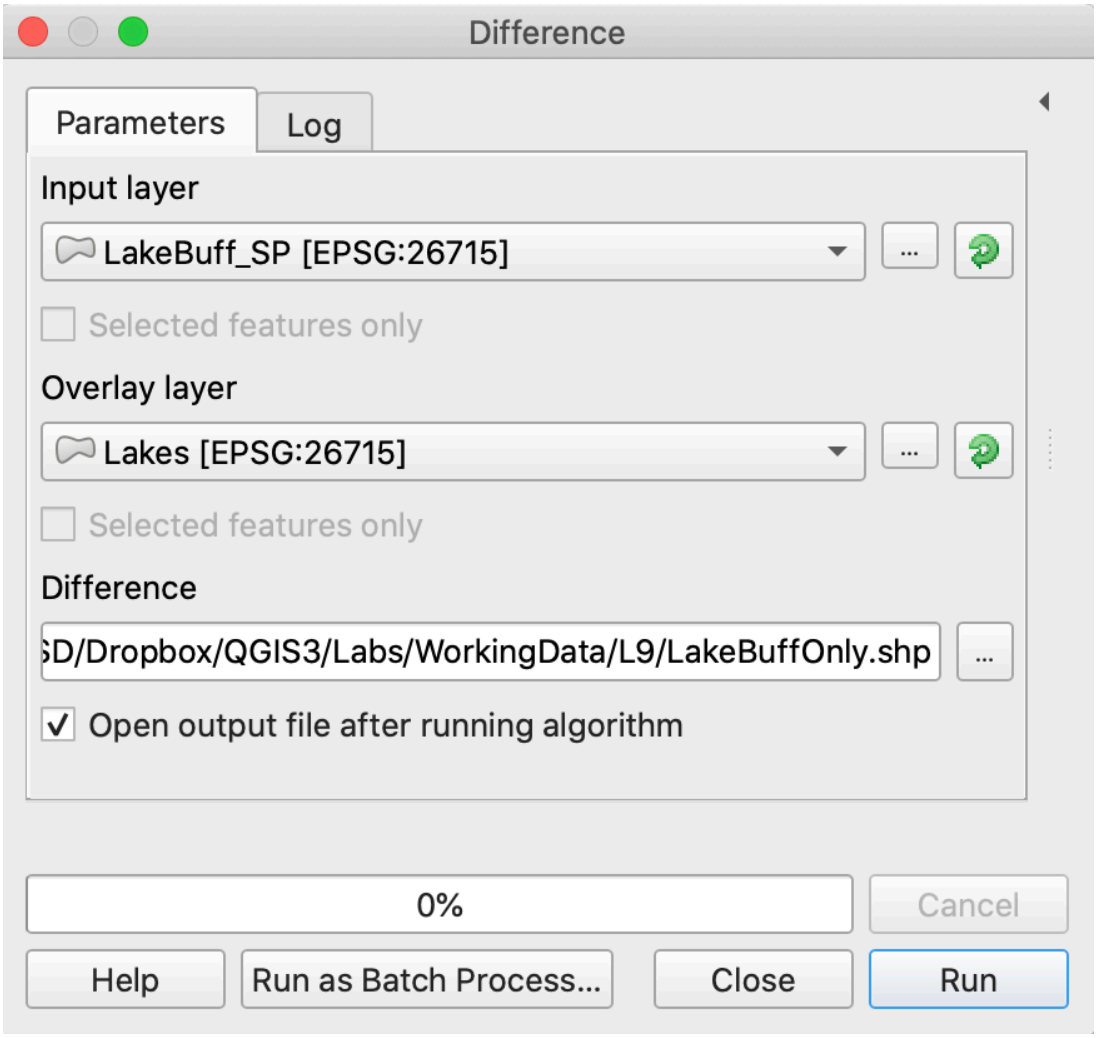
- Specify Input Vector Layer as the variable lakes buffer layer
- Specify the Difference Layer as the lakes layer
- Set the output destination to something like LakeBuffOnly.shp
- Run,

Display the output and verify that the results are the lakes buffer layer with the lakes area removed, something that looks like a bunch of moth-eaten blobs (here is a portion of the correct output):

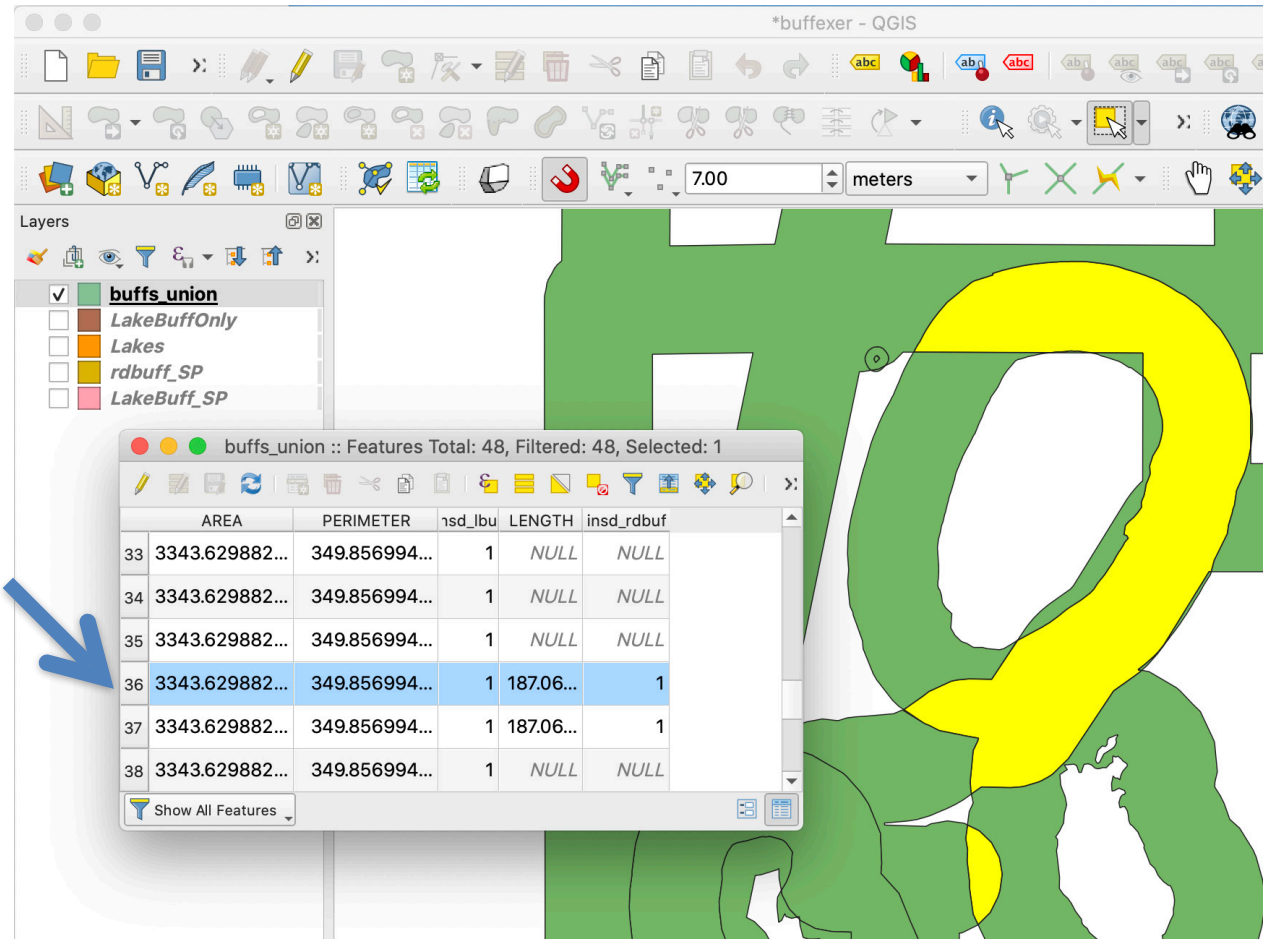


Now to overlay the two buffer layers, using the Union command (Video: Union).

- Select Vector→GeoprocessingTools → Union
- Specify the input layers – LakesBuffOnly and rdbuff_SP,
- Specify the output layer  something like buffs_union, and Run.



Examine the “unioned” layer and open the attribute table for this layer. Use the manual selection tool (icon at right, usually found near the tope-center of the main QGIS frame) and click in a polygons that meets both the within the roads buffer and the within the lakes buffer criteria (see the figure below for an example).



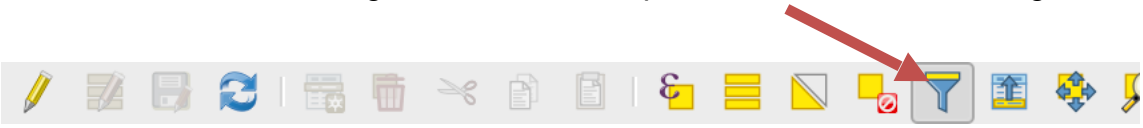

The selected polygon meets both the road proximity and lake proximity criteria, that is, the table entry shows both the insd_rdbuf and insd_lbuf are equal to 1.

Note that there also appear to be multiple, distinct polygons linked to this row.

QGIS groups polygons in the data files when performing analysis. When we are finished with our analysis we will “ungroup” polygons in the file, creating a table row for each polygon.

Open the attribute table for the overlain file (I named mine buffs_union.shp).

Click on the filter/select using form button, on top of the table towards the right:



This should open a form window, with the parameter entry portion as shown below.

Originally, all the buttons on the right are set to exclude field.

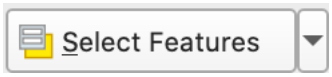
I can click on the caret at the right end of each button, and change its operation by clicking in the appropriate check box, here "Equal to (=) for insd_lbuf:


Above, I've specified the filter to select polygons with the

insd_lbuf = 1 and the

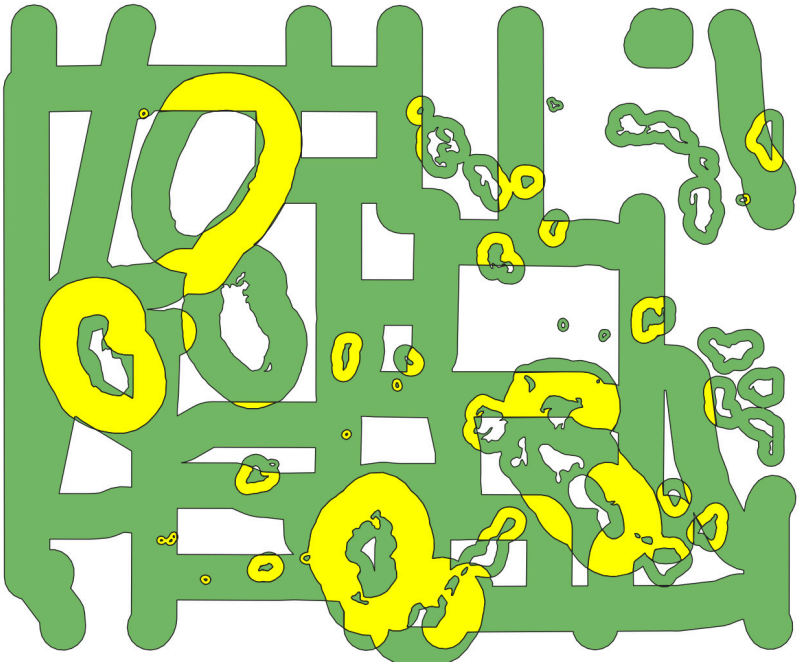
insd_rdbuf = 1.

When I click on the select features button near the bottom right of the filter tool,




it yields the selection on the right.

On visual inspection, these are the polygons within both the road and lake buffers.



Close the attribute table, and with the polygons above still selected, export these to a new shapefile (remember, in the Layers/TOC,

- right click on the buffs_union, then
- Export -> Save selected features…

Display the data, and verify you have something like that on the right:

Use the manual selection tool, and verify that some of these are still multipart, by clicking on a few polygons.

Convert the multiparts to single parts (Select Vector→ Geometry Tools → Multipart to singleparts).

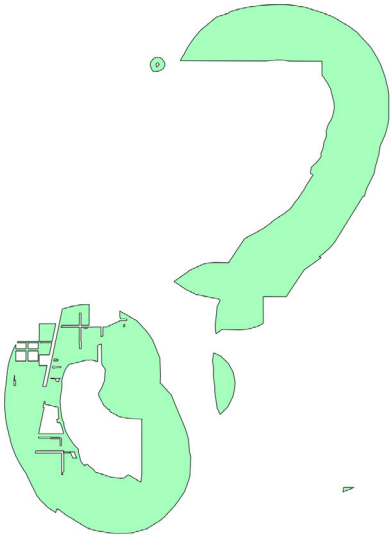
We have one final criteria to meet, that these campgrounds be on private land.

We have a digital layer of public land, in the Public.shp layer.

Do you remember a tool we used earlier in this lab to remove a portion of an existing layer?

If you don't remember, look above, find the appropriate tool, and use the tool along with the Public.shp data layer and singlepart Road_Lakes buffer (mine was named RdLks_Only_SP) to create your final layer.

The westernmost lakes should look like the figure here, with the public bits carved out of the lower lake:



Create a Layout that includes roads, lakes, and lands suitable for campgrounds on private land. (see below)

Label each layer with descriptive text in the legend, and include a scale bar, north arrow, and title.

Export a pdf of your map.