# Step-by-step protocol for randomizing plots using QGIS

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1. **Delimit the extent of the landscape assessment area**
   a. Method 1: Set extent based on imagery
      i. Load a raster (GeoTIFF)
      ii. Select *Vector* → *Research Tools* → *Polygon* from layer extent
      iii. Select image from the *input layer* dropdown menu
      iv. Name your file in the *Output polygon shapefile* field
      v. Click *OK* and then click *Yes* to add the new shapefile layer to the Table of Contents (TOC). A rectangular polygon shapefile will be created that matches the extent of the image layer (if you use this method, you can skip ahead to Step 2)
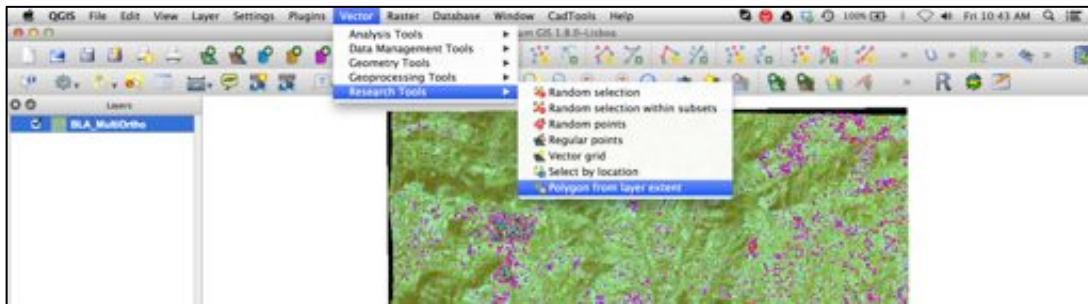

Step 1. a. ii.
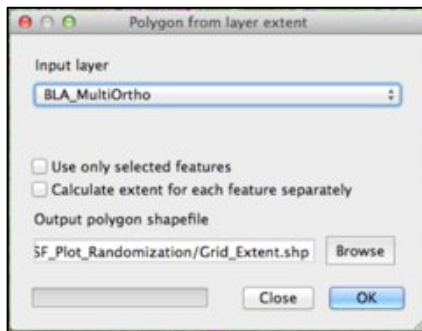
Step 1. a. iii.
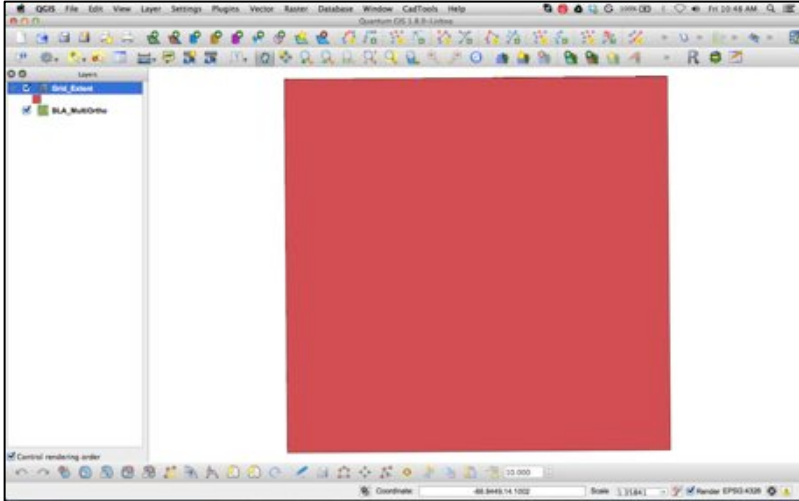
Step 1. a. v.

b. Method 2: Set extent based on a defined area
    i. First create a new point shapefile, roughly in the center of the landscape assessment area. To do this:
        1. Click the *New Shapefile Layer* button in the toolbar. Select *Point* as the shapefile type and set the appropriate CRS by clicking *Specify CRS*. Click *OK* and name your file. A new shapefile layer will be created without any features.
        2. Click the *Toggle Editing* button on your toolbar or right-click the layer and select *Toggle Editing*.
        3. Click the *Add Feature* button (looks like 3 dots) and then click on the screen approximately where you would like the center of your project area to be. Click the *Save* button (looks like a floppy disk) and then *Toggle Editing* again to stop editing.
    ii. Create a buffer around this point to set the bounds of the project area.
        1. Select *Vector* → *Geoprocessing Tools* → *Buffer(s)* from the menu
        2. Select the point feature layer you created from the *Input vector layer* drop-down menu. Select *Buffer distance* and set the buffer distance to **half** the desired length of your project area extent using whatever units you have specified in your CRS. (For example: in the case of the LDSF methodology, we want to create a 10 by 10km square. Our CRS units are meters so we will set the buffer distance to 5000. Since we are buffering around a point, this will create a circular-shaped polygon with a radius of 5km, resulting in a rectangular extent of 10km.) Name the file and click *OK*. Click *Yes* to add it to your TOC. A circular shaped polygon will be added to your map.

iii. Create a rectangular extent for the project area using the circular buffered polygon
1. Select *Vector* → *Research Tools* → *Polygon from layer extent* from the menu
2. Select the circular polygon you just created from the *Input layer* drop-down menu, name your file and click *OK*. Click *Yes* to add the new shapefile to your TOC.
3. A square polgygon shapefile will be created based on the extent of the circle you had created before. (In this example with a circle of 5000m, a 10,000 x 10,000m, or 10 x 10km, square is created.)
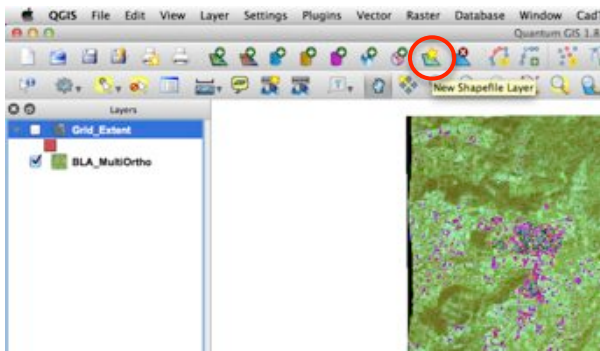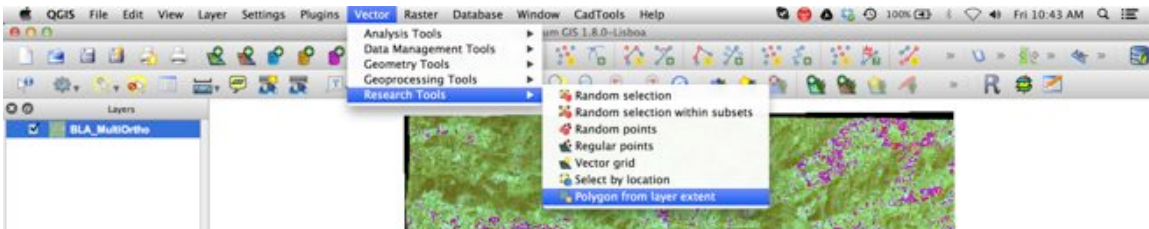

Step 1. b. i. 1.
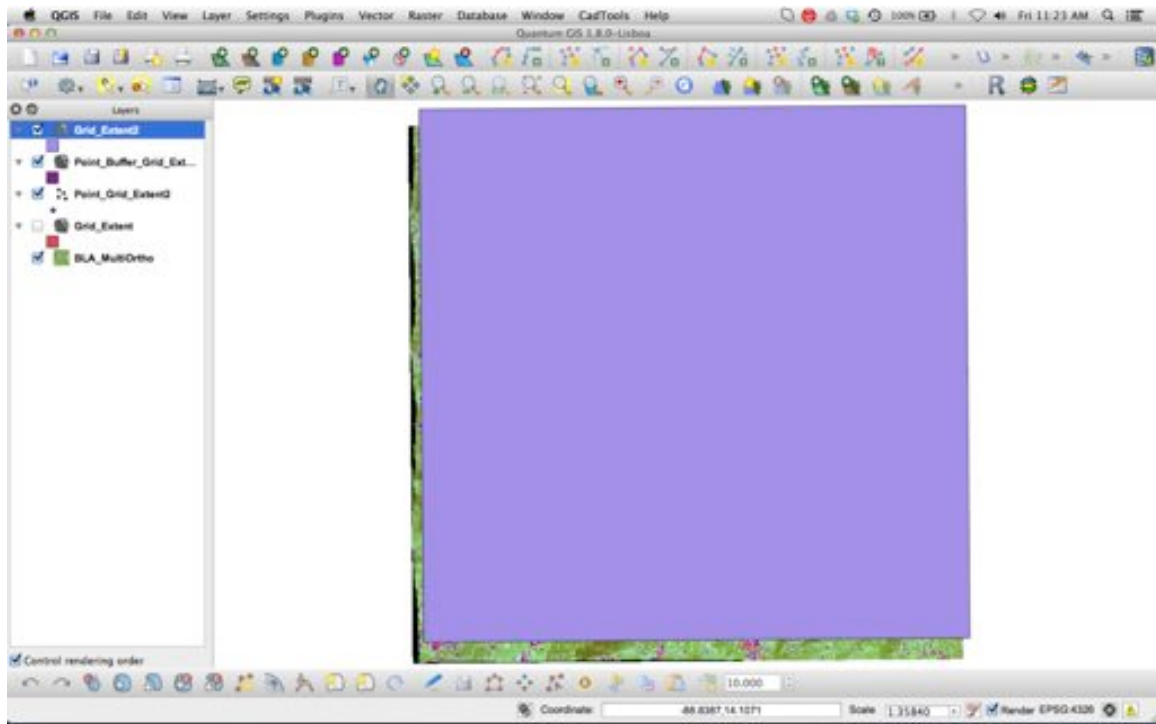

Step 1. b. i. 2.
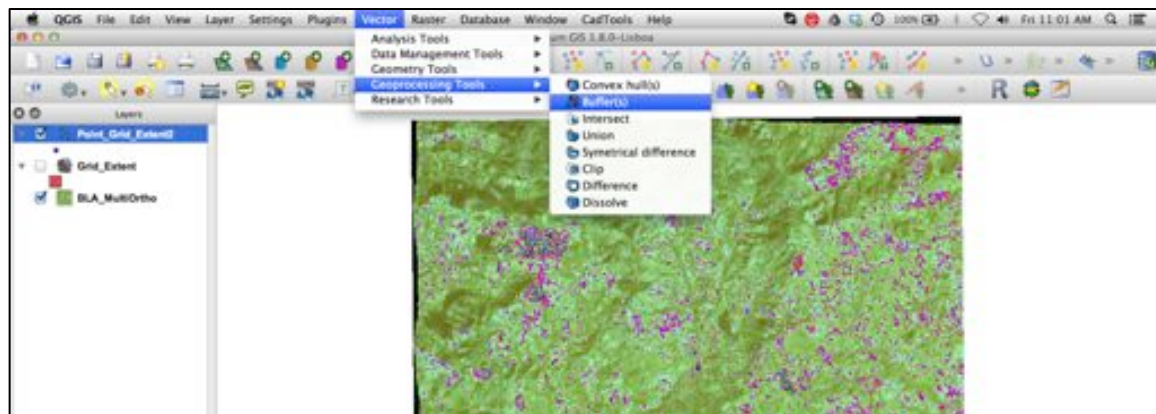
Step 1. b. ii. 1.

Step 1. b. ii. 2.
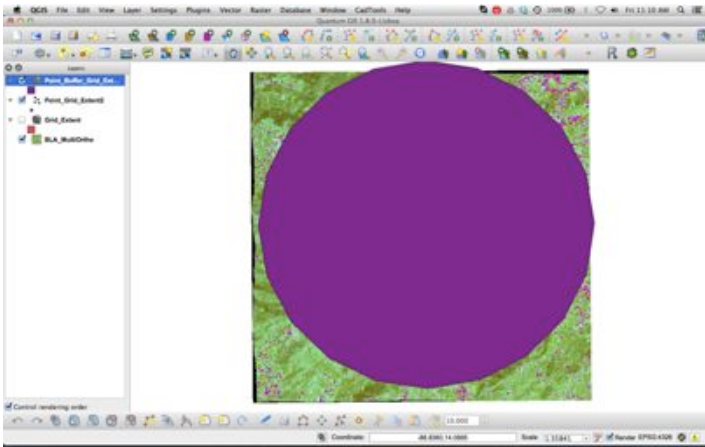

Step 1. b. ii. 2.


Step 1. b. iii. 1.

Step 1. b. iii. 3.

2. **Create a grid within the rectangular project extent area**
   a. For the LDSF methodology, each grid within the 10 x 10km project extent should be 2.5 x 2.5km, resulting in 16 tiles (4 x 4).
   b. Select *Vector* → *Research Tools* → *Vector grid* from the menu
   c. Select the newly created rectangular project extent area from the *Grid extent* drop-down menu.
   d. Click the *Update extents from layer* button and the X Min and Y Min fields will be updated with the extent of the project area
   e. Change the X and Y *Parameters* to 2500.1 (**Note:** you must make the grid tiles slightly larger or extra tiles will be created adjacent to the project area)
   f. Select *Output grid as polygons*
   g. Name the file and click *OK*. Click *Yes* to add the newly created file to your TOC. A grid of 16 polygons will be created.
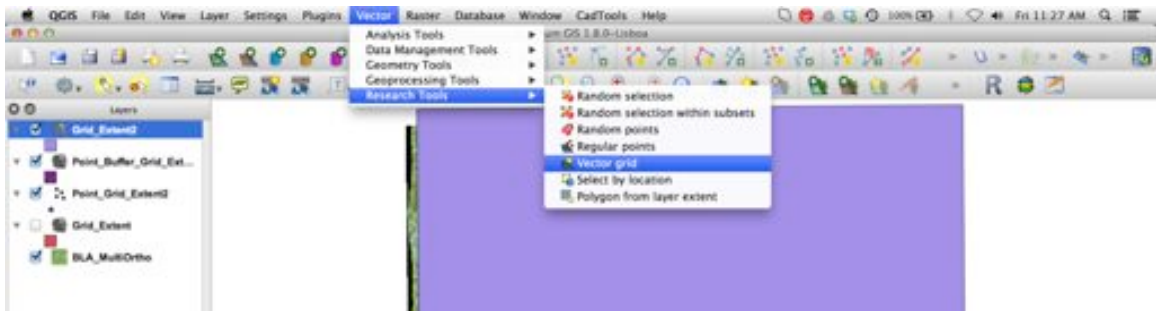
Step 2. b.
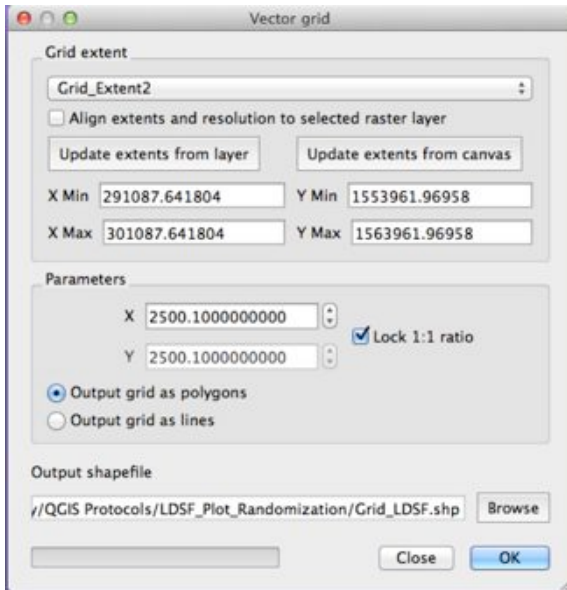
Step 2. c - f.
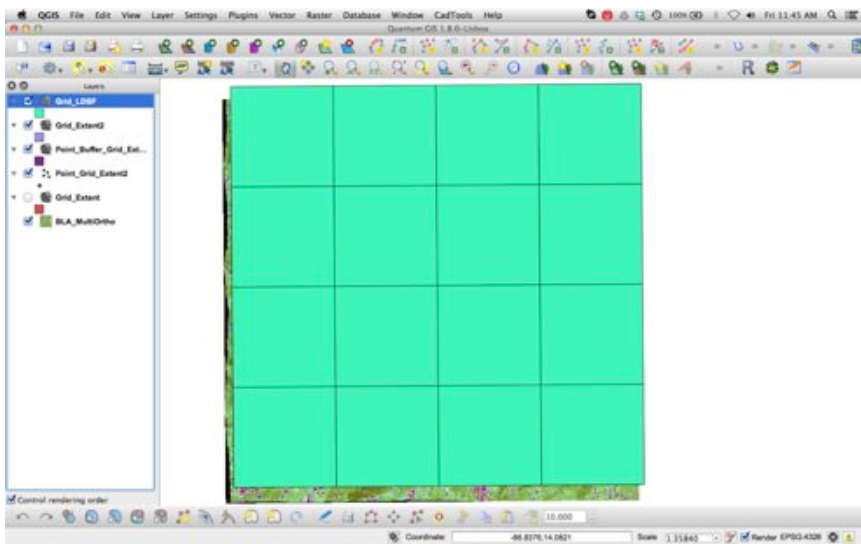
Step 2. g.

3. **Be sure that the grid is aligned with your project site**
   a. If you created your project extent polygon based on an image (using Method 1 above) than this should not be a problem.
   b. If you used Method 2, you may need to move the grid based on what coordinates, imagery or information you have that defines your project area.

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4. **Create one random point in each of the 16 grid tiles that will serve as the cluster centroid**
   a. First buffer the 16 grid tile polygons (**Note:** This is necessary to ensure that the Cluster center points are at least 581.84m from the grid tile boundary. Plots will randomly be placed within 564m of the Cluster center and each plot has a radius of 17.84m. Therefore, the maximum distance away from the Cluster center point that a plot boundary could lie is 581.84m and therefore the Cluster center point must be this far from the grid tile boundary.)
      i. Select *Vector → Geoprocessing Tools → Buffer(s)*
      ii. Select the gridded polygon from the *Input vector layer* drop-down menu
      iii. Set the buffer distance to -581.84 (**Note:** The value must be negative so that the buffer is processed *inside* each grid tile)
      iv. Select an output file name and location. Click *OK* and then click *Yes* to add the new shapefile to your TOC.
      v. A new shapefile will be created with square polygons set within each grid tile polygon.
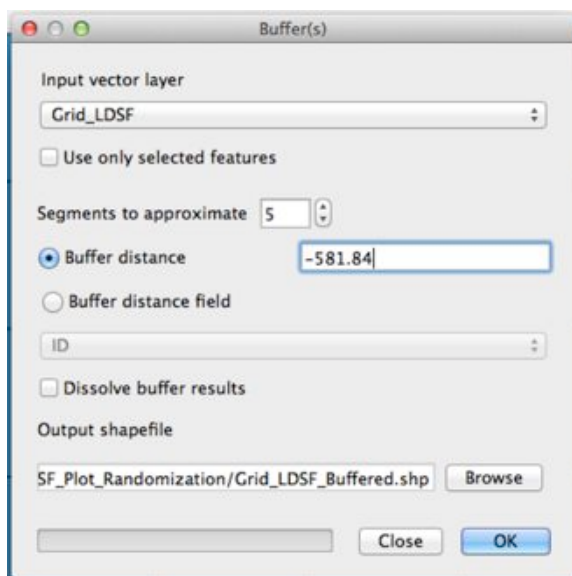

Step 4. a. ii – iv.
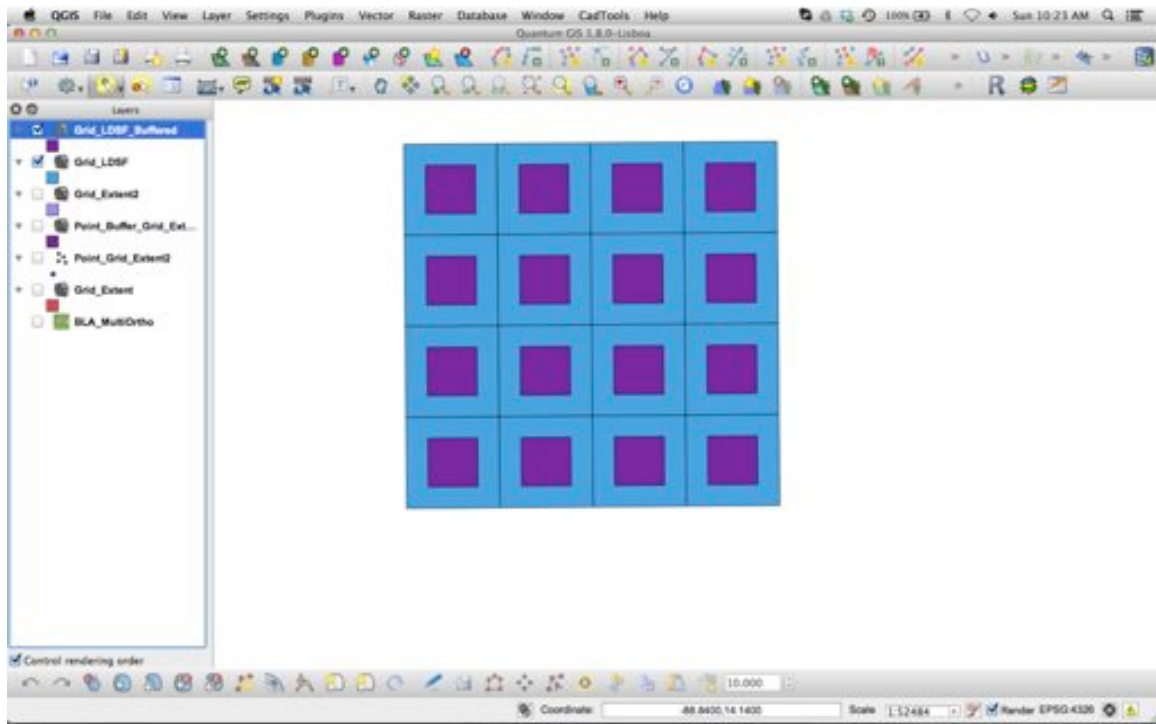
Step 4. a. v.

b. Create one random point within each of the buffered grid tiles.
   i. Select *Vector → Research Tools → Random points*
   ii. Select the newly created shapefile layer with the buffered grid tiles from the *Input Boundary Layer* drop-down menu.
   iii. Under the *Stratified Sampling Design (individual polygons)* option, select the first radio button titled *Use this number of points* and set the number of points to 1.
   iv. Set the output file name and location. Click *OK* and then click *Yes* to add the new shapefile to your TOC.
   v. **Note:** If the points do not show up inside the buffered grid tile polygons, you may have to set the CRS for the newly created point shapefile to match the polygon shapefile.
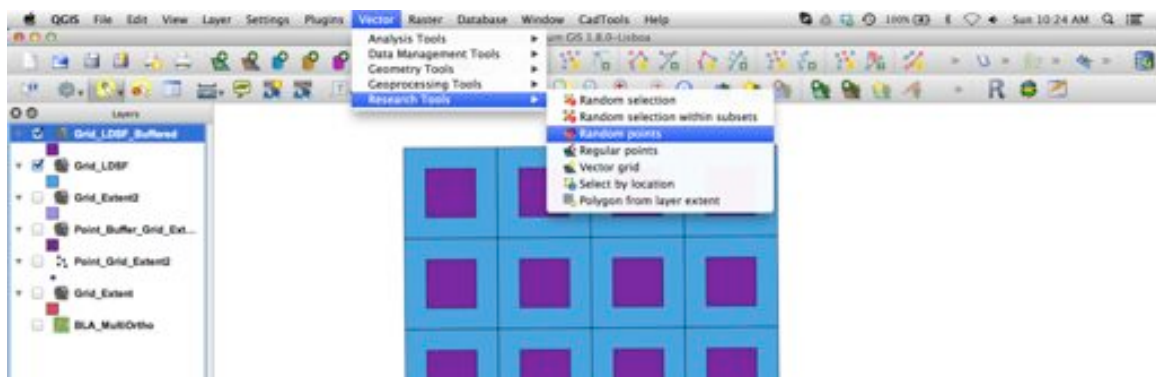


Step 4. b. i.
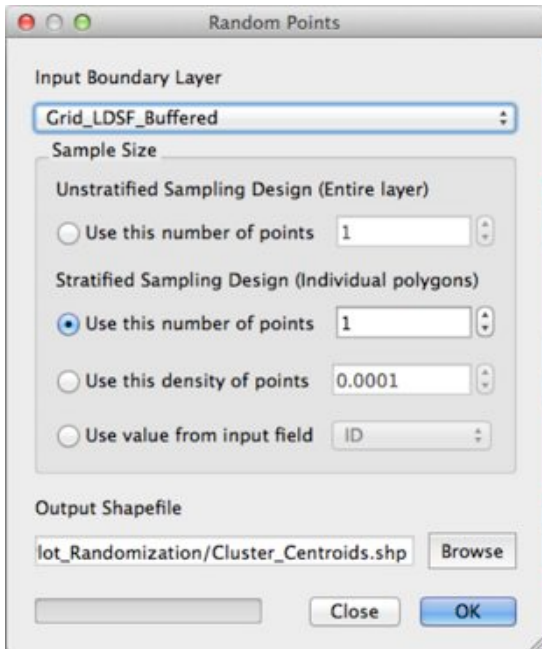
Step 4. b. ii – iv.
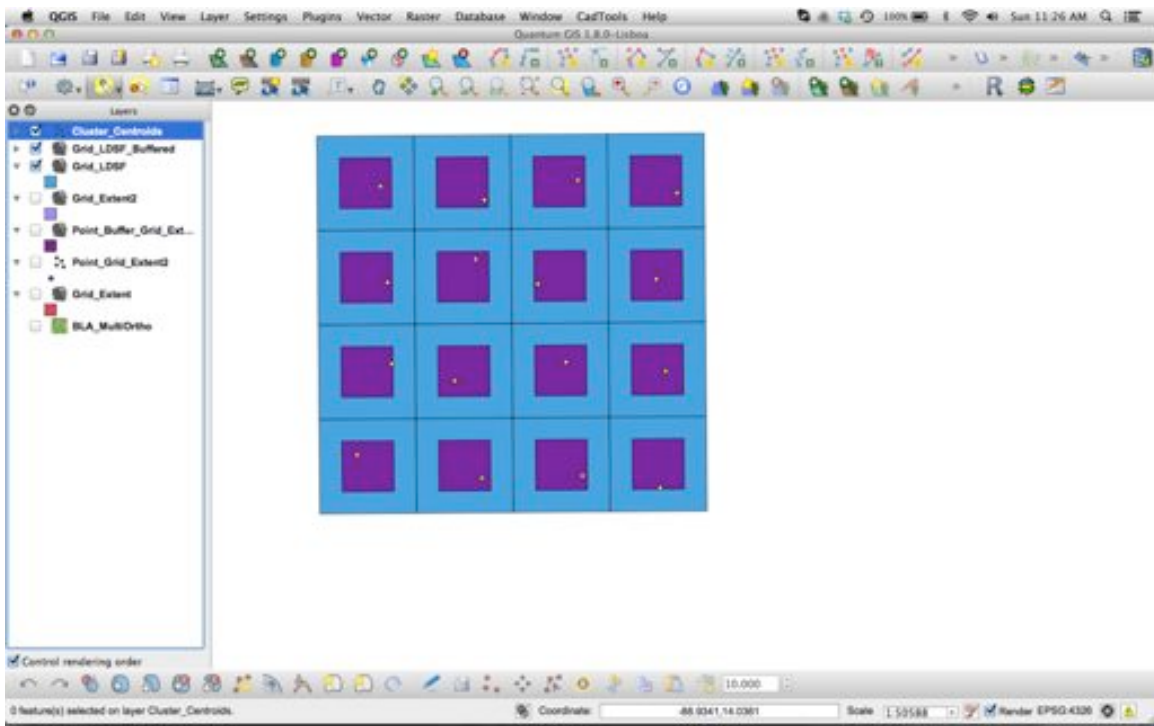

Step 4. b. iv.

5. Create 15 random points within a 564m radius (1km^2) of the cluster centroid
 a. Buffer a circle with a radius of 564m around the cluster centroid
    i. Select *Vector* → *Geoprocessing Tools* → *Buffer(s)* from the menu
    ii. Select the point shapefile representing the cluster centroids from the *Input vector layer* dropdown menu
    iii. Set the *Buffer distance* to 564m
    iv. Select an output file name and location. Click *OK* and then click *Yes* to add the new shapefile to your TOC.
    v. A circle will appear around each of the cluster centroids. (**Note:** You may have to set the layer CRS to match your project CRS)
    vi. If your circles appear as solid circles you may want to change them to lines. This can be done by the following steps:
      1. Right-click the layer in your TOC and select *Properties*
      2. Select *Style* from the tab-menu at the top of the window
      3. Click the button with a wrench labeled *Change…* under the symbol style preview box
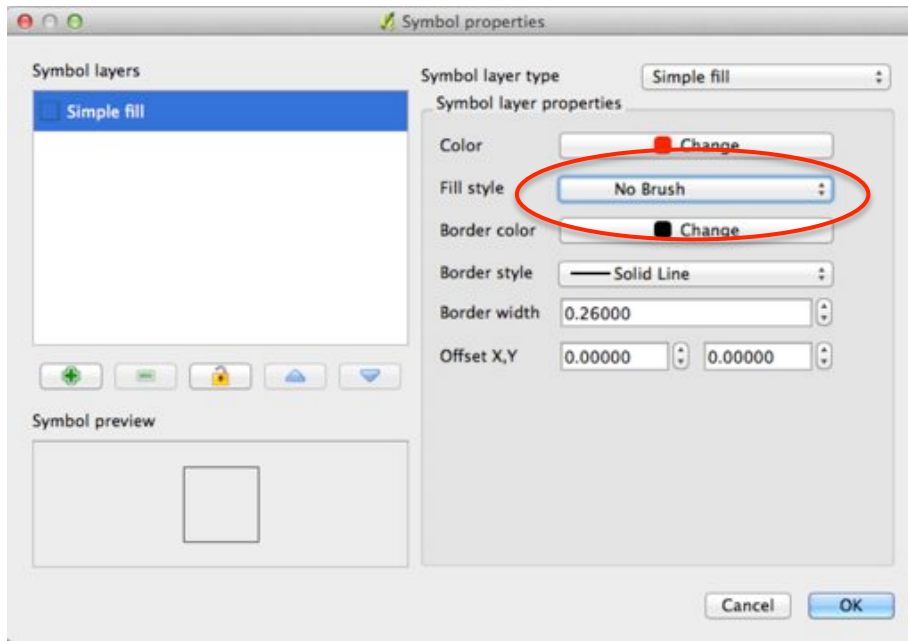   4. Change the *Fill style* to *No Brush*
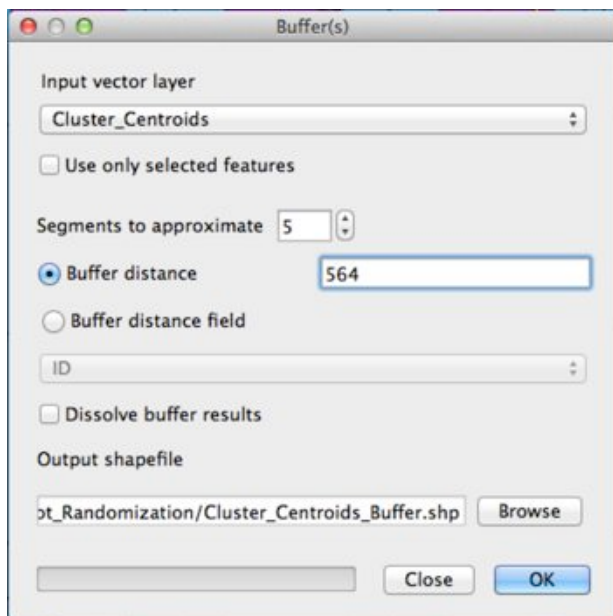

Step 5. a. ii – iv.
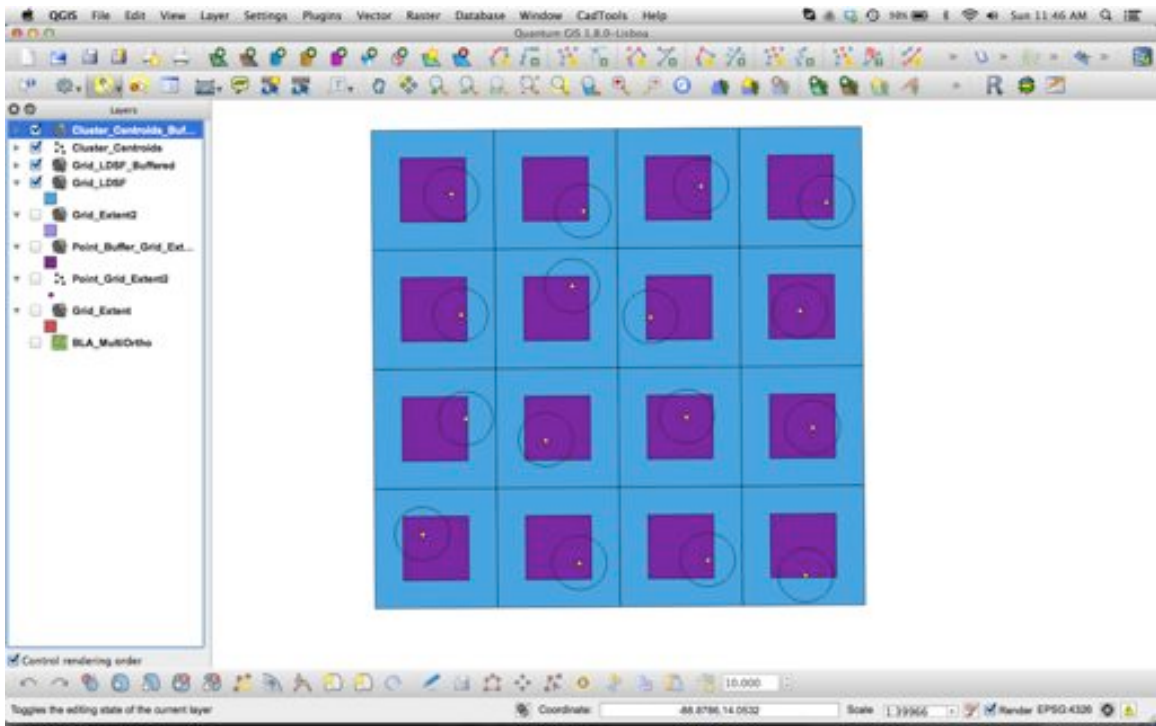
Step 5. a. v.
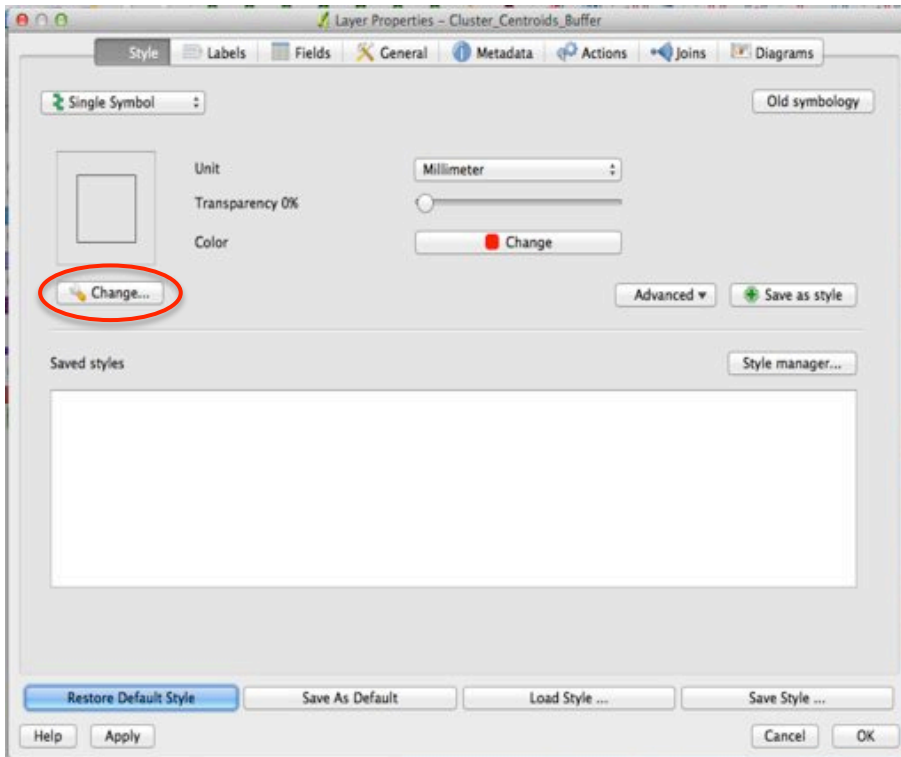
*Step 5. a. vi. 3.*

Step 5. a. vi. 4

b. Create 15 random points within the buffered circles around the cluster centroids
   i. Select *Vector* → *Research Tools* → *Random points* from the menu
   ii. Select the newly created shapefile layer for the buffered circular polygons around the cluster centroids from the *Input Boundary Layer* dropdown menu
   iii. Under the *Stratified Sampling Design (individual polygons)* heading, select the radio button *Use this number of points* and set the number of points to 15
   iv. Select a name and location for the output file. Click *OK* and then click *Yes* to add the new file to your TOC
   v. **Note:** again, you may need to set the CRS for this shapefile to match your project CRS
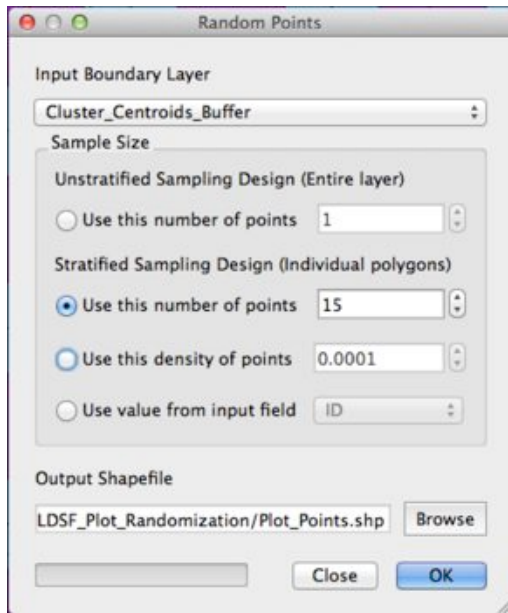
Step 5. b. ii – iv.
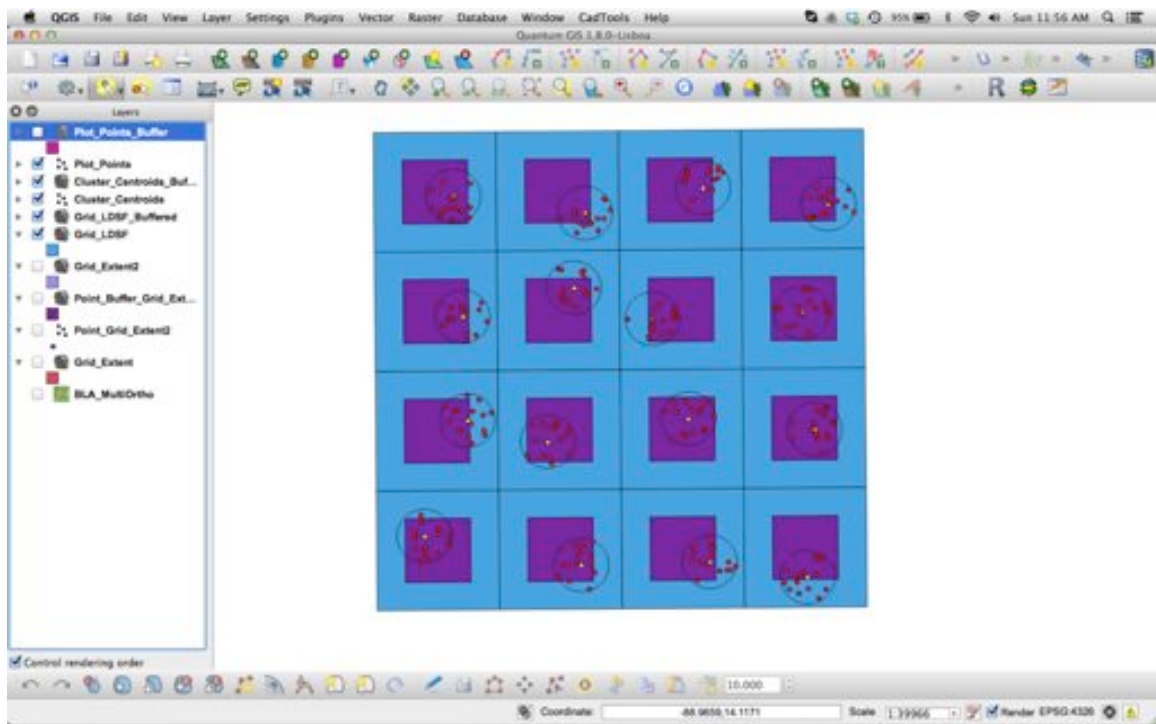
Step 5. b. iv.

  c. Buffer the plot points to represent the 17.84m radius of each plot
    i. Select *Vector → Geoprocessing Tools → Buffer(s)* from the menu
    ii. Select the plot point shapefile from the *Input vector layer* dropdown menu
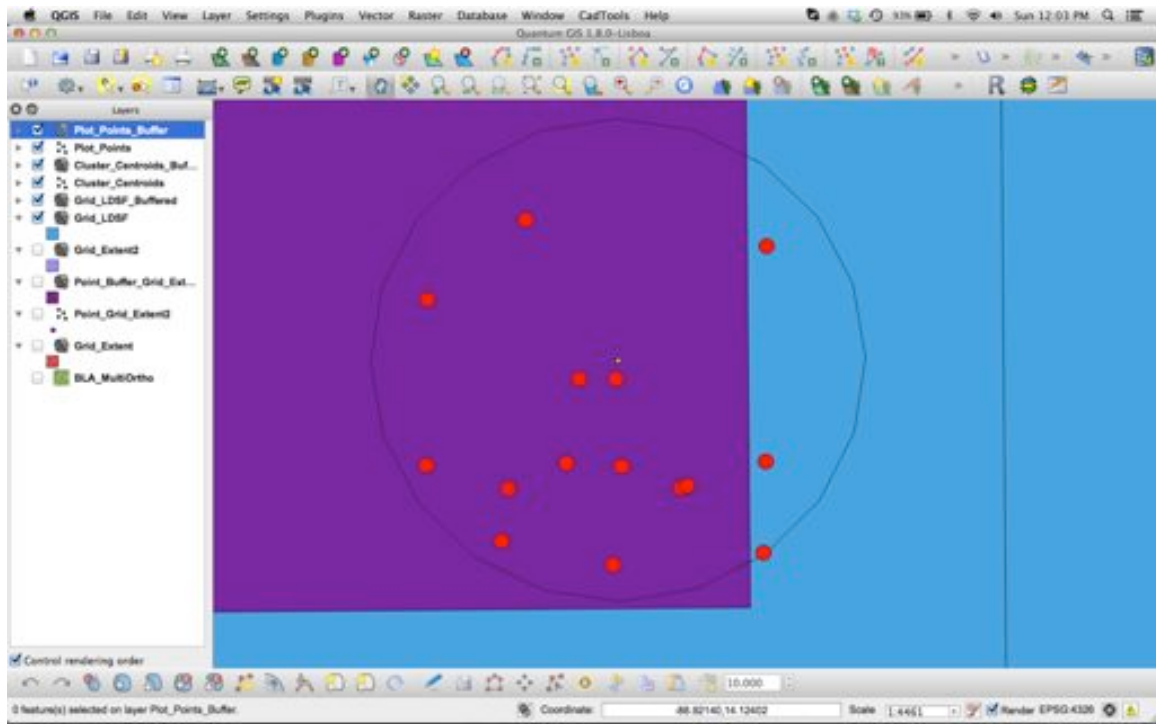   iii. Set the *Buffer distance* field to 17.84

iv. Select the name and location for the output file. Click *OK* and then click *Yes* to add the file to your TOC

v. **Note:** Again, you may need to set the CRS for this new shapefile
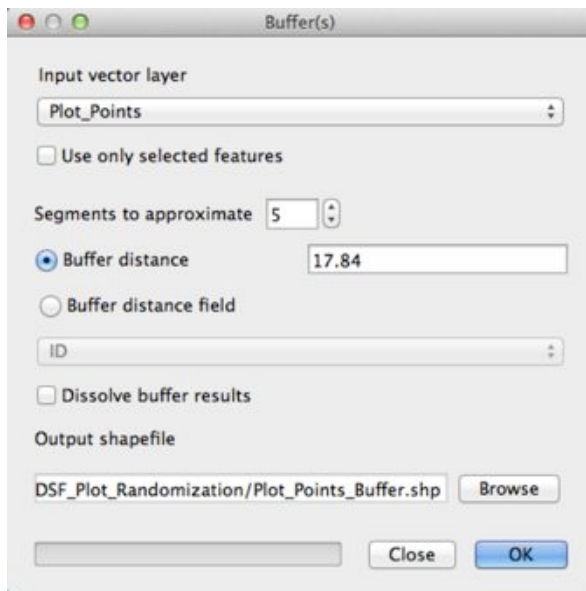
Step 5. c. ii – iv.
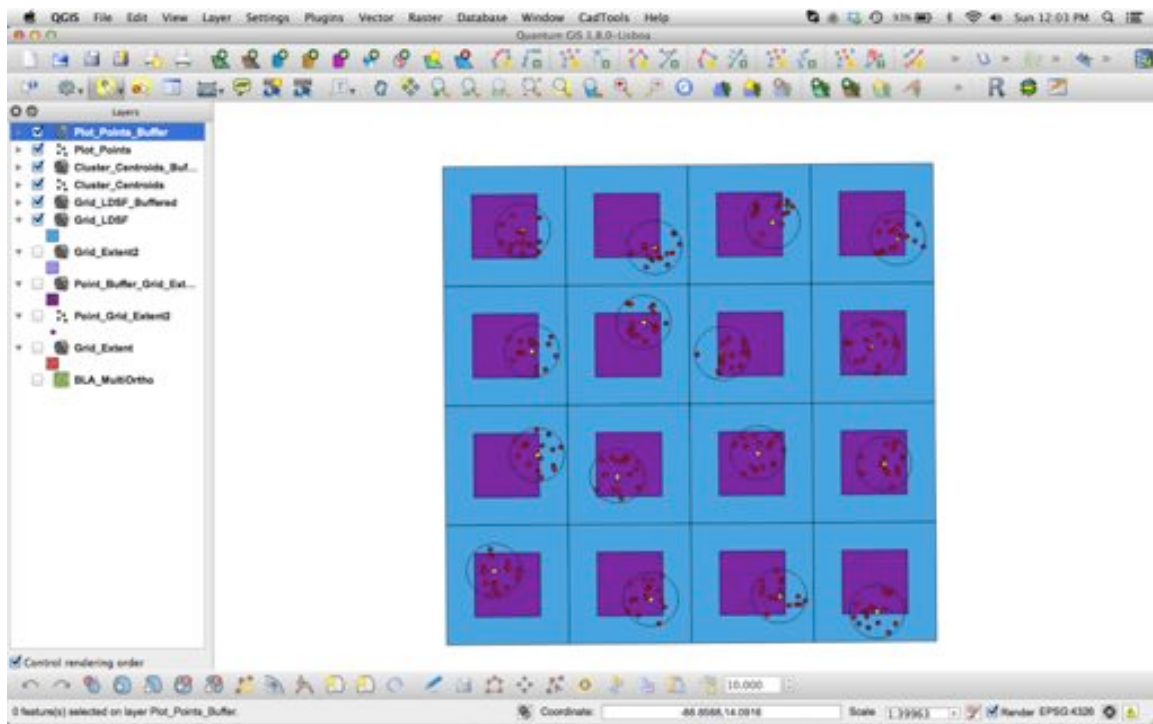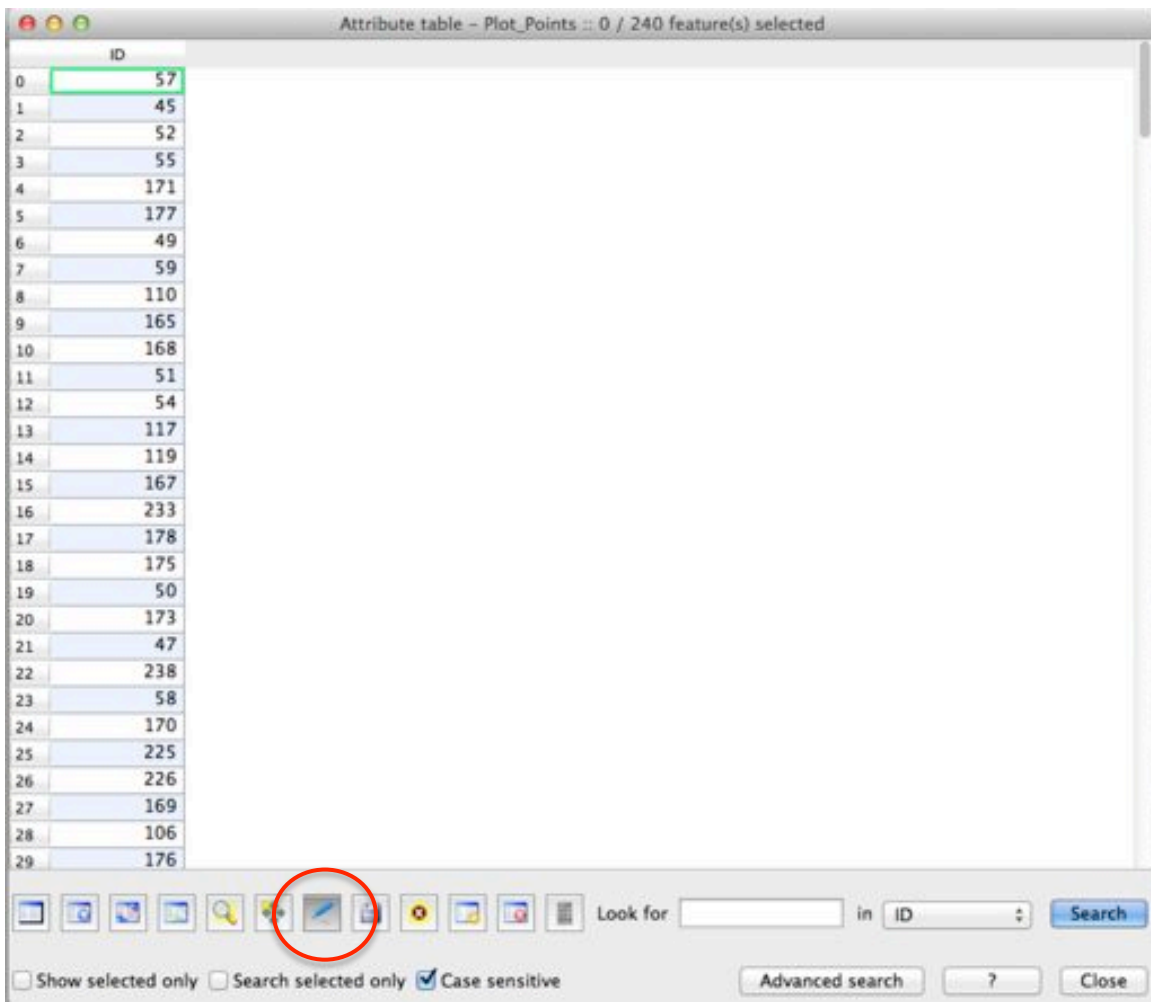

Step 5. c. iv.

Step 5. c. iv.

Note: We only needed 10 plot points, but we created 15. This is done in order to have extra points in case some need to be thrown out. For example, they might lie in a water body, be unreachable for sampling, or overlap with another plot (actually in ArcGIS you can avoid this, but in QGIS it is very complicated to ensure points do not overlap)

6. **Add the plot point coordinates to the Attribute Table for easy export**
   a. Open the attribute table for the shapefile of your plot points by right-clicking on the layer in your TOC and selecting *Attribute Table*
   b. Toggle editing in the attribute table and open the field calculator
   c. Select *Create a new field* and name your new field X_COORD
   d. In the *Function List*, select *Geometry* and then double-click *$x* and *$x* will appear in the *Expression* field below. Or you can simply type $x into the *Expression* field below.
   e. Click *OK* and a new column will appear in your attribute table with the X-Coordinates for all the plot points.
   f. Repeat the same process and create a new field called Y_COORD and select *$y* from *Function List* or type it into the *Expression* field
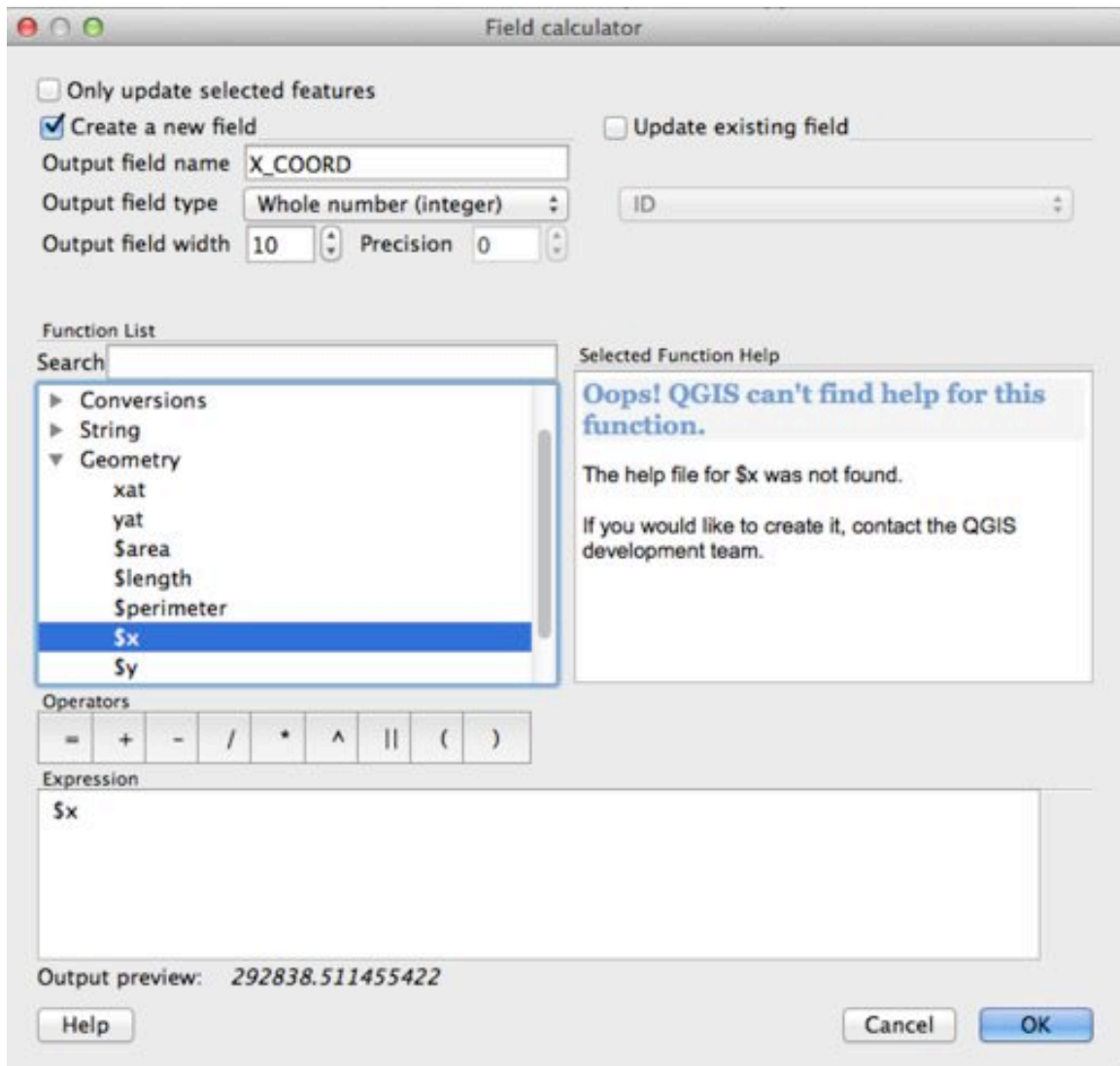   g. Two new columns will have been created in the attribute table titled X_COORD and Y_COORD
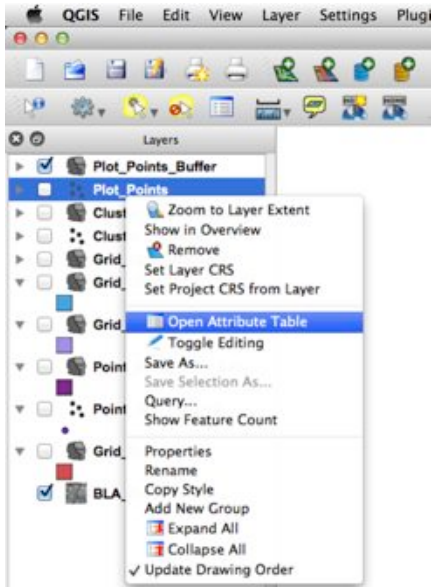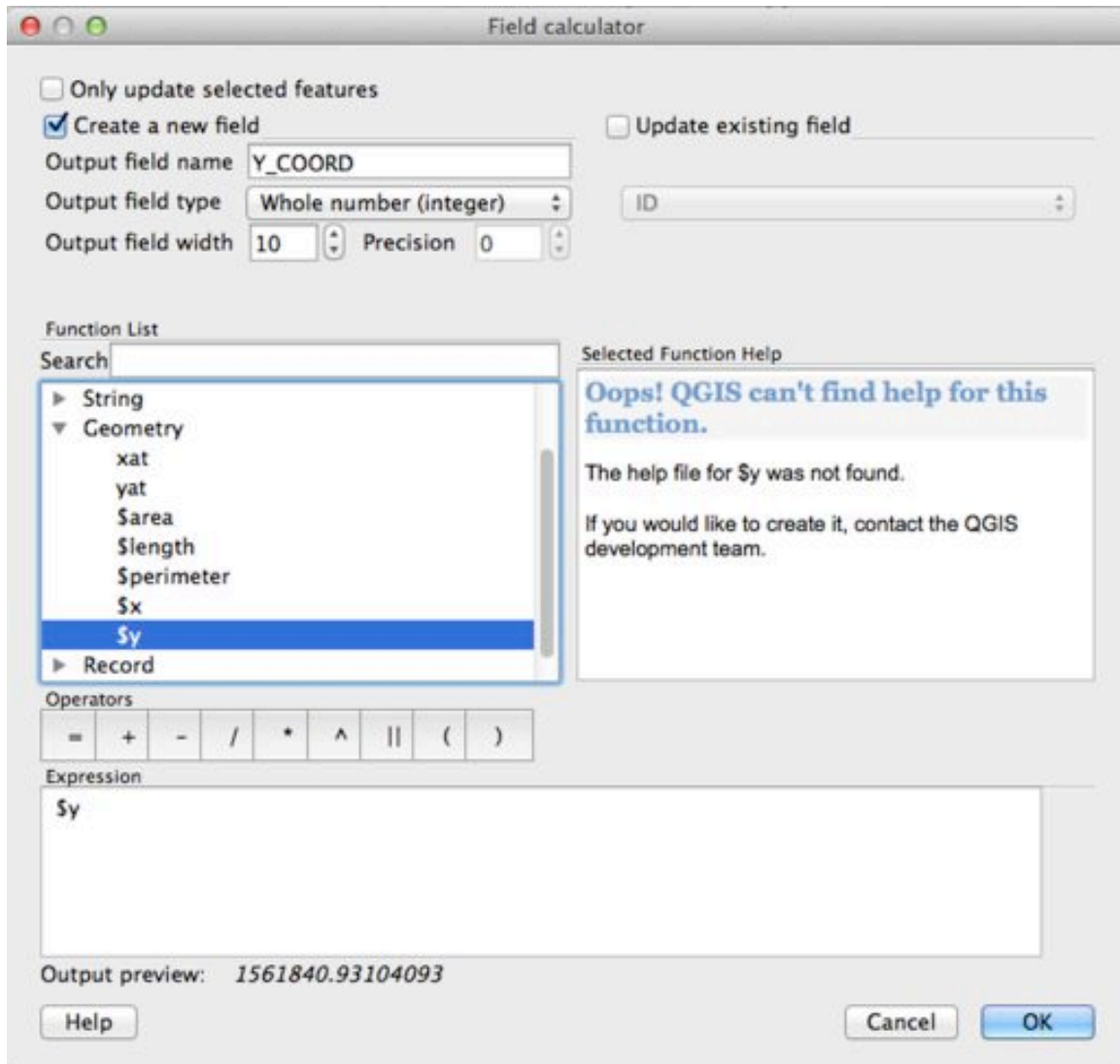
Step 6. a.

Step 6. b.

Step 6. c & d.

Step 6. f.

Step 6. g.

Final result (Note: the size of the plots has been enlarged to make them easier to see)