

Spatial Analysis with QGIS

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INTRODUCTION

QGIS is an open-source geographic information system that can be used to map specimens and conduct spatial analyses. By connecting your specimen data points to form a polygon, you will calculate the range of your species and examine how it changes over time. To complete this assignment successfully, it is critically important that you follow each step closely and save frequently. Take your time!

By the end of this assignment, you will be able to:

- Create a map with overlapping polygons using the Concave Hull tool
- Use the polygon map to measure the area of the species range at multiple time points
- Create a spreadsheet showing the area of the range of a species over time

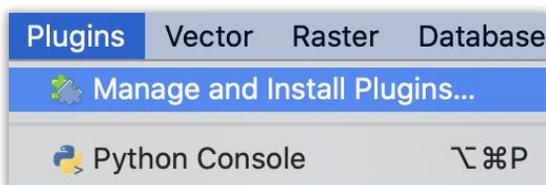
PART 1: MAPPING SPECIMEN OCCURRENCE DATA WITH QGIS

To begin, complete step 1 through 3 of "[Mapping Specimen Occurrence Data with QGIS](#)" (C.D. Bronson 2021). As you work through this activity, be sure to **name your files using your species name**.

Keep in mind that you also need to make sure that the correct Coordinate Reference System (CRS) is selected for your data. For our data, it will end with WGS84, for [World Geodetic System](#).

Another Way to Add Map Layers (optional)

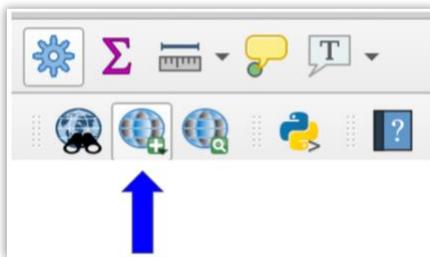
1. QGIS is versatile because of its many potential plugins. You can also install a plugin that allows you to access more basic base maps. Go to *Plugins > Manage and Install Plugins*.



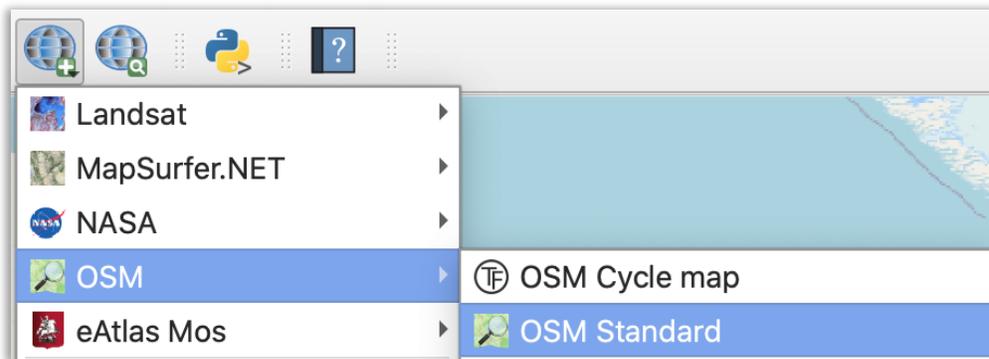
- Now type *QuickMap* into the search bar and select the top hit: *QuickMapServices*. Click *Install Plugin*.



- You will now have a new icon for *QuickMapServices* in the right-hand side of the screen.



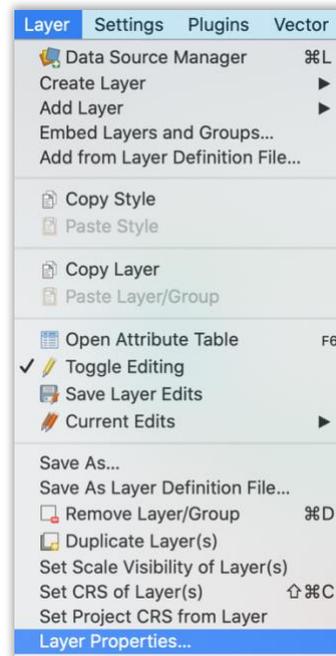
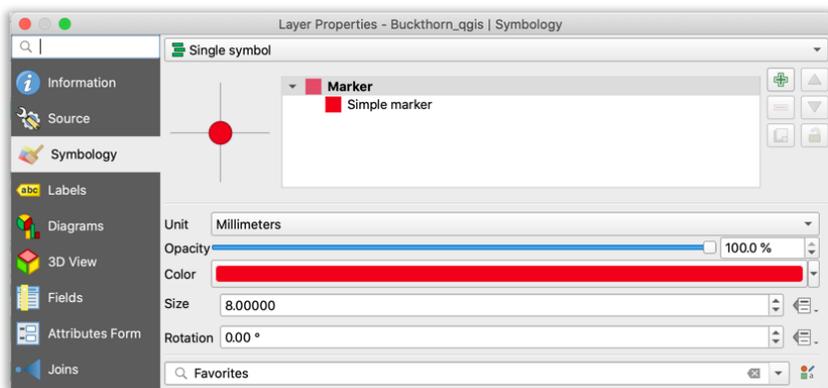
- Click the icon and select *OSM > OSM Standard*.



PART 2: CHANGE SYMBOLS

“Symbology” is a critical part of geographic analyses. The default symbols may be small and difficult to see. We will now make your points easier to see.

1. From the very top menu on your screen select *Layer > Layer Properties*.
2. Under *Symbology* change your default marker color to red and change the size from 4 to 8.
3. Click *OK* in the bottom right corner of the screen to make your changes.



PART 3: INSPECT THE DATA

1. Take a minute to look at your data to make sure it looks correct and that nothing has been georeferenced to the middle of the ocean or anywhere else inappropriate for your species. If you *still* have outliers in your data set, inspect individual points and click *Identify Features*. This will open a side window with the associated data.
2. Select individual points with the selection tool.
3. Delete data points as needed.
4. If these options are not available, enable *Toggle Editing*.



PART 4: SPLIT THE SHAPEFILES BY 20-YEAR INTERVALS

Split this shapefile into separate shapefiles for each time interval. We are going to use 20-year intervals, but you could use decades, depending on your species and research question. To do this:

1. Right click on the shapefile layer > *Open Attribute Table*
This can also be done from the *Layer* menu > *Open Attribute Table*, or via the attribute table icon.



2. Scroll the attribute table to the right so the *Year* field is visible, click the *Year* column heading and sort ascending, from oldest to most recent specimen collected.
3. Highlight all the rows within your first 20-year interval (for example, 1844-1863).

1	08cdf9e1-5a...	41.82361999...	-71.4219899...	1844
2	9969232e6	41.82361999...	-71.4219899...	1844
3	b5ae7106-d0...	39.88970499...	-75.0330060...	1866
4	afcc8338-f7...	41.97972000...	-73.6563900...	1876

Note: To make polygons, your first 20-year interval needs to contain at least four points. In the example above, we will select the next available point, which is at 33 years.

4. Right click (or control+ click on a Mac) on the shapefile layer (left side of window) > *Export* > *Save Selected Features As* then click on the icon with the three dots, name the new shapefile (e.g., “YourSpeciesName_20y”) and select where you want it to save (make a new project folder named “Intervals”). Click *Save*.



Note: If your first interval is longer than 20 years to get 4 records then change the name as needed. In this example the first name ended with “_33y”.

5. Make sure the format *ESRI shapefile* is selected from the dropdown menu, then click *Ok*.

- Repeat steps 3-5 but this time highlight all records from the **beginning of the earliest interval to the end of your next interval** (e.g., 40y, 60y, 80y). This will include all the points from the first interval **plus** the additional points from the second interval.

	ID	Latitude	Longitude	Year
1	08cdf9e1-5a...	41.82361999...	-71.4219899...	1844
2	39da35ad-6...	41.82361999...	-71.4219899...	1844
3	b5ae7106-d0...	39.88970499...	-75.0330060...	1866
4	afcc8338-f7...	41.97972000...	-73.6563900...	1876
5	f265d4f9-7e...	44.0043999...	-73.12176999...	1882
6	9253021e-76...	44.0043999...	-73.12176999...	1882
7	5696fc0c-5f...	44.0043999...	-73.12176999...	1882
8	9a9dcde4-77...	44.0043999...	-73.12176999...	1882

1844-1883: Our second interval, 40 years total. (There were no specimens collected in 1883, so none are shown in the table).

Note: Make certain these all go to the same folder! QGIS does not always default to your last used folder for saving the new shapefiles. Click the  icon each time to check.

- Your final interval will be the entire dataset. Make this as a new shapefile and name it for the total number of years that your species occurs in the dataset.

PART 5: CREATING POLYGONS FOR EACH TIME INTERVAL

1. First, we must add a new plugin, the Concave Hull, that allows us to make and measure polygons. From the *Plugins* menu > *Manage and Install Plugins* > type “Concave Hull” in the search, click on the top result, and click *Install*. Then close the plugin window.

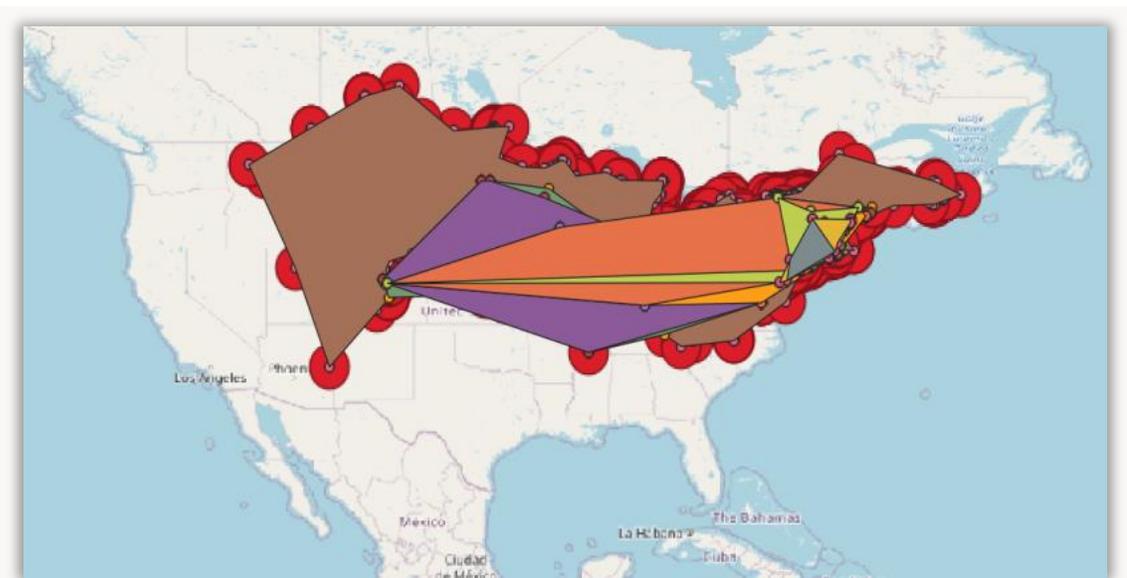


2. Highlight the shapefile layer with your first interval, then click the *Concave Hull* plugin button



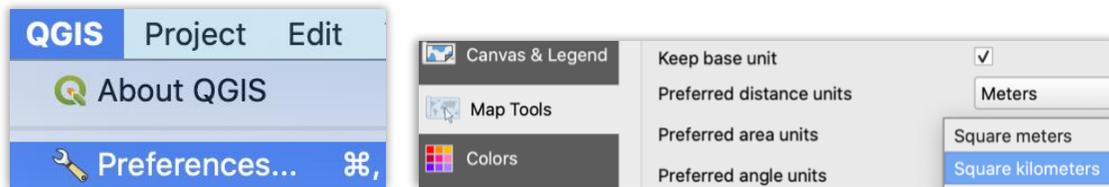
3. Leave the default settings, and do not select any additional layers.
4. Click the *New Shapefile* radio button towards the bottom of the popup window.
5. Browse to where you want the shapefile saved and name the file (e.g., in a new “Polygon” subfolder use: “YourSpeciesName_40y_Polygon”
6. Check *Add result to map* and the polygon shapefile will be added to your QGIS project. Save your work.
7. Repeat steps 2-6 for all other time intervals.

Note: The last time interval will likely take a while, especially if you have lots of records. Just BE PATIENT.

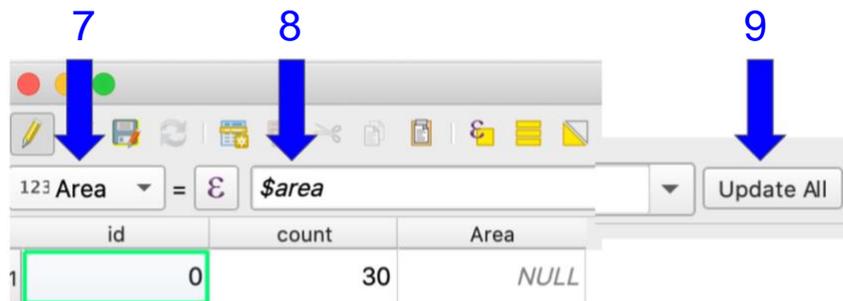


PART 6: CALCULATE THE AREAS OF YOUR POLYGONS

1. Make sure the area units are set to square kilometers: Under the *QGIS > Preferences* menu > *Map Tools*. On a PC this may require *Settings > Options > Map Tools*.
2. Under the *Preferred area units* select *Square kilometers* then click *Ok*.



3. Make the polygon for your first time interval shapefile editable: Under the *Layer* menu > *Toggle Editing*.
4. Right (or control) click the shapefile in the layers window pane > *Open Attribute Table*.
5. Command (Mac) or control (PC) W to add a new field to the attribute table or select: 
6. Name this new field: *Area*, and set type to *Decimal number (real)*.



7. In the drop-down menu in the upper left, select *Area*.
8. Type the operator “\$area” (no quotes) in the blank field calculator.
9. Click *Update All* and the area of the polygon will be added to the attribute table.
10. Close the attribute table window.
11. Save your edits and close editing. Under the *Layer* menu > *Toggle Editing*.
12. Repeat steps 2-11 for each time interval shapefile.
13. Save your project!

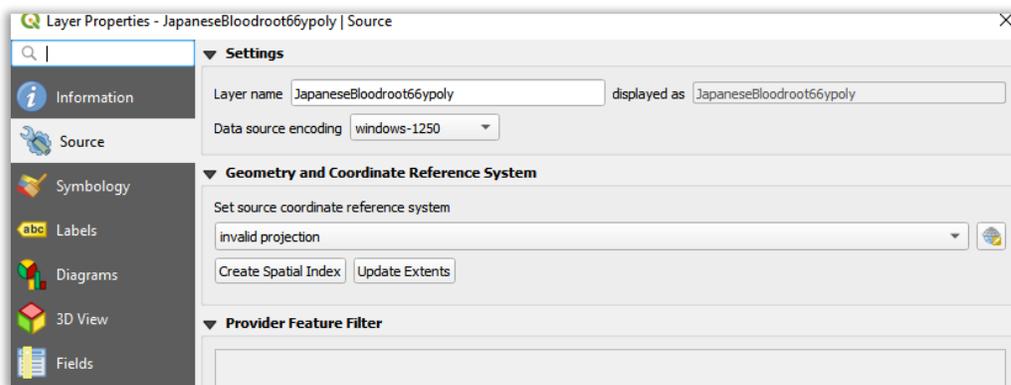
14. Copy and paste the area for each interval into a spreadsheet with the associated time periods.

	Area (km ²)	
Time Period	Species A	Species B
22	14999	10500
40	15032	16250
60	18944	19280
80	19562	24175
100	20945	29874
115	25900	36124

Correcting Invalid Area Values (as needed)

You may get area values that are clearly not correct for a given polygon. Usually, they will appear far too small if this error occurs. The issue is usually in the shapefile formation because the WGS84 projection was not set at the beginning of the project. To correct these invalid area measurements:

1. Click on the *Layer Tree*.
2. Right click the polygon with invalid area values.
3. Select *Properties*.
4. Check the *Geometry and Coordinate Reference System*.
5. If the dropdown says “Invalid projection” then select the option ending in “WGS84”
6. Re-measure the areas and they should be correct.



REFERENCES

Cecily, B. (2021). Mapping Specimen Occurrence Data in QGIS. [BCEENET- Biological Collections in Ecology & Evolution Network](#), QUBES Educational Resources. doi:10.25334/9EE1-AB83

GISGeography. (2021, June 8). *World Geodetic System (WGS84)*. GISGeography. <https://gisgeography.com/wgs84-world-geodetic-system/>