

# Mapping Specimen Occurrence Data in QGIS

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## INTRODUCTION

The North American beaver, *Castor canadensis*, is the largest rodent in North America and was nearly hunted to extinction for its prized waterproof pelt in the 19<sup>th</sup> century. It has since recovered and can be found all over the United States. In this assignment, we will use digitized natural history collection occurrence data from the Global Biodiversity Information Facility (GBIF) to map the distribution the beaver in the state of Oregon from 1800-2020. To map our data, we will use Quantum Geographic Information System (QGIS). QGIS is a free and open-source geographic information system that researchers use to visualize, edit, analyze, and publish geospatial data. Most specimens in natural history collections have location data associated, and we can use QGIS to map the specimens and investigate trends in the data.

In this assignment you will:

1. [Import digital natural history specimen data as a csv into QGIS](#)
2. [Convert the csv to a shapefile](#)
3. [Open the attribute table](#)
4. [Symbolize data by the basis of observation attribute](#)
5. [Create a basic map and export it as a jpg or pdf](#)

## ARE YOU READY TO MAP?

Below are the steps that you should take before you begin this assignment:

### 1. Download your data from a digital data portal

The data used in this assignment was downloaded from [GBIF](#), but you can use data from any portal as long as it is in csv format. If you need more help, learn [how to open GBIF files in Excel](#).

### 2. Clean downloaded data

Need help cleaning your data? Follow this resource: [Cleaning Biodiversity Data: A Botanical Example Using Excel or RStudio](#) (Gaynor, 2020)

### 3. Download QGIS

Click here to [download QGIS](#). Install the **stand-alone long-term release version**. [Detailed download instructions are available](#). Versions may vary and may even look different depending on your operating system. This assignment was made using QGIS version 3.10.8-A Coruña.

### *A note on data management*

Be sure to save your csv file in a folder where you plan to keep it and the rest of your QGIS data.

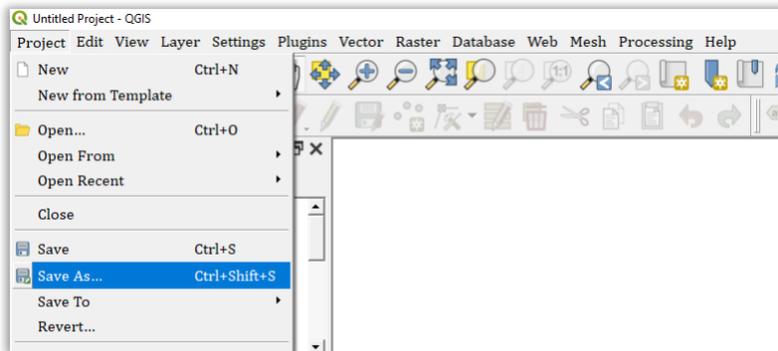
**Do not use any spaces in any of your column headers, file name, or folder.** Spaces can cause issues while importing into QGIS (many people use an underscore (\_) to replace a space).

**Make sure that you know what datum your data was collected in** (WGS84, NAD83...) and know which columns contain your latitude and longitude coordinates.

The data in this example was obtained through GBIF, the file name is 'Castor\_canadensis.csv', and the datum is WGS 84.

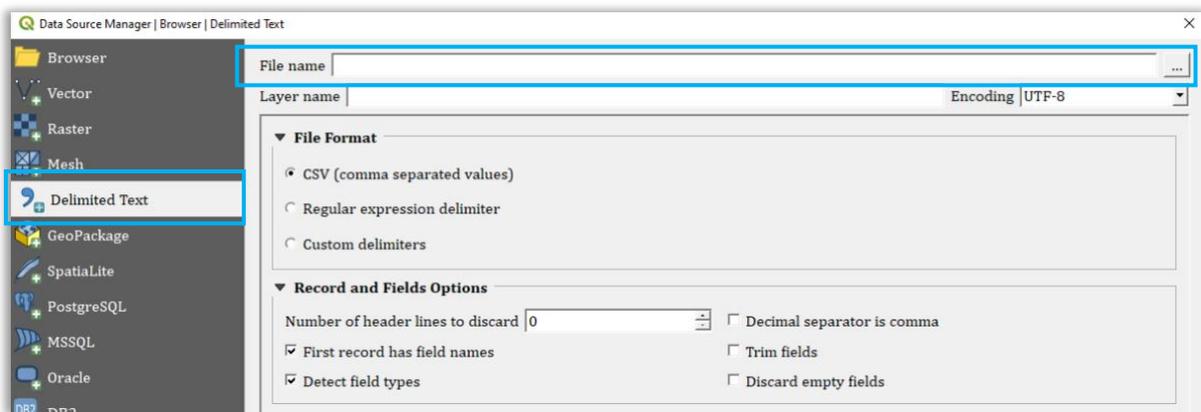
## STEP 1: IMPORT A CSV FILE TO QGIS AND ADD A BASIC WORLD MAP

1. Open QGIS.
2. Begin a new project by clicking on *New Empty Project*.
3. Save your project in the folder with your csv by going to *Project >> Save As*.



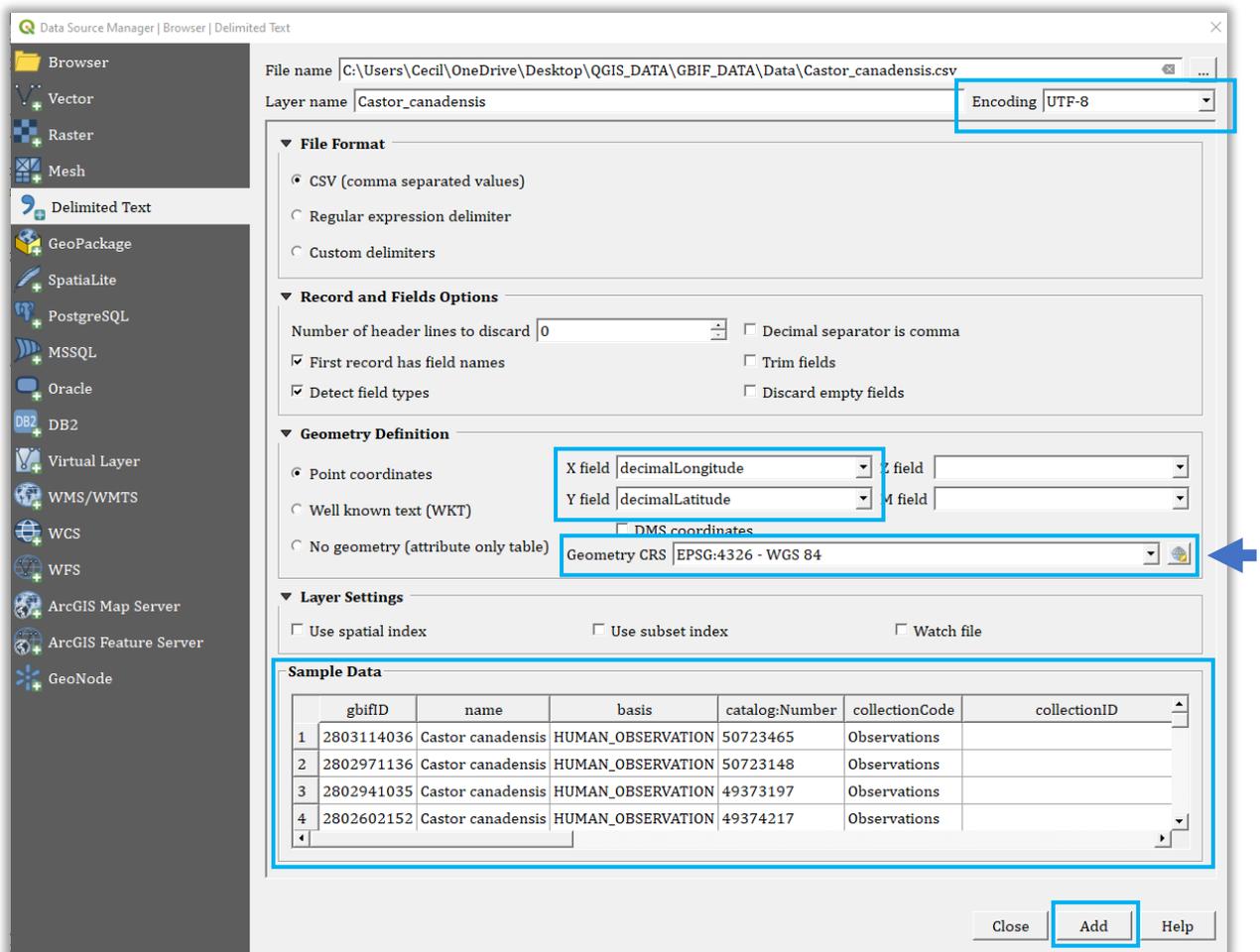
4. Save using a name that has no spaces and is relevant to your work (we are working with Beaver data, so our Project will be called "BeaversOfOregon". Click *Save*.
5. Now we need to find our csv file with our Beaver data, so click on the *Data Source Manager* button  or go to *Layer >> Data Source Manager*.
6. In the new window, select *Delimited Text* on the left-hand side, and click on the  button next to the field that says *File name*. This will let you browse to your csv file in a new window.

Find your file, select it, and click *Open*.

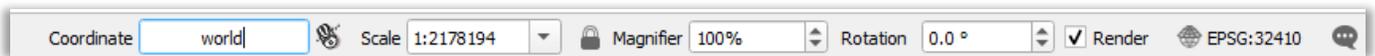


7. This will auto populate a few fields in our Data Source Manager window. Be sure to double check that the *Encoding* is correct for your data (it should be UTF-8 for csv files).
8. Make sure that your *X field* and *Y field* match up to the correct columns in your csv that contain your decimal longitude and decimal latitude (X is longitude, Y is latitude). For our data those columns are labeled as 'decimalLongitude' and 'decimalLatitude'.  
**Note:** if your coordinates are in degrees minutes seconds (DMS), make sure to check the box for *DMS coordinates*, otherwise leave it unchecked.

- You also need to make sure that the correct Coordinate Reference System (CRS) is selected for your data (this should be noted in the original csv file from the data portal). For our data, it is WGS84 but if you need a different datum click on the  button.
- Preview your data in the *Sample Data* panel to verify that the data associated with this csv is correct and matches the format of your csv.

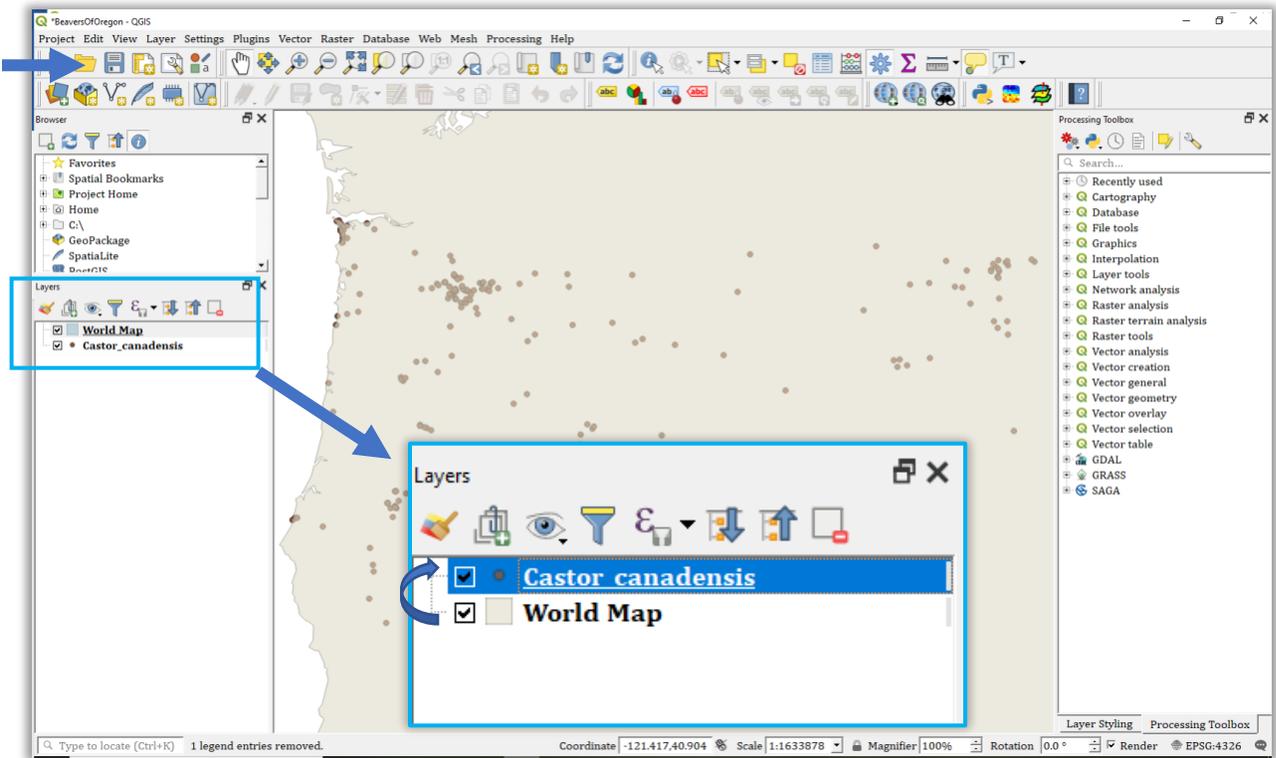


- Click *Add* to add this to your project. Then click *Close*.
- You should now see a bunch of points on your map, but they are on a blank canvas, so we will want to add some background for reference. At the bottom of your window where it says *Coordinate*, type in the word 'world' (all lowercase) and hit 'Enter' on your keyboard. This will load a default world map to your project.



- Click the  button to **save your progress** now.

14. Your points may look a little obscured, and that is because the world map layer is sitting on top of your csv file. If you want to change the order of your layers, simply click and drag the layer you want to be on top, to the top of the list of layers in your 'Layers' panel. You can also turn layers on and off by checking or unchecking the  box next the layers.



15. 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.

16. Use   to drag the map around, and   to zoom in or out. **Note:** To quickly zoom in on a specific layer, select the layer you want to see, right-click and go to *Zoom to layer*.

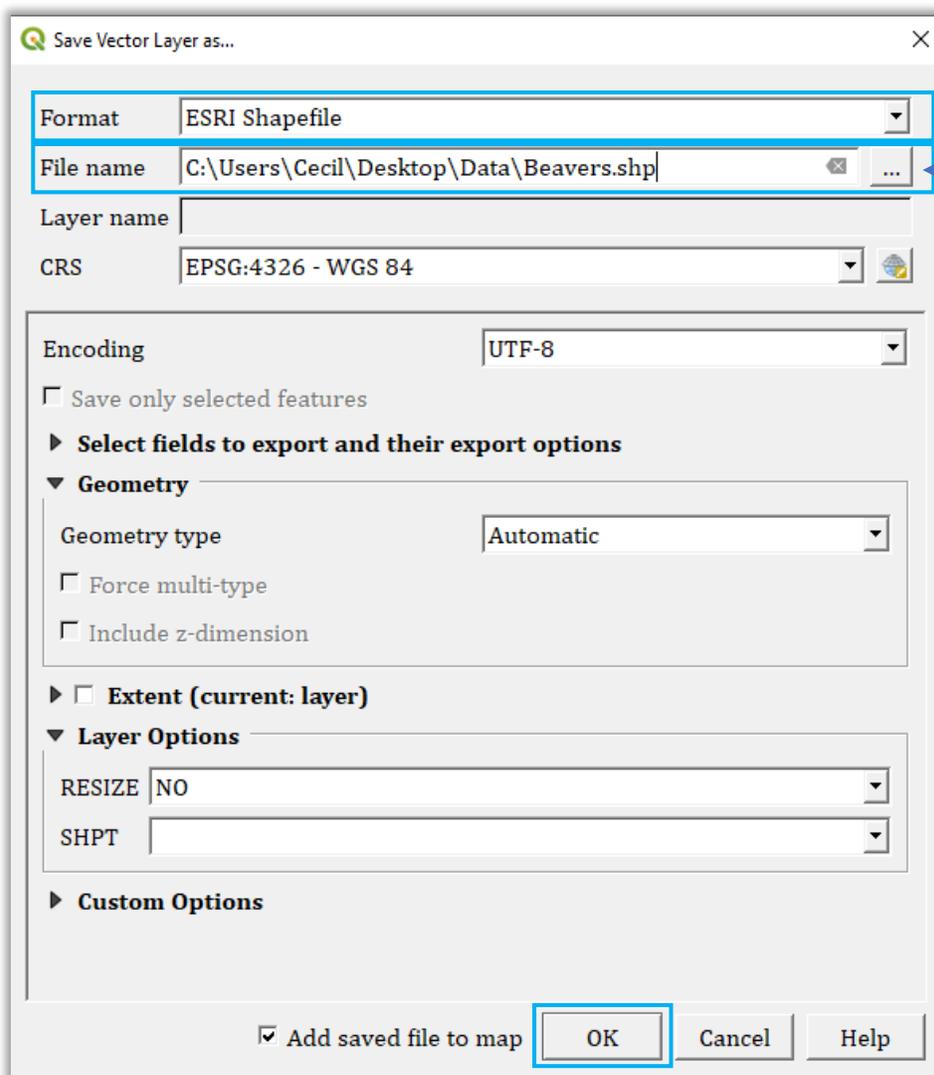
17. If you want to select specific points, use one of the *Identify Feature* buttons below:



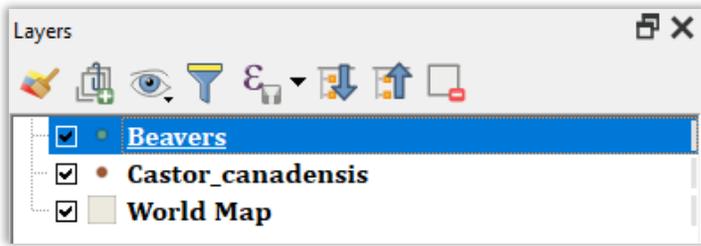
## STEP 2: CONVERTING THE CSV INTO A SHAPEFILE

Right now, our csv file is a temporary layer, so we need to save it as a permanent shapefile to use it in the future with other tools in QGIS. Shapefiles are made up of multiple files and include metadata like the CRS which is needed for any spatial analysis. Csv files do not have this data.

1. To save the csv as a shapefile, right-click (PC) or control-click (mac) and select *Export >> Save Features As*, or use go to *Layer >> Save As*.
2. When a new window appears, select 'ESRI Shapefile' as the format.
3. To name the shapefile and save it to your data folder, click the  button next to *File name*, and navigate to your data folder (remember no spaces!).
4. Click *OK* and make sure the check box next to *Add saved file to map* is checked and the layer will automatically add to your map.



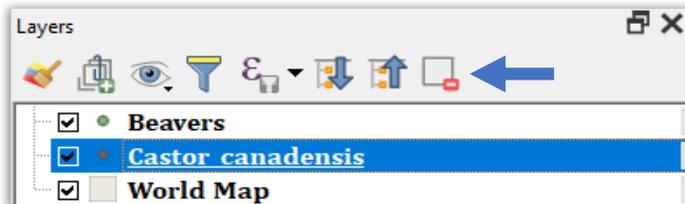
5. You should now see your new shapefile added to your 'Layers' panel. Ours is called "Beavers".



6. Your new shapefile should lay perfectly on top of your csv file. If the data points are showing up somewhere else on your map, you most likely choose the wrong CRS when you converted it into a shapefile. To fix that, remove your shapefile and convert your csv again and choose the correct CRS.

**Note:** You can change the projection or CRS of shapefiles anytime by using the reproject tool. This can be handy if you have other data that is in a different CRS that you want to add to your map. If you would like to learn more about projections or how to reproject your data, go [here](#).

7. Now that we have a shapefile, remove the old csv file by selecting it, and then clicking the *Remove layer* button found in the top of your 'Layers' panel.



8. You have now successfully imported and converted your csv file into a shapefile in QGIS! This would be a great time to **save your project**.

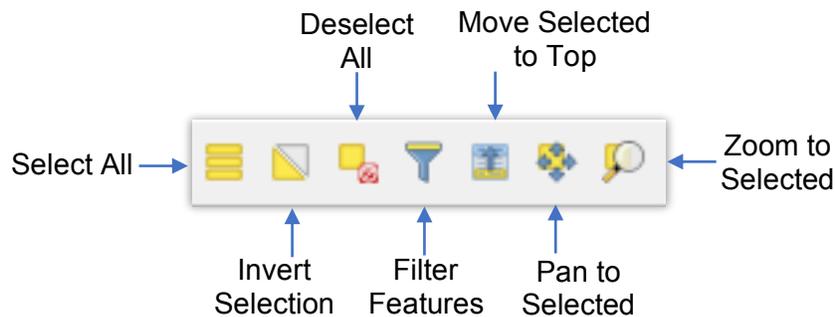
### STEP 3: OPEN THE ATTRIBUTE TABLE

The shapefile with our beaver data points has an associated attribute table that contains all the data that was in your csv file. Let's open this table and see what we have in there.

1. To open your attribute table, first click on your shapefile in the 'Layers' panel.
2. Right-click (PC) or control-click (mac) and select *Open Attribute Table* or go up to *Layer >> Open Attribute Table*.
3. Take a minute to scroll around and check out all the fields. Notice that the table tells you how many features you have and how many are selected.

gbifID	name	basis	catalogNum	collection	collecti_1	institutio	decimalLat	decimalLon	coordinate	scientific	year
2634018917	Castor canad...	HUMAN_OBSE...	46884580	Observations	NULL	iNaturalist	45.01956200000...	-117.021957000...	27222	Castor canad...	
2634019217	Castor canad...	HUMAN_OBSE...	47062266	Observations	NULL	iNaturalist	45.67337100000...	-117.113759000...	27126	Castor canad...	
2634022226	Castor canad...	HUMAN_OBSE...	47062970	Observations	NULL	iNaturalist	45.66896899999...	-117.199731000...	27126	Castor canad...	
2634035153	Castor canad...	HUMAN_OBSE...	47061273	Observations	NULL	iNaturalist	45.78755000000...	-117.124234000...	27126	Castor canad...	
2634089787	Castor canad...	HUMAN_OBSE...	47427765	Observations	NULL	iNaturalist	42.99628100000...	-121.090281000...	NULL	Castor canad...	
2634111893	Castor canad...	HUMAN_OBSE...	48164211	Observations	NULL	iNaturalist	45.34790900000...	-122.680631000...	8363	Castor canad...	
2634154927	Castor canad...	HUMAN_OBSE...	48164212	Observations	NULL	iNaturalist	45.34790900000...	-122.680631000...	8363	Castor canad...	
2634231191	Castor canad...	HUMAN_OBSE...	47061601	Observations	NULL	iNaturalist	45.60618399999...	-117.118223999...	27126	Castor canad...	
2634240223	Castor canad...	HUMAN_OBSE...	47062400	Observations	NULL	iNaturalist	45.76235299999...	-117.041655000...	27126	Castor canad...	
2634243521	Castor canad...	HUMAN_OBSE...	38440762	Observations	NULL	iNaturalist	43.22721200000...	-123.373114000...	4	Castor canad...	
2634276228	Castor canad...	HUMAN_OBSE...	47062658	Observations	NULL	iNaturalist	45.62135800000...	-117.127257999...	27126	Castor canad...	
2634282616	Castor canad...	HUMAN_OBSE...	47342951	Observations	NULL	iNaturalist	45.33997500000...	-117.410900999...	9	Castor canad...	
2634355214	Castor canad...	HUMAN_OBSE...	47061979	Observations	NULL	iNaturalist	45.68771699999...	-117.194777000...	27126	Castor canad...	
2634361162	Castor canad...	HUMAN_OBSE...	47061794	Observations	NULL	iNaturalist	45.71594400000...	-117.142810000...	27126	Castor canad...	

4. You can dock your attribute table to your map by clicking the  button. This allows you to see your map better as you work in the table.
5. Familiarize yourself with how to select and unselect features (specimen records) by selecting entire rows and using the buttons below:



6. Notice how the points on your map change color as you select specimen records in your attribute table.

**Note:** If you can't find a selected record on your map, it may be hiding under other records that have the exact same coordinates. If that happens, use one of the *Identify Features* buttons in the main map toolbar. Selecting features this way will also highlight them in the attribute table.

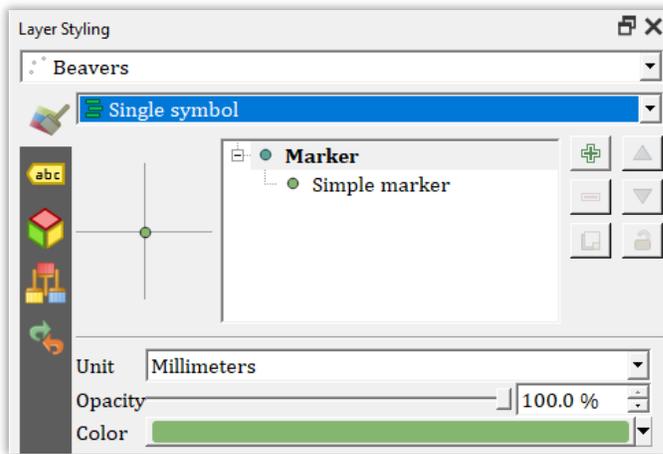
7. To organize your data click on the column headers. The first click will organize numerically or alphabetically depending on the data in the column, the second click will reverse it. This is a great way to organize or group similar records together (ex. institution name, species name, dates, etc.)
8. Lastly, notice the pencil button.  This toggles the editing feature so you can add columns, rows, or update any of the data. Only click this if you need to make edits.
9. If you do any editing, be sure to save your edits by clicking this  button, and close editing by clicking the pencil button again before moving on. If you don't save your edits before closing editing, it may not save your changes.  
**Note: Edit with caution and only if you need to!** It may be easier to make major changes in your csv file and then import the edited version into QGIS.
10. Deselect any selected features and close your attribute table.

For more information on all the things you can do with your attribute table, including the field calculator, see the [QGIS User Guide, Attribute Table](#) section.

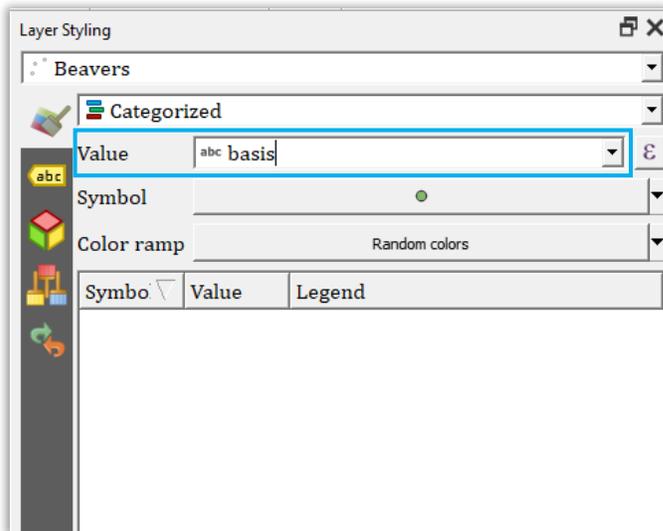
## STEP 4: SYMBOLIZE DATA BY THE BASIS OF RECORD ATTRIBUTE

Currently all the beavers are symbolized in the same way, let's change the way they are symbolized to represent how they were observed. We are going to symbolize these beavers according to the 'basis of record' attribute from our data. This refers to how each specimen was observed (ie. fossil record, museum specimen, human observation, etc.) This data is found in the 'basis' column in our attribute table.

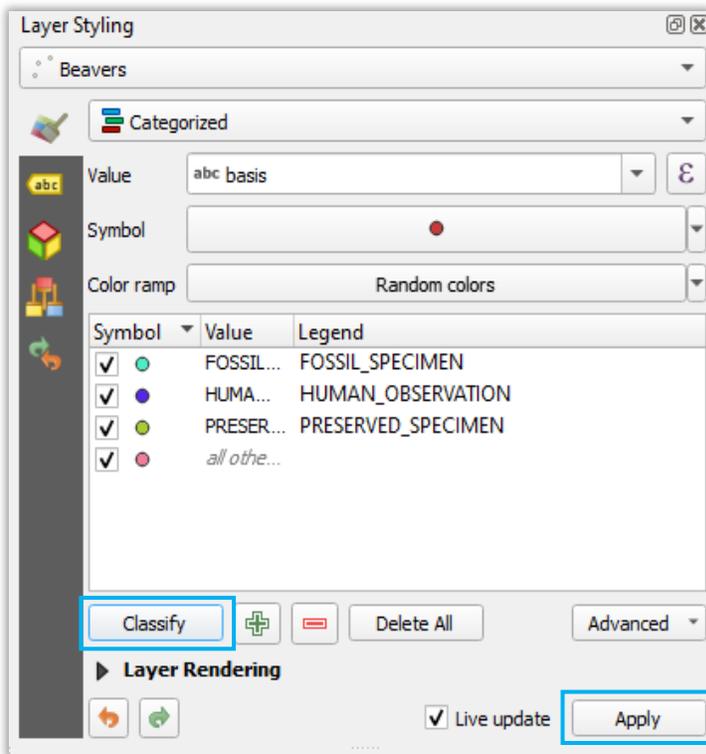
1. Select your 'Beavers' shapefile in the 'Layers' panel, and click the  button to open the 'Layer Styling' panel.



2. Currently the beavers are represented in a 'Single Symbol' manner. Expand the drop-down menu to view the rest of the options and select 'Categorized'. A new field will appear below called 'Value'. From that menu select 'basis' (notice that all columns from the attribute field are displayed here).



- Once you have selected 'basis', click the 'Classify' button down at the bottom of the panel, then click 'Apply'. You'll see your map point change to what you have selected and you will now have a legend underneath your 'Beavers' shapefile in the layers panel. If you wish to further customize the shape or color of your symbols, click on the 'Symbol' box and select something of your own choice.



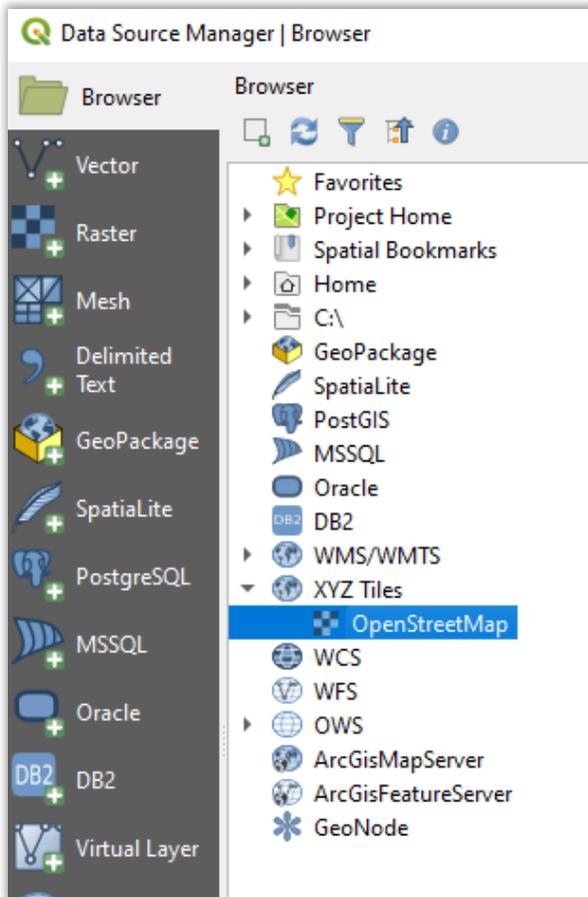
- Once you have finished customizing your colors and symbol shapes, click 'Apply' and observe how your map looks now. **Save your project.**

**Something to think about:** Do you see any new patterns emerge that you didn't see before? Can you think of any biases or issues with representing your data this way? How else would you like to view your data?

## STEP 5: CREATE A BASIC MAP AND EXPORT AS A JPG OR PDF

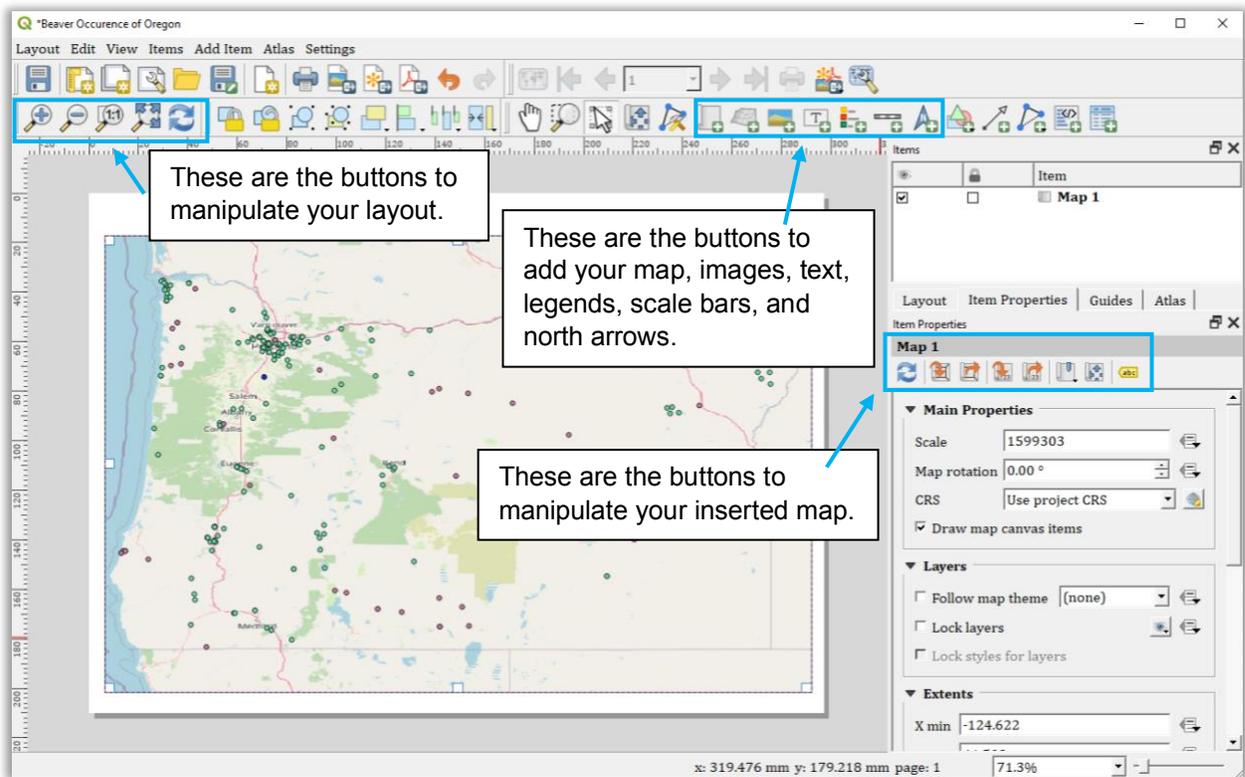
Now that our data points are symbolized by a category, we are going to prepare to make a nice basic map. First, we are going to replace our basemap with one that is a bit more detailed.

1. Click the 'Open Data Source' button, and on the left-hand side select 'Browser'. Look for 'XYZ Tiles' and select 'Open Street Map' (double-click to add it to your map).



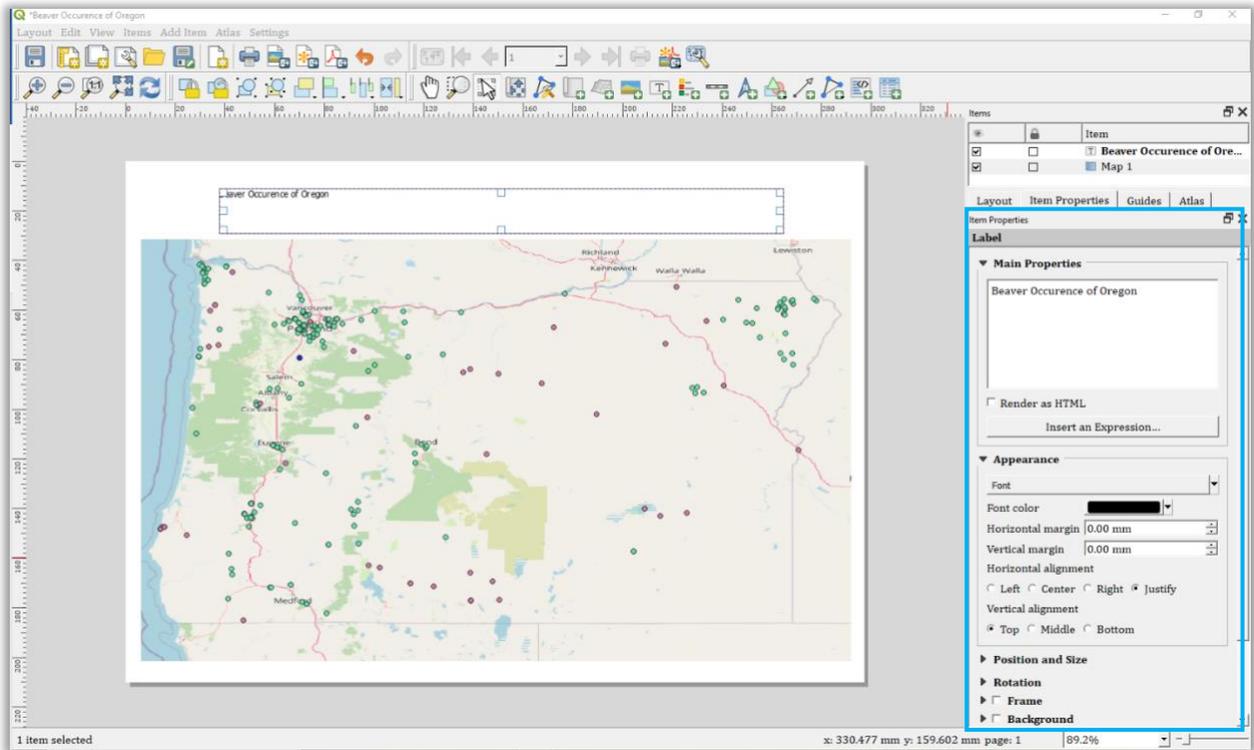
2. Remove your 'World Map' layer.
3. Zoom out to the extent of your 'Beavers' layer, select the layer and right-click and choose 'Zoom to layer' or click the  button.
4. Now we are ready to make our map. Go to the *Project >> New Print Layout*. It will ask you to give your map layout a unique title, let's call ours "Beaver Occurrence in Oregon". Click *OK*.
5. We now have a new window in QGIS for our map layout. This is where we will create our map to be exported as a jpg and pdf.
6. Make sure you are viewing all the necessary panels and toolbars by going to the 'View' menu and selecting all options.
7. First, we need to add the map that we have been working on in the project section of QGIS. You can do this by going to *Add Item >> Add Map* or by clicking the  button.

8. Draw a large rectangle that covers most of the white background page, this is where your map will load.
9. In this layout window, it is important to note that there are specific buttons to manipulate the entire map layout and separate buttons to manipulate the map itself.



10. To manipulate the map that we inserted, click the button  in the 'Item Properties' panel (be sure you have 'Map 1' selected). Now you can use your mouse to pan the map around by clicking and dragging, and zoom-in/out using the wheel of your mouse or by entering a scale in the 'Item Properties' panel (the smaller the number, the closer you will zoom). When you are done manipulating the map, click the  button in the upper toolbar to resume working on your map layout.
11. Next let's add a title. Go *Add Item >> Add Label* and draw a rectangle near the top of your map where you would like your title to go.
12. Edit the text of your title in the 'Item Properties' panel in the 'Main Properties' section. To adjust to size of the font, select the 'Font' drop down menu and choose 'Configure Format'.

- Choose a font size and style that you like best and click 'OK'. Center your title by selecting 'Center' in the 'Horizontal Alignment' section of this panel.



- Now we need a scale bar to show the scaling of this map. Go back to *Add Item >> Add Scalebar*. Put the scale bar somewhere out of the way where it will not occlude any datapoints. Just like the title you can adjust the properties of the scale bar in the 'Item Properties' panel. Change the style to whatever you like, and make sure you choose an appropriate unit (km or miles are good). Do not adjust the unit multiplier. You can adjust the size of the scale bar using the 'Segments' section by adjusting the number of segments and the units between each segment.

**15. Save your progress.**

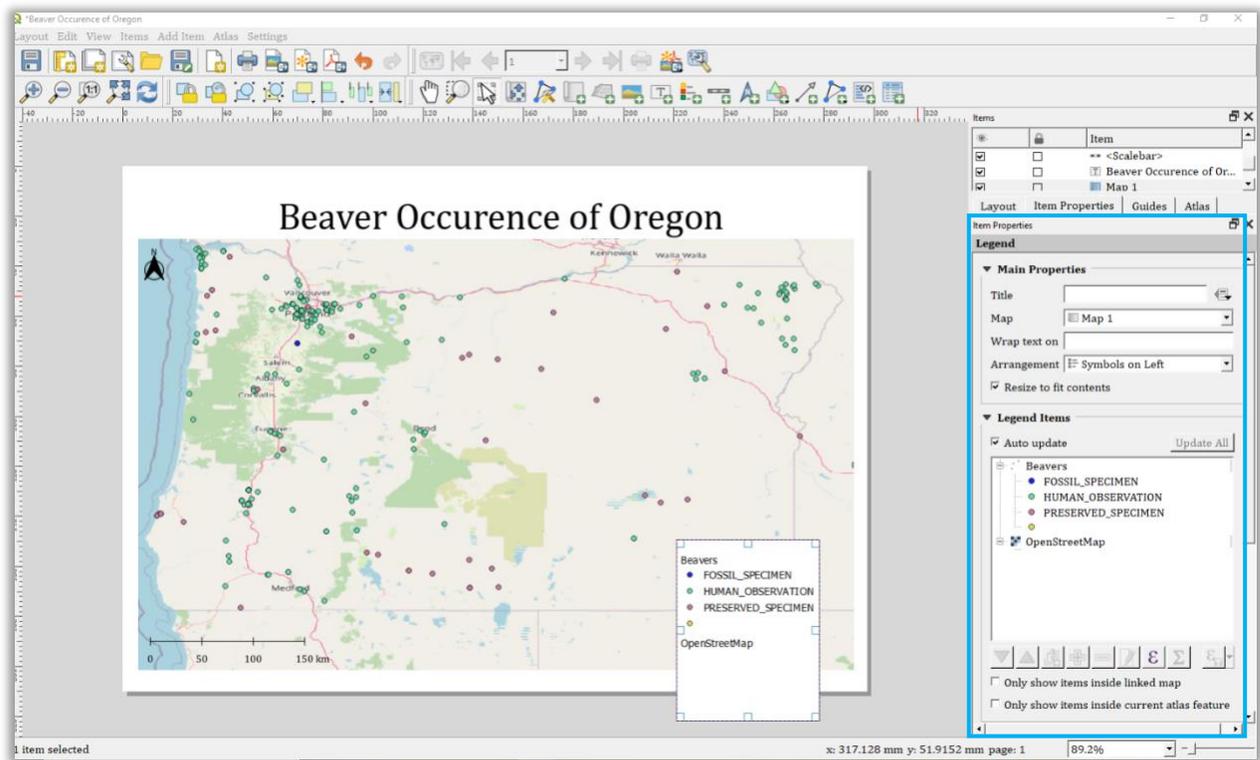
- Now we need to add a north arrow. Go back to the 'Add Item' menu and find the north arrow. Add this to another area on your map where it will not occlude any datapoints or get in the way of anything else. The corners or down next to the scale bar tend to work well. Using the 'Item Properties' panel customize your North arrow like you have with your scalebar and title. The 'Search Directories' section is where you will find a few options to choose from.

- Lastly, we need to add a legend or key so that anyone looking at your map knows what each colored dot means. Go back to the 'Add Item' menu and find the 'Add Legend' option. Be sure to draw a large enough box because this is where all of your layers from your map are going to show up. It should look something like this:

- Using the 'Item Properties' panel, we can customize our legend so that it displays only what we want it to. It needs a title, so add 'Legend' or 'Key'.

- The 'Legend Items' section, uncheck the 'Auto update' box. This will allow us to remove things that we do not need to include like the basemap and the empty symbol  when have left over from changing the symbology of our Beaver data. You can also update the text

on these layers by double clicking on them. To remove something just select it and click on the button.

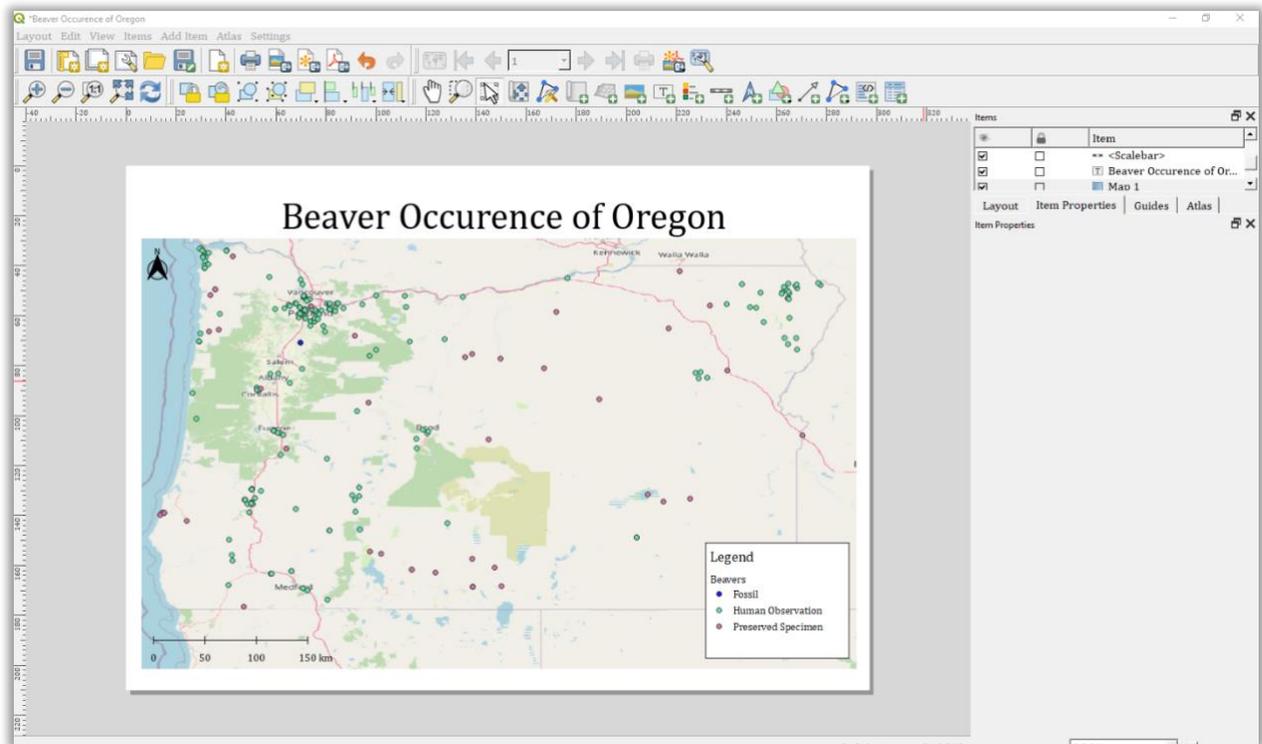


20. Customize the text to match your title and scalebar in the 'Fonts and Text Formatting Section'.

21. Add a border to the legend or alter its fill color in the 'Frame' and 'Background' sections.

22. Once you are done customizing your legend be sure to **save your work**.

23. We now have all the main elements of our map, and it should look something like this:



24. Try adding a border to your map and move things around until you are satisfied that your map is easy to read and shows the viewer what you want them to see. If you want to change any things like symbology, just switch back to your project view and change it there, then come back to this layout view and hit the refresh  button and it will update your map.

25. Now that we have our map the way we want it, it is time to export it as a jpg or pdf. Go to the 'Layout' menu and choose either 'Export as Image' to save as a jpg, or 'Export as PDF' to save as pdf. Make sure to have the resolution set at 300dpi for best quality for the jpg image. Be sure to save your jpg or pdf in the same folder that you have been working in so it is easy to find.

26. Add your jpg map into an existing document or turn in your pdf map as a separate document.

**References:**

Gaynor, M. (2020). Cleaning Biodiversity Data: A Botanical Example Using Excel or RStudio. Biodiversity Literacy in Undergraduate Education, QUBES Educational Resources. <https://doi.org/10.25334/DRGD-F069>

GBIF.org (12 July 2020) GBIF Occurrence Download <https://doi.org/10.15468/dl.tz46v3>