Guide to producing species distribution maps using the ZSL CTAP and QGIS

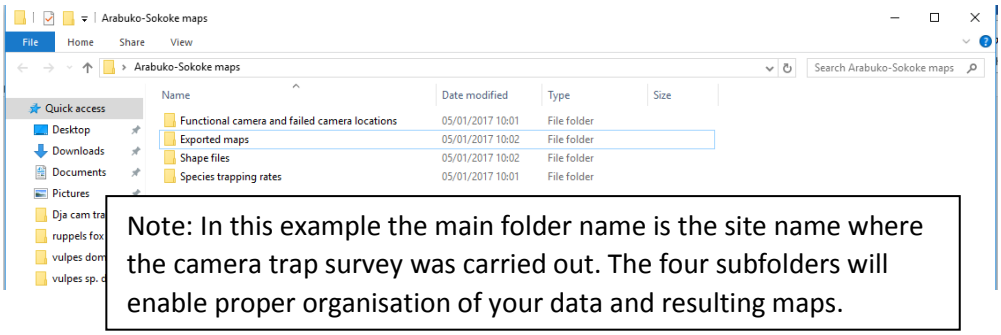
Installing QGIS

Run the QGIS executable setup file 'QGIS-OSGeo4W-2.18.2-1-Setup-x86_64.exe', and follow the on-screen prompts in the installer. For the following exercise, only the basic QGIS package is required with none of the optional example datasets included in the software installation.

Exporting and formatting data from ZSL CTAP for mapping in QGIS

Organising data

The first step is to setup folders to store all of the spatial data files and data exported from the ZSL CTAP program, as this involves multiple files and can become disorganised very quickly. The file structure as demonstrated below is the best way to keep the spatial data files (shape and raster files) and CTAP data organised and easily accessible.

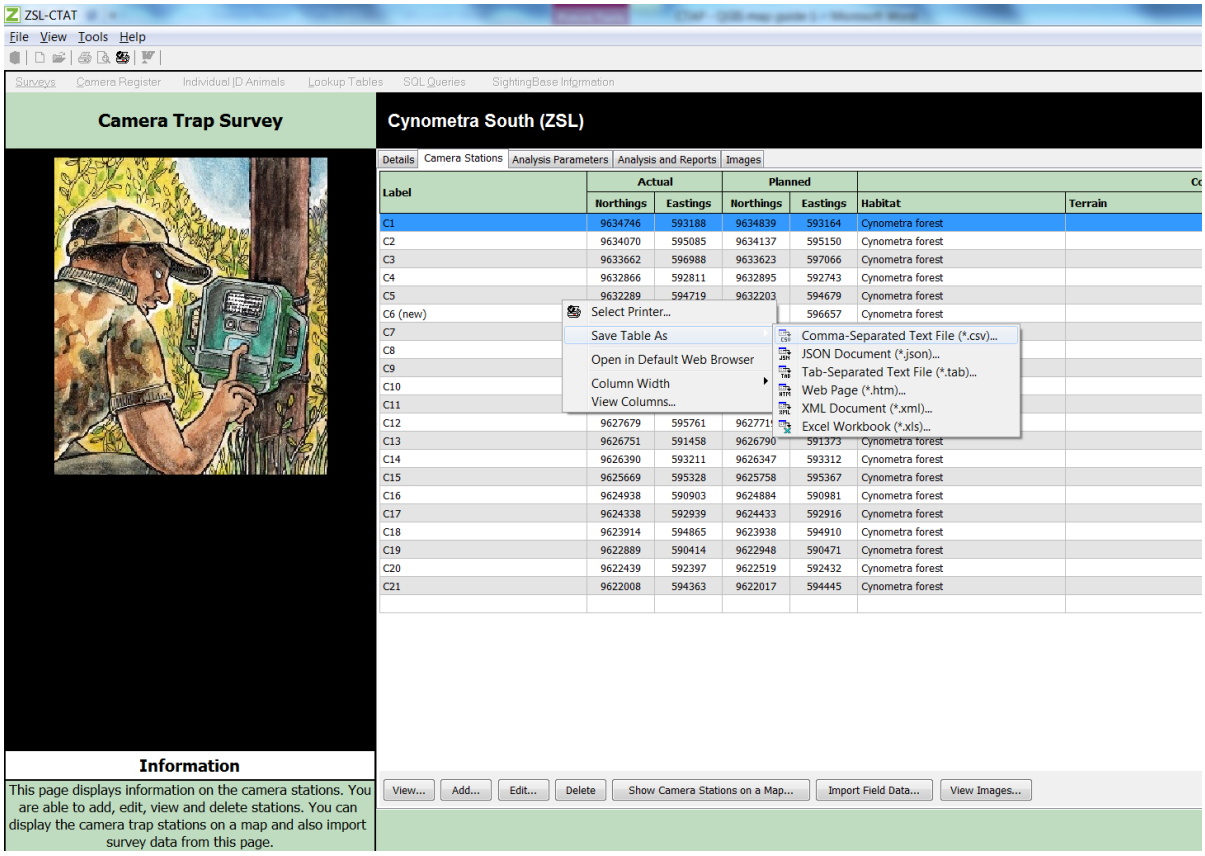


Note: In this example the main folder name is the site name where the camera trap survey was carried out. The four subfolders will enable proper organisation of your data and resulting maps.

Exporting camera location data from CTAP

The file format used by QGIS to read spatial 'numerical' data is comma separated ".csv". Therefore, any data to be imported into QGIS needs to be exported from CTAP in this format.

To export survey camera locations open the 'Camera Stations' tab for the selected survey and right mouse click on the table and select 'Save Table As -> Comma-Separated Text File (*.csv) as shown below. Save this file into the 'Functional and failed camera locations' folder created in the previous step. In this example it is called 'Camera Trap Stations Cynometra.csv'.



Formatting camera trap location data before importing into QGIS

The exported .csv file then needs to be opened in EXCEL and formatted prior to importing into QGIS. All columns except the 'Actual – Latitude and Longitude' and 'Label' columns need to be deleted as shown below. Any failed cameras then need to be removed and placed in a separate 'Failed cameras.csv' file in the 'Functional and failed camera locations' folder. The functional cameras data file can then be saved as with name 'Functional cameras.csv' also in the 'Functional and failed camera locations' folder.

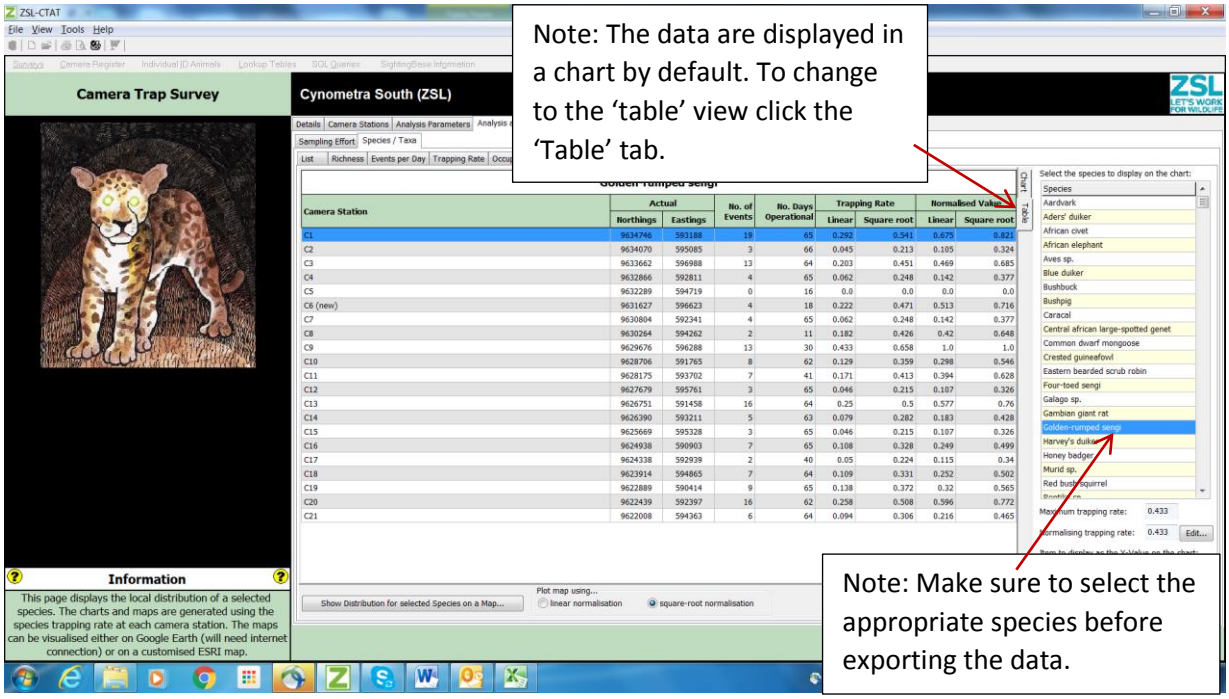
1	Label	Actual		Planned		Covariates				
2	Camera Station	Northings	Eastings	Northings	Eastings	Habitat	Terrain	Aspect	Alt. (m)	Slope
3	C1	9634746	593188	9634839	593164	Cynometra forest				
4	C2	9634070	595085	9634137	595150	Cynometra forest				
5	C3	9633662	596988	9633623	597066	Cynometra forest				
6	C4	9632866	592811	9632895	592743	Cynometra forest				
7	C5	9632289	594719	9632203	594679	Cynometra forest				
8	C6 (new)	9631627	596623	9631637	596657	Cynometra forest				
9	C7	9630804	592341	9630778	592305	Cynometra forest				
10	C8	9630264	594262	9630230	594218	Cynometra forest				
11	C9	9629676	596288	9629643	596220	Cynometra forest				
12	C10	9628706	591765	9628755	591786	Cynometra forest				
13	C11	9628175	593702	9628263	593726	Cynometra forest				
14	C12	9627679	595761	9627719	595746	Cynometra forest				
15	C13	9626751	591458	9626790	591373	Cynometra forest				
16	C14	9626390	593211	9626347	593312	Cynometra forest				
17	C15	9625669	595328	9625758	595367	Cynometra forest				
18	C16	9624938	590903	9624884	590981	Cynometra forest				
19	C17	9624338	592939	9624433	592916	Cynometra forest				
20	C18	9623914	594865	9623938	594910	Cynometra forest				
21	C19	9622889	590414	9622948	590471	Cynometra forest				
22	C20	9622439	592397	9622519	592432	Cynometra forest				
23	C21	9622008	594363	9622017	594445	Cynometra forest				

2	Camera Station	Northings	Eastings
3	C1	9634746	593188
4	C2	9634070	595085
5	C3	9633662	596988
6	C4	9632866	592811
7	C5	9632289	594719
8	C6 (new)	9631627	596623
9	C7	9630804	592341
10	C8	9630264	594262
11	C9	9629676	596288
12	C10	9628706	591765
13	C11	9628175	593702
14	C12	9627679	595761
15	C13	9626751	591458
16	C14	9626390	593211
17	C15	9625669	595328
18	C16	9624938	590903
19	C17	9624338	592939
20	C18	9623914	594865
21	C19	9622889	590414
22	C20	9622439	592397
23	C21	9622008	594363

Note: Any camera traps considered to have failed needs to be removed from this file and placed in a separate 'Failed cameras.csv' file.

Exporting species trapping rates

Species trapping rates at each camera station can be obtained from the following location in CTAP program 'Analysis and Reports->Species/Taxa->Distribution->Table'. Each species that a distribution map is going to be produced needs to have it's own trapping rate csv file saved in the 'Species trapping rates' folder. The data export step is the same as that performed for the camera locations, by right clicking and selecting 'Save Table As > Comma-Separated Text File (*csv)..'.



Formatting species trapping rates for import into QGIS

Next the species trapping rate csv files need to be formatted before importing into QGIS. As we want to plot the trapping rate at each camera station, the first step is to remove any unnecessary data as shown below. We will be plotting the untransformed 'linear' trapping rate.

1	Golden-rumped sengi								
2		Actual		No. of Events	No. Days Operational	Trapping Rate		Normalised Value	
3	Camera Station	Northings	Eastings			Linear	Square root	Linear	Square root
4	C1	9634746	593188	19	65	0.292	0.541	0.675	0.821
5	C2	9634070	595085	3	66	0.045	0.213	0.105	0.324
6	C3	9633662	596988	13	64	0.203	0.451	0.469	0.685
7	C4	9632866	592811	4	65	0.062	0.248	0.142	0.377
8	C5	9632289	594719	0	16	0	0	0	0
9	C6 (new)	9631627	596623	4	18	0.222	0.471	0.513	0.716
10	C7	9630804	592341	4	65	0.062	0.248	0.142	0.377
11	C8	9630264	594262	2	11	0.182	0.426	0.42	0.648
12	C9	9629676	596288	13	30	0.433	0.658	1	1
13	C10	9628706	591765	8	62	0.129	0.359	0.298	0.546
14	C11	9628175	593702	7	41	0.171	0.413	0.394	0.628
15	C12	9627679	595761	3	65	0.046	0.215	0.107	0.326
16	C13	9626751	591458	16	64	0.25	0.5	0.577	0.76
17	C14	9626390	593211	5	63	0.079	0.282	0.183	0.428
18	C15	9625669	595328	3	65	0.046	0.215	0.107	0.326
19	C16	9624938	590903	7	65	0.108			
20	C17	9624338	592939	2	40	0.05	0.224	0.115	0.34
21	C18	9623914	594865	7	64	0.109	0.331	0.252	0.502
22	C19	9622889	590414	9	65	0.138	0.372	0.32	0.565
23	C20	9622439	592397	16	62	0.258	0.508	0.596	0.772
24	C21	9622008	594363	6	64	0.094	0.306	0.216	0.465

1	Camera Station	Northings	Eastings	Linear
2	C1	9634746	593188	0.292
3	C2	9634070	595085	0.045
4	C3	9633662	596988	0.203
5	C4	9632866	592811	0.062
6	C5	9632289	594719	0
7	C6 (new)	9631627	596623	0.222
8	C7	9630804	592341	0.062
9	C8	9630264	594262	0.182
10	C9	9629676	596288	0.433
11	C10	9628706	591765	0.129
12	C11	9628175	593702	0.171
13	C12	9627679	595761	0.046
14	C13	9626751	591458	0.25
15	C14	9626390	593211	0.079
16	C15	9625669	595328	0.046
17	C16	9624938	590903	0.108
		9624338	592939	0.05
19	C18	9623914	594865	0.109
20	C19	9622889	590414	0.138
21	C20	9622439	592397	0.258
22	C21	9622008	594363	0.094

The daily trapping rate then needs to be converted into number of event per 100 days, by multiplying the daily trapping rate by 100. The trapping rate per 100 days then needs to be rounded to a whole number. Camera traps with trapping rate zero need to be removed (highlighted in blue). Scaling points (highlighted yellow) are required to ensure that all species distribution maps are porpotional to one another. These values are established once all of the trapping rates for each species has been exported, as the maximum scale point is the largest recorded trapping rate of all of the species for which distribution maps are to be produced. The minimum is always one to allow QGIS to correctly scale the points relative to one another.

Note: trapping rate per 100 days is calculated in this cell using =D2*100, and is then rounded using =ROUND(E2,0) in the F column.

Note: This is how the .csv file should look once the steps above have been followed. It is now ready for import into QGIS.

1	Camera Station	Northings	Eastings	Linear	Events / 100 days	Rounded - Events / 100 days
2	C1	9634746	593188	0.292	29.2	29
3	C2	9634070	595085	0.045	4.5	5
4	C3	9633662	596988	0.203	20.3	20
5	C4	9632866	592811	0.062	6.2	6
6	C5	9632289	594719	0	0	0
7	C6 (new)	9631627	596623	0.222	22.2	22
8	C7	9630804	592341	0.062	6.2	6
9	C8	9630264	594262	0.182	18.2	18
10	C9	9629676	596288	0.433	43.3	43
11	C10	9628706	591765	0.129	12.9	13
12	C11	9628175	593702	0.171	17.1	17
13	C12	9627679	595761	0.046	4.6	5
14	C13	9626751	591458	0.25	25	25
15	C14	9626390	593211	0.079	7.9	8
16	C15	9625669	595328	0.046	4.6	5
17	C16	9624938	590903	0.108	10.8	11
18	C17	9624338	592939	0.05	5	5
19	C18	9623914	594865	0.109	10.9	11
20	C19	9622889	590414	0.138	13.8	14
21	C20	9622439	592397	0.258	25.8	26
22	C21	9622008	594363	0.094	9.4	9
23	SCALE	1	1			1
24	SCALE	1	1			43

1	Camera Station	Northings	Eastings	Rounded - Events / 100 days
2	C1	9634746	593188	29
3	C2	9634070	595085	5
4	C3	9633662	596988	20
5	C4	9632866	592811	6
6	C6 (new)	9631627	596623	22
7	C7	9630804	592341	6
8	C8	9630264	594262	18
9	C9	9629676	596288	43
10	C10	9628706	591765	13
11	C11	9628175	593702	17
12	C12	9627679	595761	5
13	C13	9626751	591458	25
14	C14	9626390	593211	8
15	C15	9625669	595328	5
16	C16	9624938	590903	11
17	C17	9624338	592939	5
18	C18	9623914	594865	11
19	C19	9622889	590414	14
		9622439	592397	26
21	C21	9622008	594363	9
22	SCALE	1	1	1
23	SCALE	1	1	43

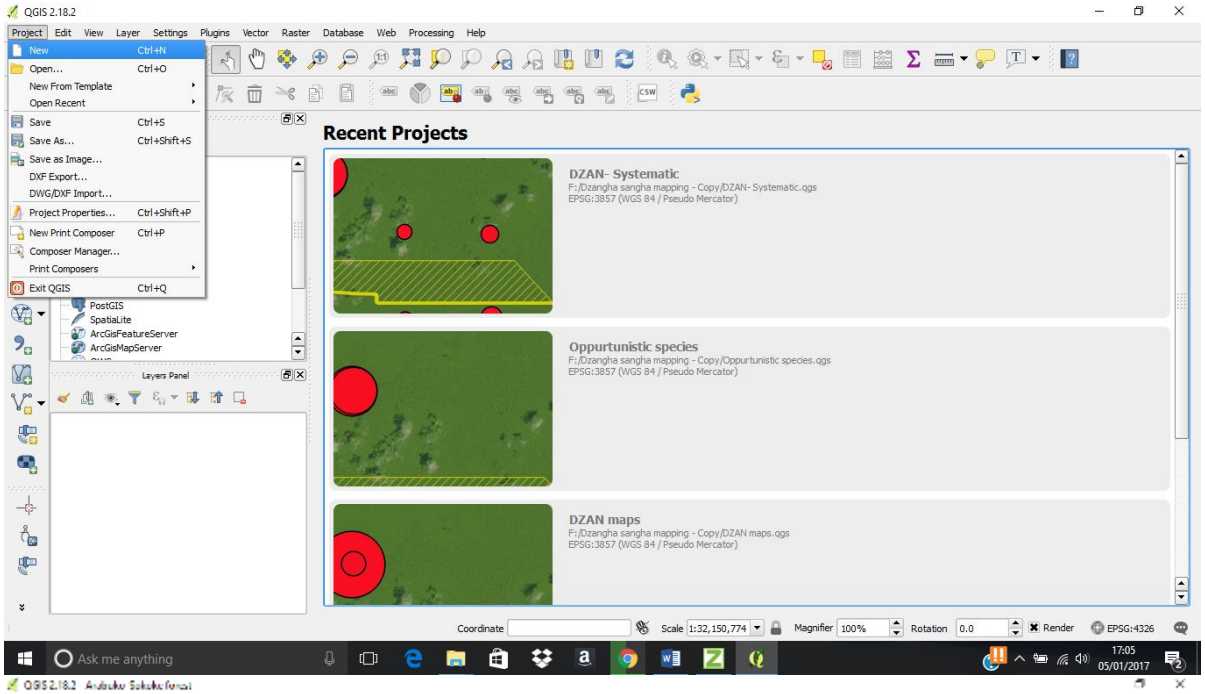
Note: In this example the larger scaling point is the same as the highest value. As the maps aren't being produced for multiple species. However, if the highest trapping rate for another species detected in this survey was 68, the larger scaling point would be 68

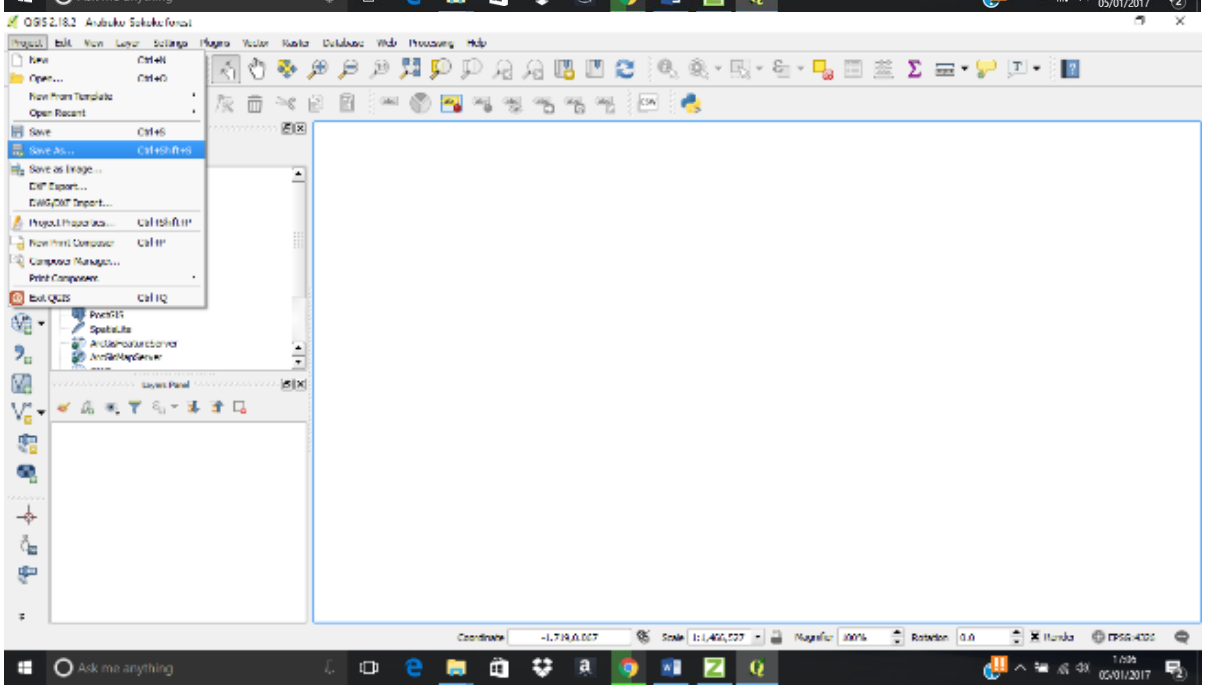
Note: The northing and eastings have all been set to 1 for the scale points, to ensure they don't appear on the exported map.

The edited .csv file should be saved as the species name in the 'Species trapping rates' folder, replacing the original export file from the tool. This process needs to be repeated for all species for which distribution maps to be produced.

<u>Setting up a project in QGIS</u>

Open 'QGIS Desktop 2.18.x' and select 'Project'->'New' to begin a new project. Then select 'Project'->'Save as', and save the project to the folder created in the beginning of this tutorial. In this example the project will be saved to the 'Arabuko-Sokoke maps' folder and saved as 'Arabuko-Sokoke forest'.

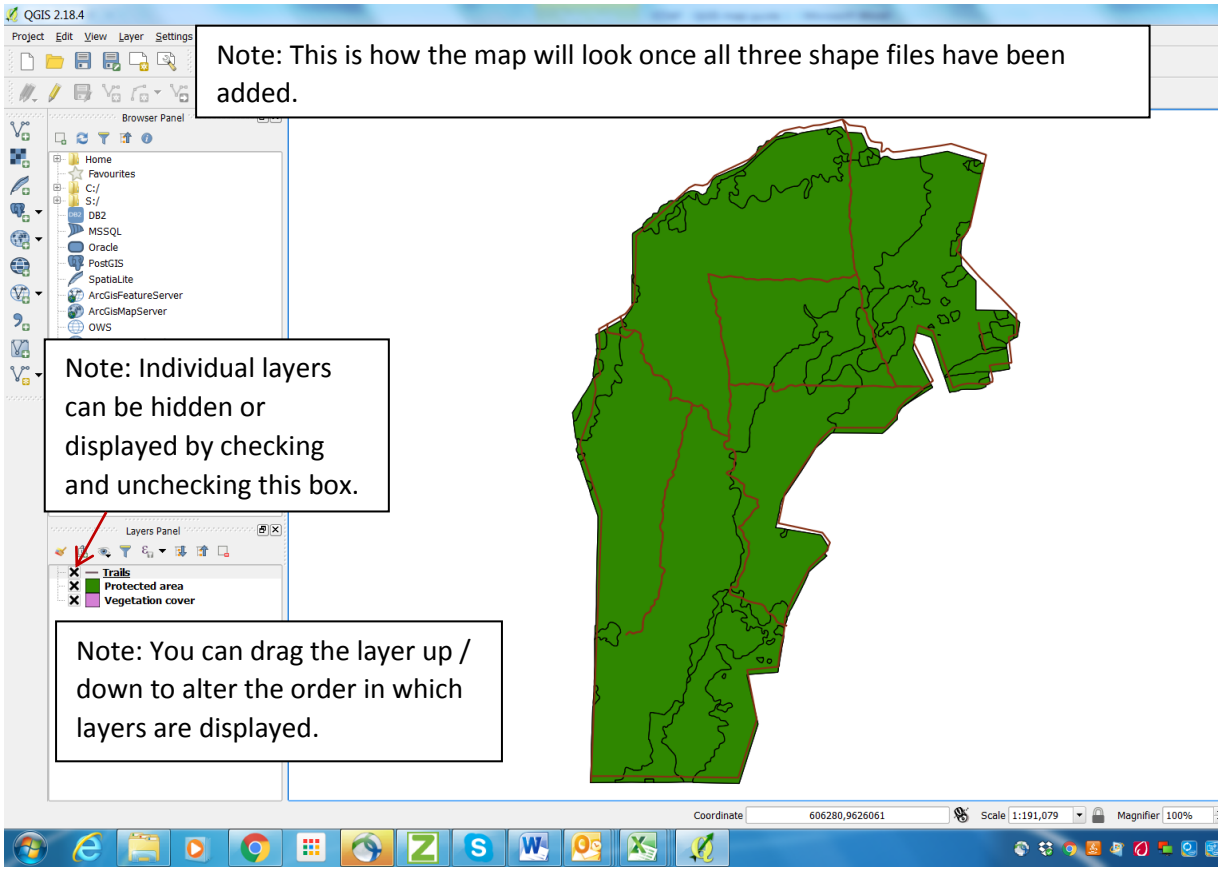




<u>Importing and displaying shape files</u>

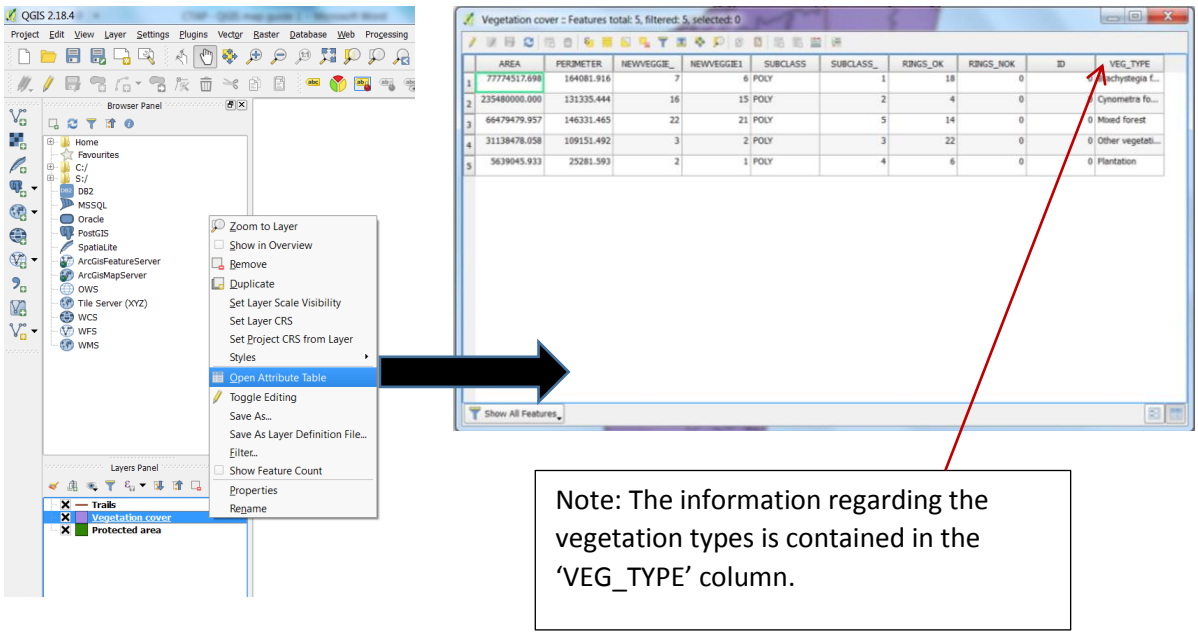
Vector and raster files are used to display features as layers on the map in QGIS. Vector files 'ESRI Shape' files consist of points, lines and polygons which are geospatially referenced. In the case of Arabuko-Sokoke forest we will use the following shape files; Vegetation type, trails around the forest and the protected area boundary. These shape files can be found in the 'shape files' folder (Arabuko-Sokoke forest> Shape files>Features).

Shape files can be imported by selecting Layer>Add Layer>Add Vector Layer. This will bring up a console to import the layer, select browse and choose the required .shp file in this example; Arabuko-Sokoke forest> Shape files>Features>Vegetation cover.shp. Click 'Open' to add the selected shape file to the current project.



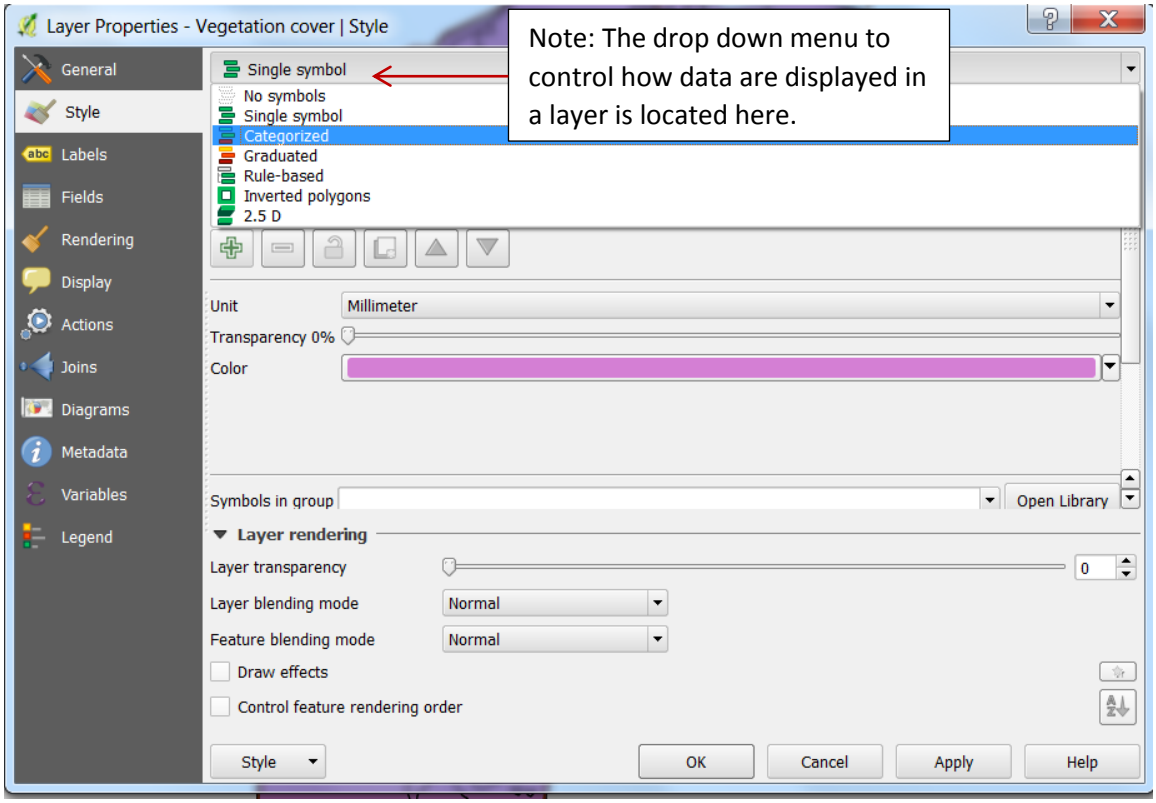
The previous steps are repeated for both the 'Protected area' and 'Trails' shape files to add them to the project.

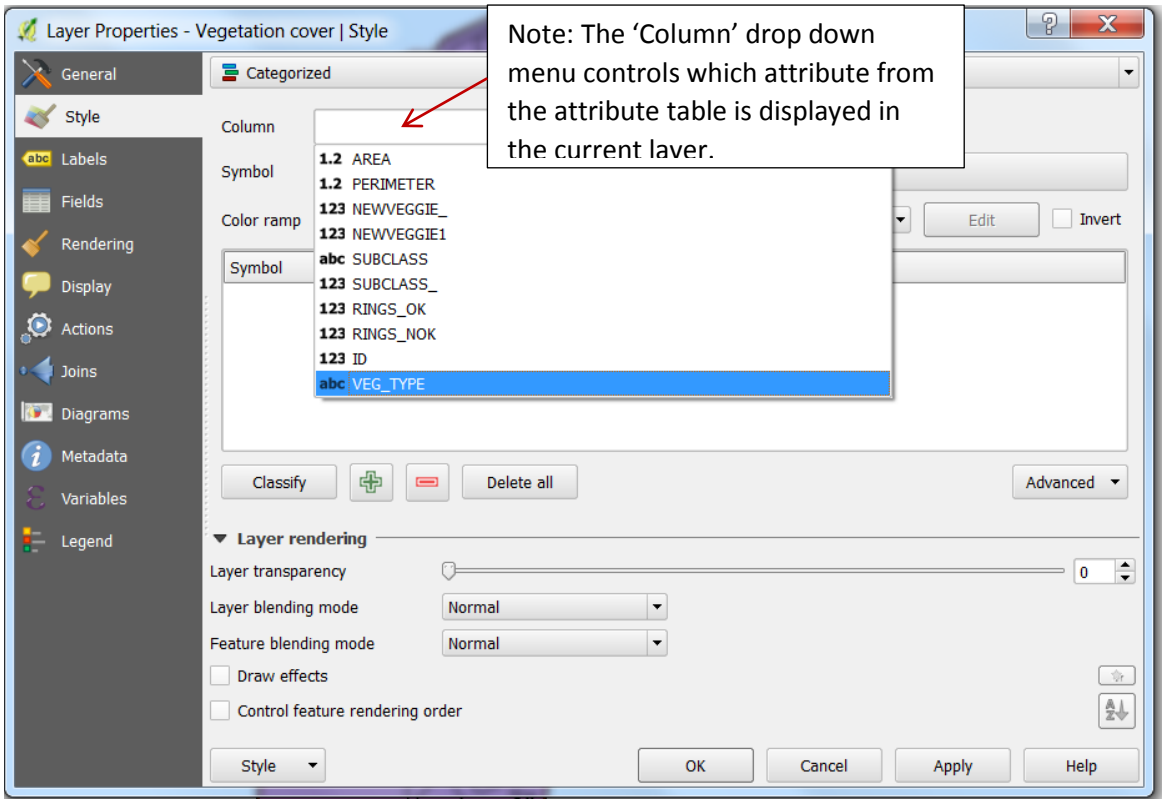
By double clicking on a layer in the 'Layers Panel', the 'Layer properties' console for that layer will be opened. This allows you to view and edit a range of information for the selected layer. To view the attribute table right click the layer in the 'Layers Panel' window and select 'Open Attribute Table'.



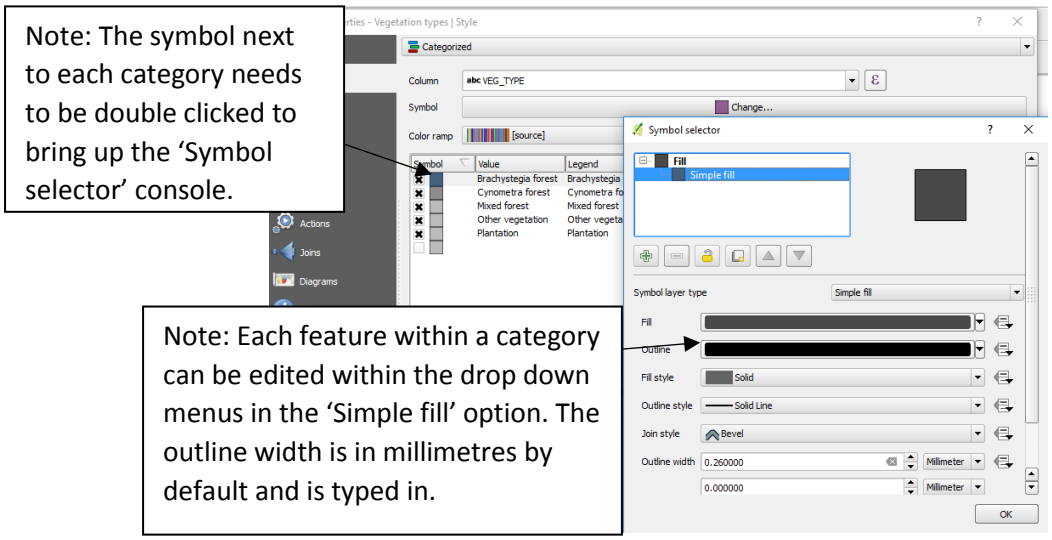
Vegetation cover will be used for this example to change how the vector data symbology is displayed. Double click on the Vegetation cover layer and then select the drop down menu at the top of the 'Layer properties' console under the 'style' tab. This will give a range of options for vegetation type: select 'categorized'. This will render the vector data by displaying different colours for each value of a selected field.

To get QGIS to display the vegetation types in different colours, select the 'VEG_TYPE' from the 'column' drop down menu, as the attribute table for the shape file indicated the relevant data was contained in that column.



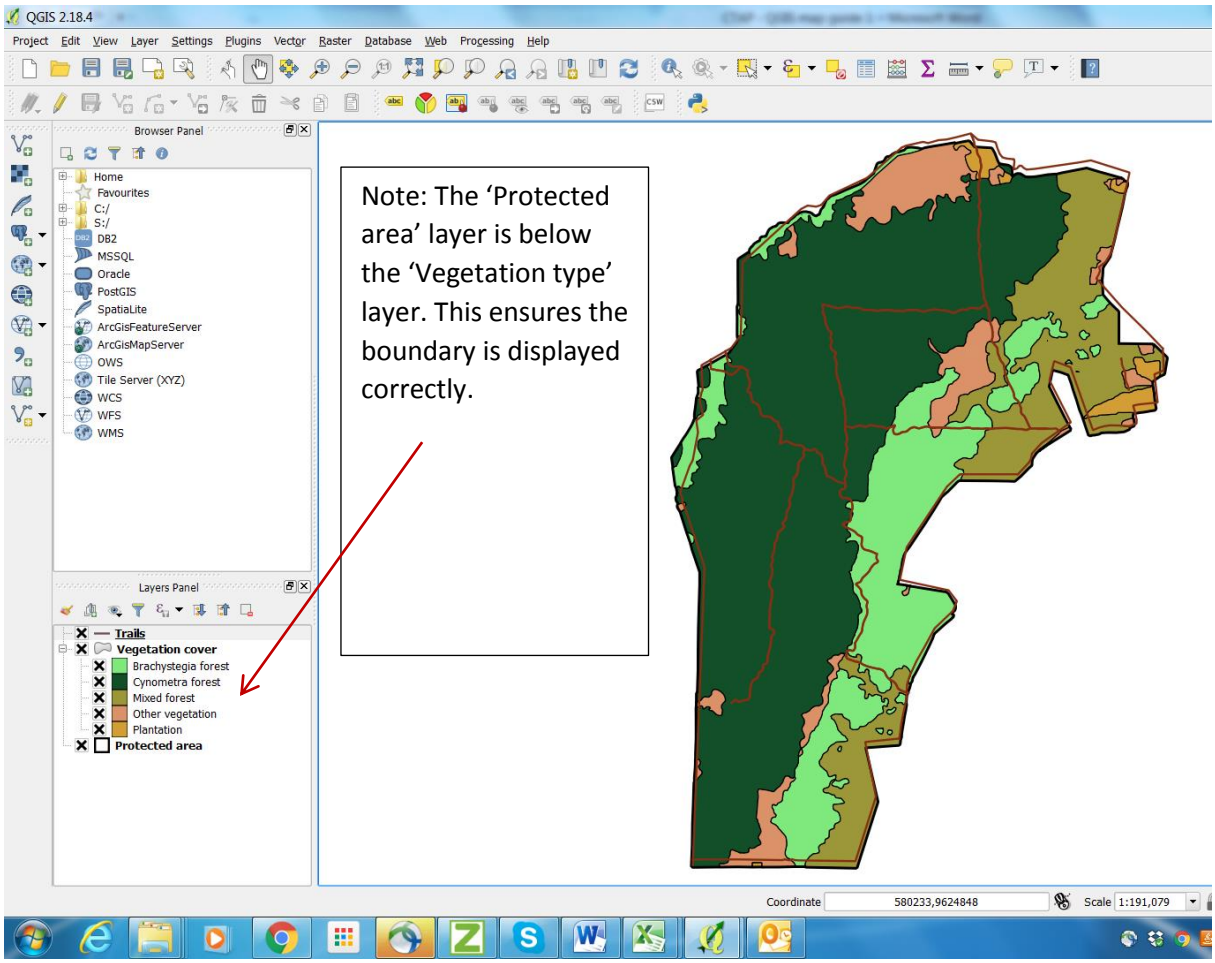


Once the correct attribute has been selected from the 'Column' drop down menu click the 'Classify' button. This will classify the data selected in the 'Column' drop down menu. To change the fill and outline of each category, double click on the symbol of the category to be modified in the 'Symbol' column. This will bring up the 'Symbol selector' console. Then select the 'Simple fill' option to alter the features of how the category will be displayed. Select appropriate colours for the different vegetation types.



In this example for the 'Protected area' and 'Trails' layers 'Single Symbol' (default) is selected from the drop down menu at the top of the 'Layer Properties' console, which means that a single style is applied. The fill for the 'Protected area' layer is set to 'transparent fill' and outline to 1mm. The 'Trails' layer needs to have the line colour changed to brown and the width set to 0.5. The image

below shows what the map should look like after the steps above have been followed. The map is now ready to have the camera trap location layer added.



Saving shape files

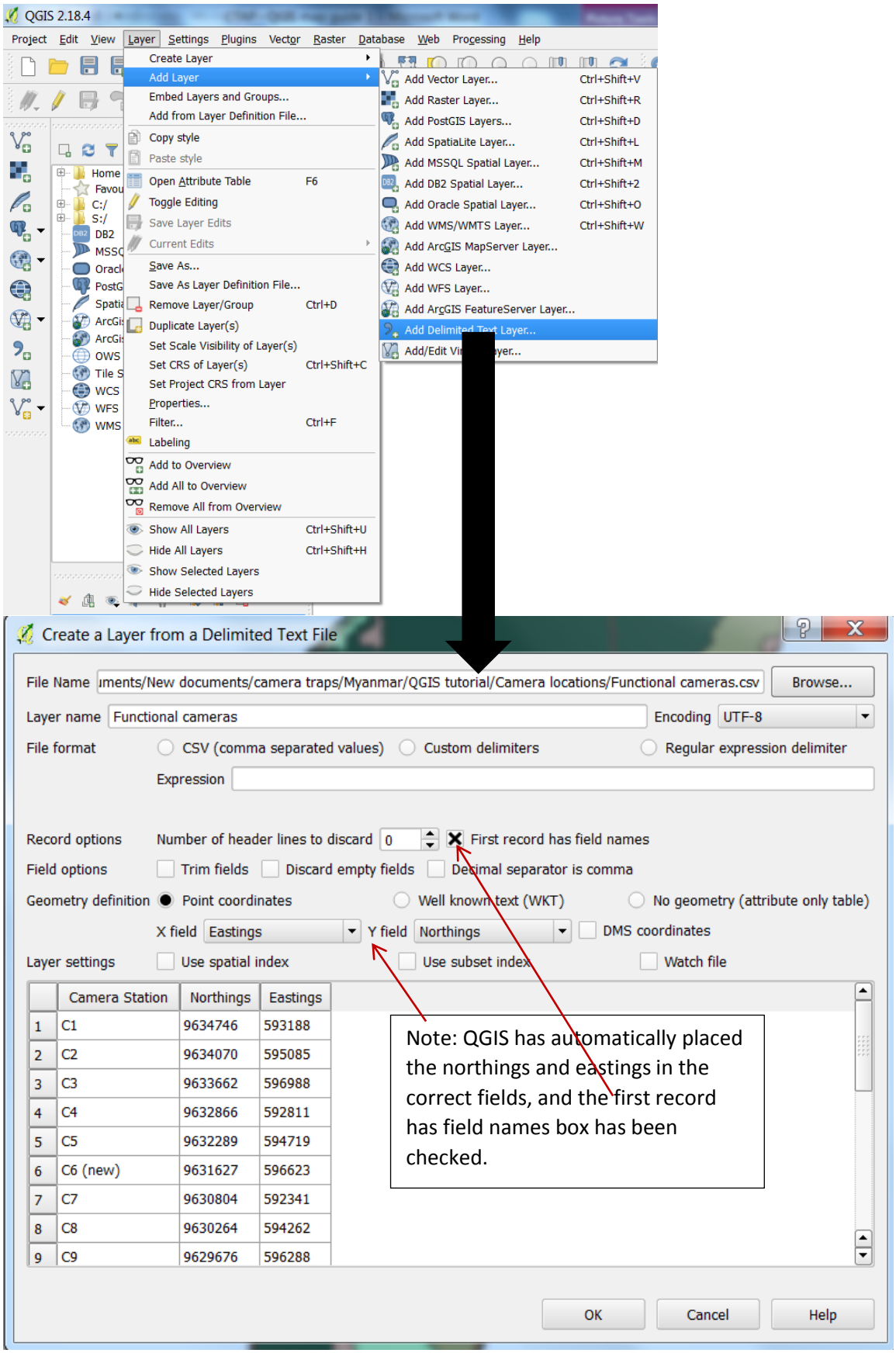
Shape files and their formatting can be exported and saved, t allowing backups of shape files to be created and sent to other QGIS users. This is done by right clicking the layer to be saved in the 'Layers Panel' and selecting 'Save As Layer Definition file…'. This brings up a dialogue box where the location that the shape file should be saved needs to be selected and the shape file named. Once this has been completed click 'Save', QGIS will then export the layer to the selected location. In this example all shape files have been saved to Arabuko-Sokoke maps>Shape files.

Importing and displaying camera trap locations

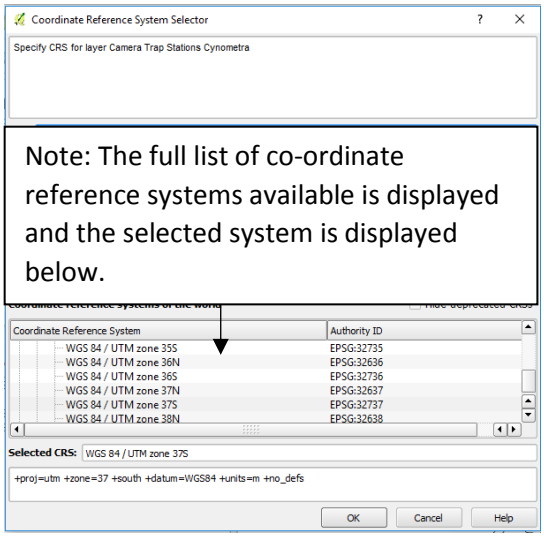
Camera trap locations are imported from the .csv file created earlier; by choosing Layer>Add Layer>Add Delimited Text Layer, then using the 'Browse' button and selecting the relevant file. In this example Arabuko-Sokoke maps>Camera locations>Functional cameras.csv.

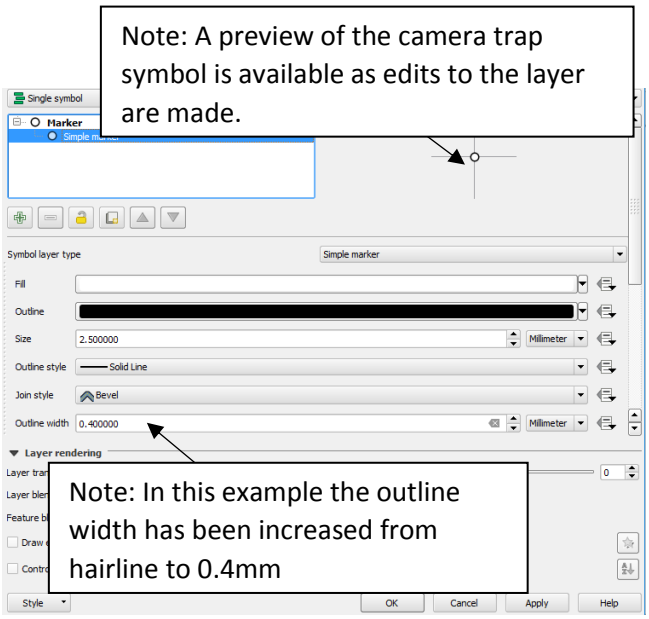
If the file is formatted correctly QGIS should automatically detect the northings and eastings headings and place them in the correct field. Press 'OK' to bring up the 'Co-ordinate Reference System Selector' console. This will be the same as the co-ordinate reference system used to import the data into the tool. In this example UTM was used and the zone the survey was conducted in was

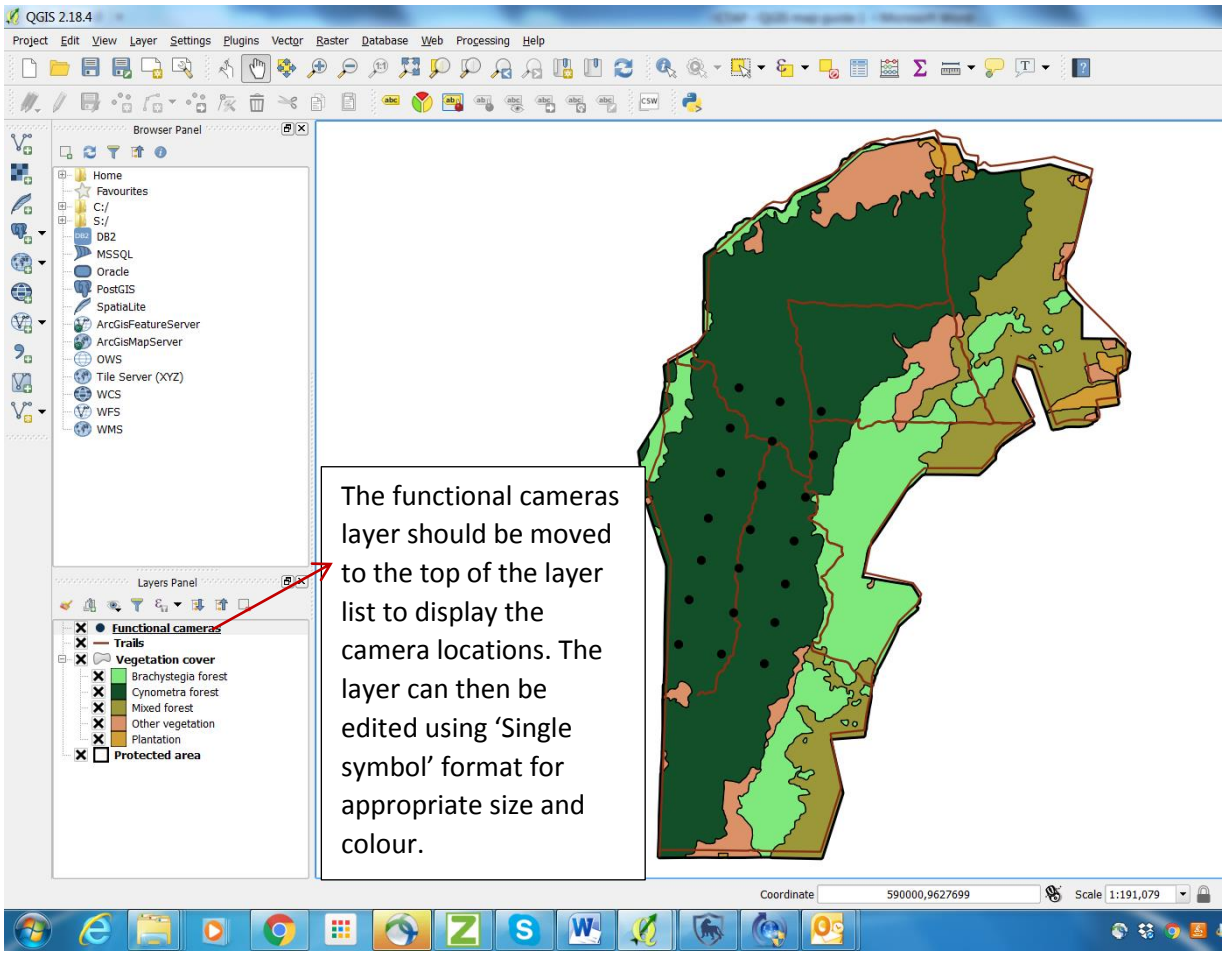
37S so the 'WGS 84 / UTM Zone 37S' option is selected.



The functional cameras layer should be moved to the top of the layer list to display the camera locations. The layer should then be edited in the same way as the other shape files that were imported previously, using 'Single symbol' format for appropriate size and colour.



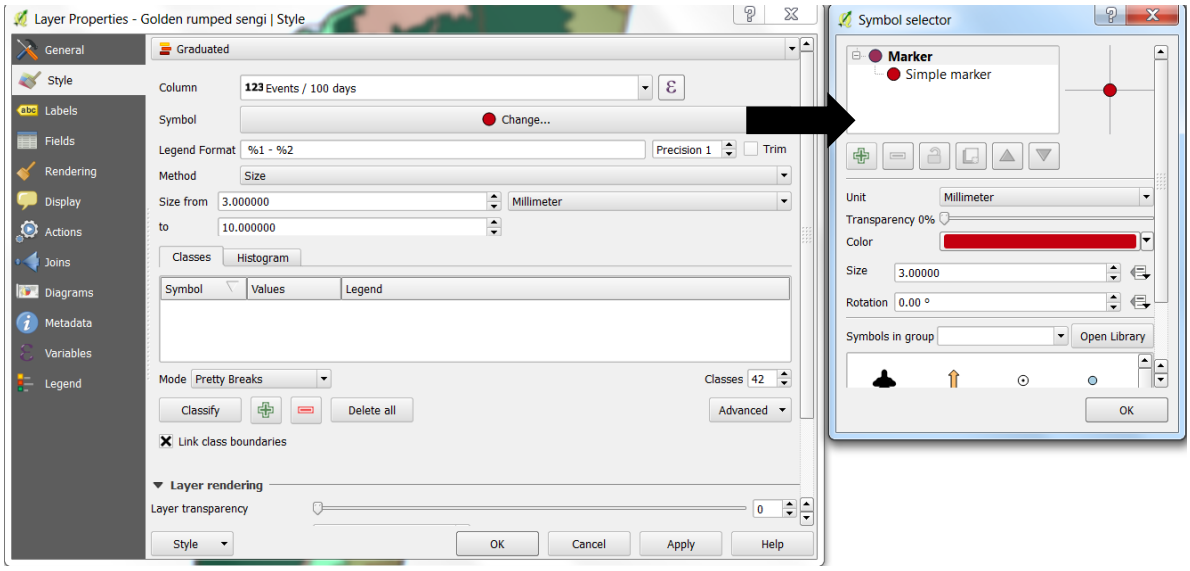




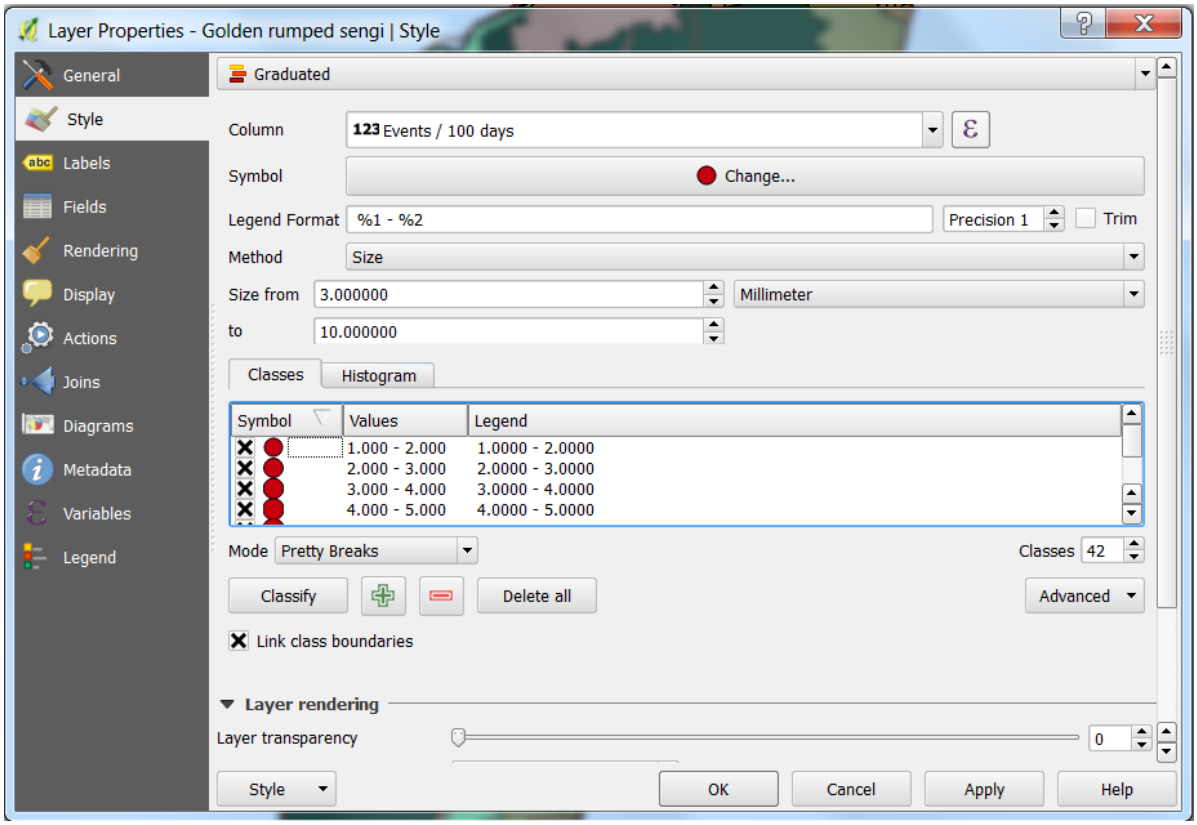
Importing and scaling species trapping rates

Species trapping rates are imported into QGIS using the same process as camera trap locations. By choosing Layer>Add Layer>Add Delimited Text Layer, then using the 'Browse' button selecting the relevant file. In this example Arabuko-Sokoke maps>Species trapping rates>Golden rumped sengi.csv. As the correct co-ordinate reference system was used to import the camera trap locations QGIS will automatically choose WGS 84/ UTM 37S.

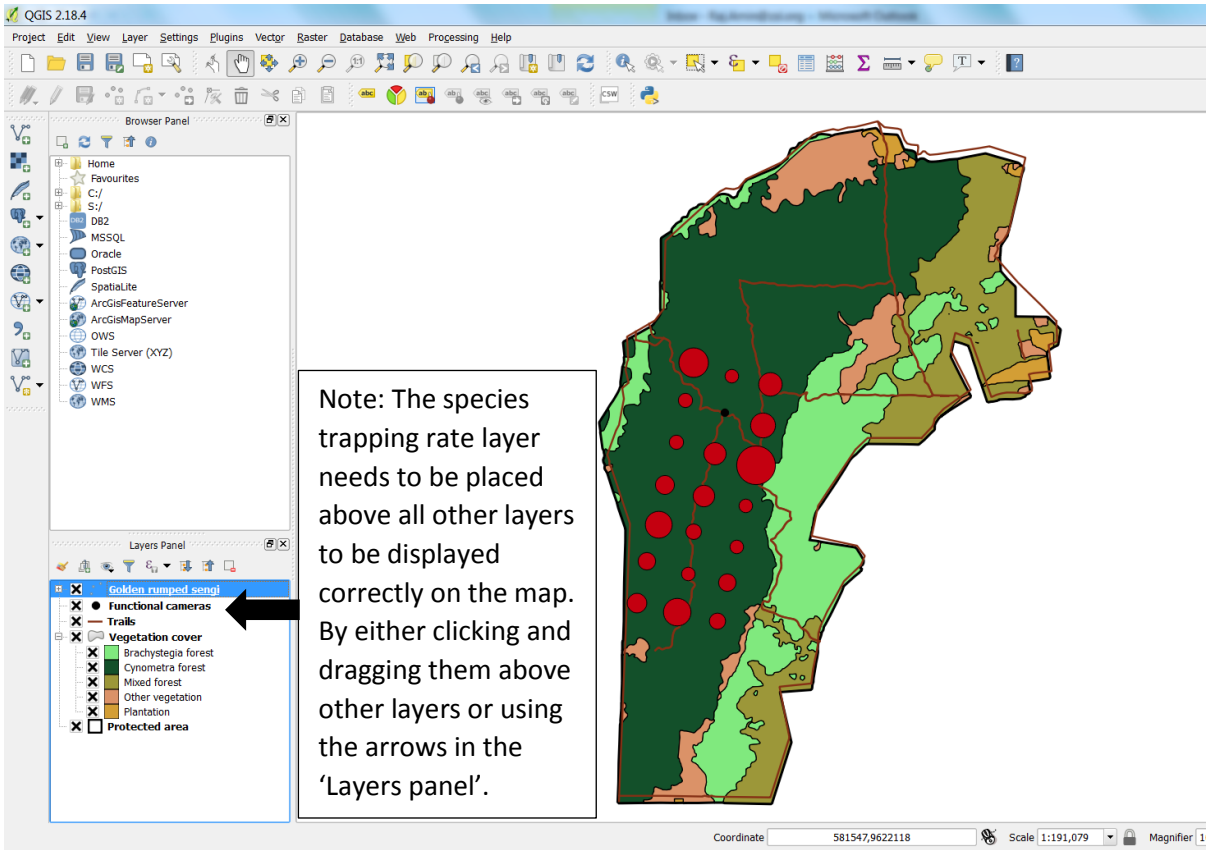
The species trapping rates layer then needs to be edited to display the trapping rate per 100 days at each camera trap location proportional to one another. To do this 'Graduated' rendering of the vector data is required, this will display the symbols proportionally to one another based on the selected attribute. Select the 'Graduated' option from the top bar of the 'Layer Properties' console. Having viewed the attribute table for the 'Golden-rumped sengi' layer, to display the trapping rate per 100 days at each camera the 'Events / 100 days' column needs to be selected in the 'column' drop down menu. To display the symbols as different sizes rather than colours, 'Size' needs to be selected from the 'Method' drop menu. The size of the smallest and largest symbols can then be specified in the relevant fields (**NB** it is important the size of the smallest trapping rate is larger than the camera trap locations symbol, to ensure it is totally covered when the species is present at a location). The appearance of each symbol can be edited in the same way as other layers by clicking the 'Change…' button, which will bring up the 'Symbol selector' console.



The final step in formatting how the trapping rates at each camera trap location are displayed is to scale the symbols relative to one another. This is achieved by setting the 'Mode' to 'Pretty Breaks' and the number of classes in the 'Classes' option to the large scaling point value minus one to have in this example 42 classes (1-2, … 42-43). This allocates each increase of trapping rate per 100 days by one its' own specific size class. Click 'Classify' and confirm that the classification has occurred correctly. 'OK' can then be clicked to complete the changes to the selected layer. This layer can then be saved as the name of the species in the relevant folder.

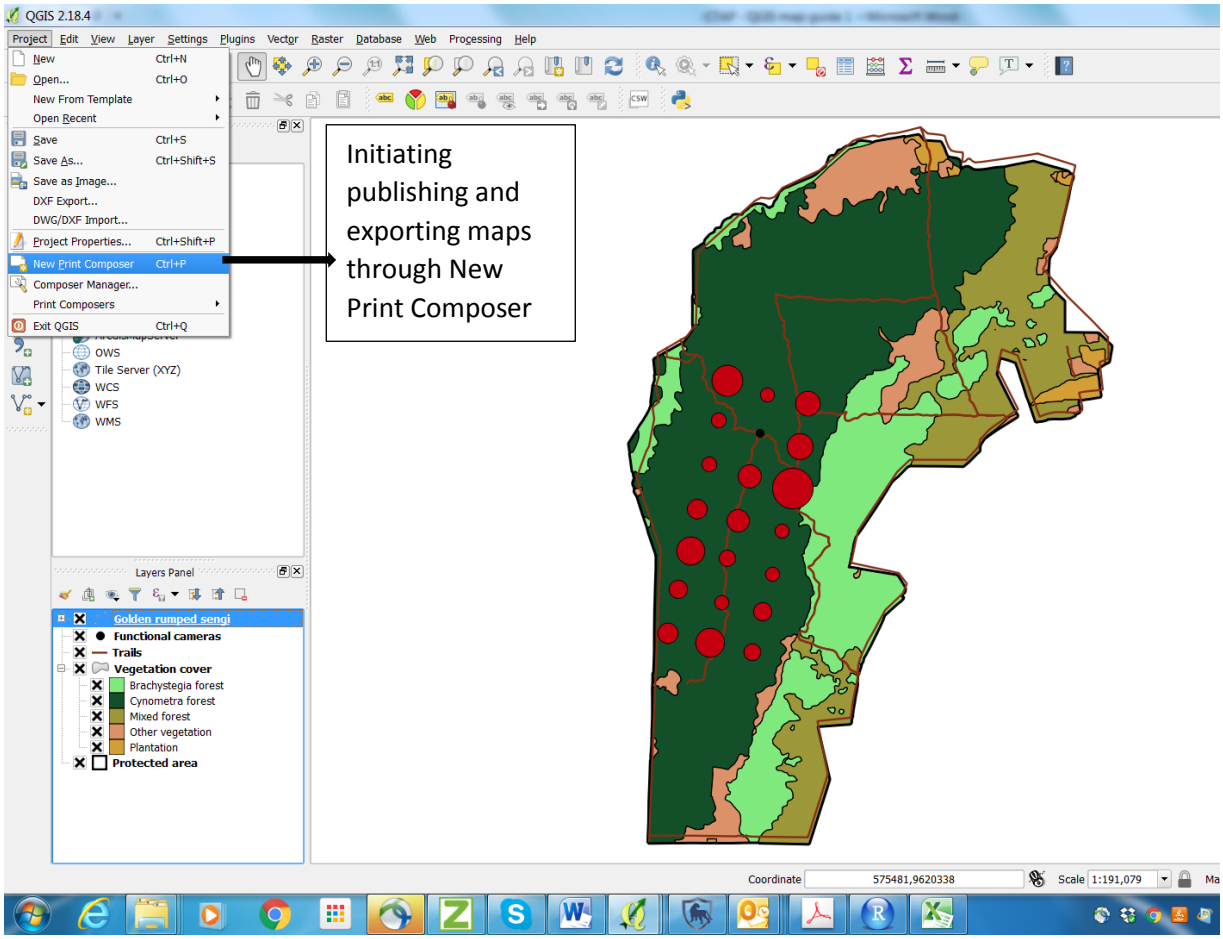


The images below demonstrate how the species trapping rate layer will appearance in QGIS after following the steps outlined above. As camera stations with zero trapping rates values were removed from the data prior to import, the camera trap location symbol in the layer below the species trapping rate layer is visible when the species was not detected at a camera trap. This process needs to be repeated for all species that require distribution maps. Once this is complete the maps are now ready to be exported.

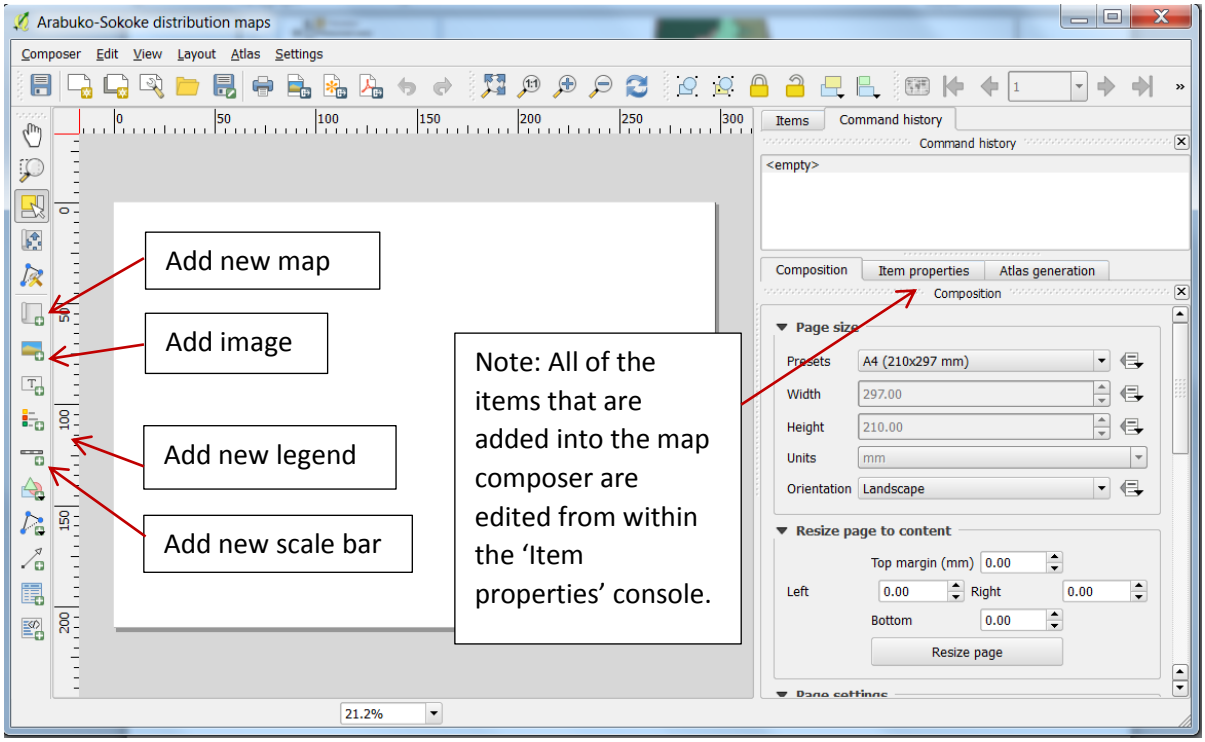


Publishing and exporting maps

To begin publishing a map, a new 'Print Composer' needs to be created by clicking Project>New Print Composer. This will bring up a dialogue box where the print composer needs to be given a title; in this example it is called 'Arabuko-Sokoke species distribution maps'.



This will then generate a new print composer. There are four key functions used to publish maps for export: ‘Add new map’, ‘Add new legend’, ‘Add new scale bar’ and ‘Add image’. These are highlighted in the image below



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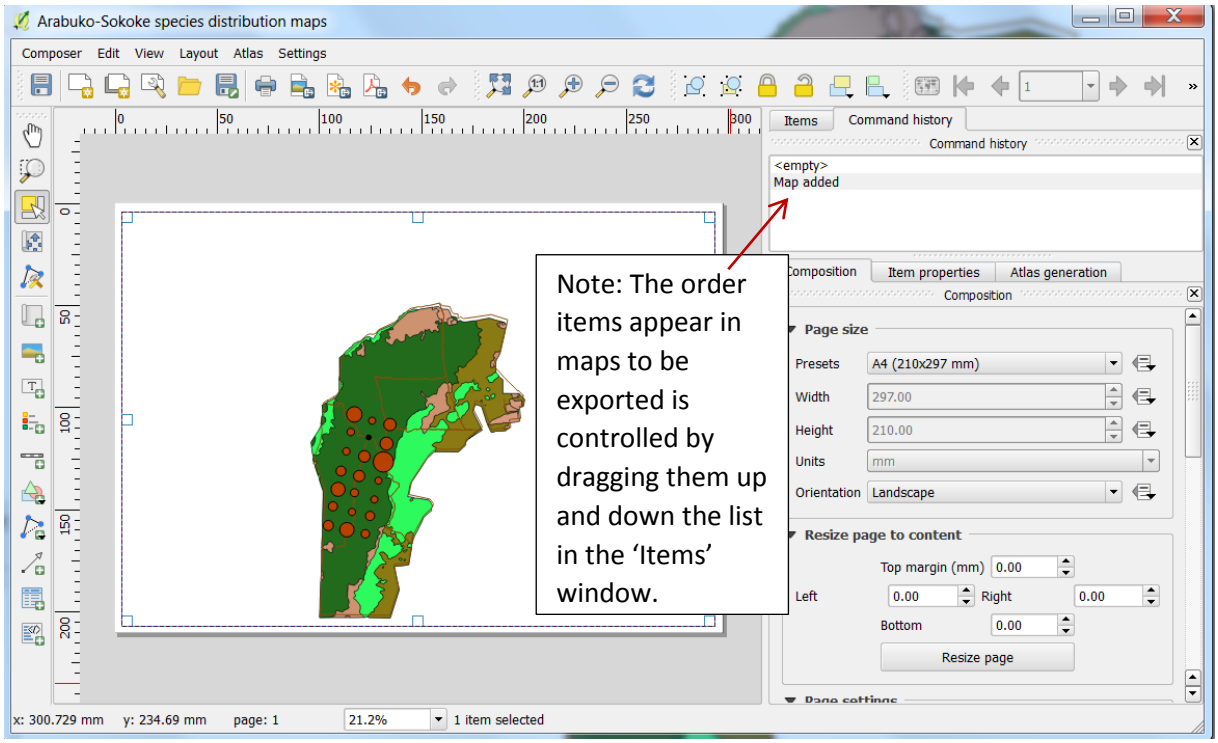
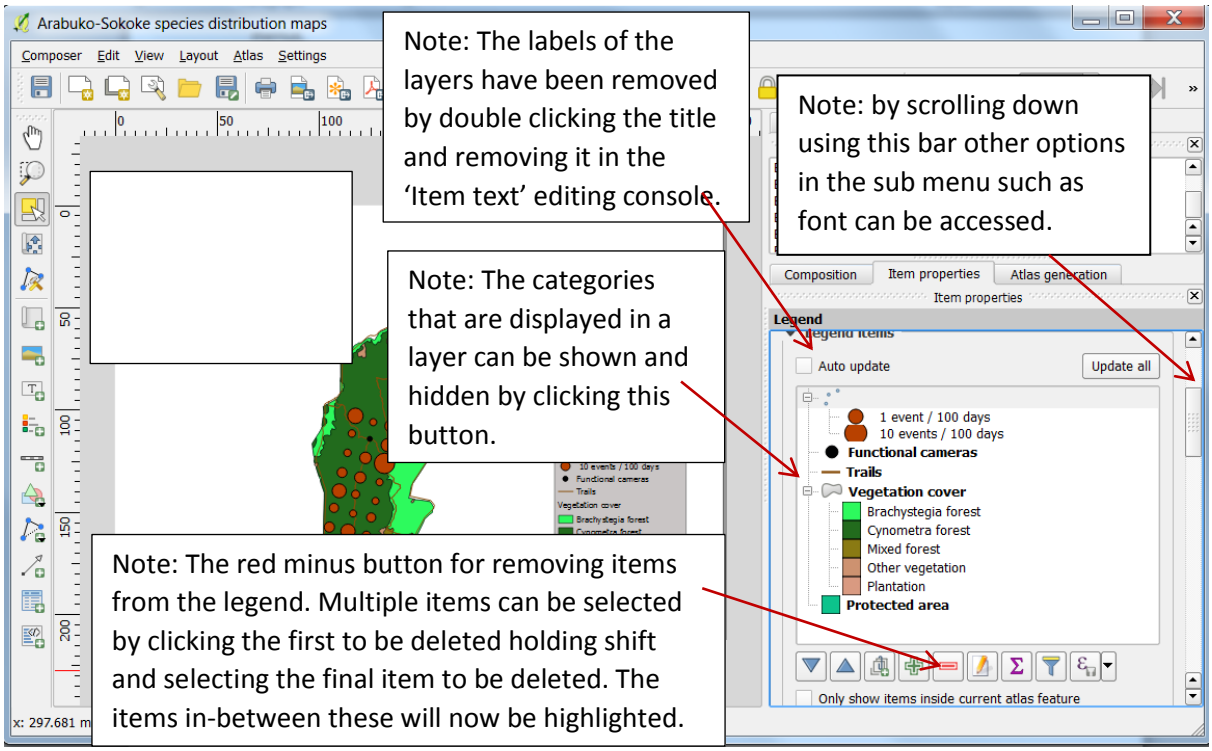
The first step is to zoom and position the map in the main project window as you would like to appear in the print composer and also selecting the appropriate 'Species distribution' layer. Next add the map by clicking on the Add new map icon. This will bring up a cursor, click and drag from the top left corner to the bottom right of the white area so the red box covers the perimeter and release the click. This will import the map into the composer.



To add a legend to the map in the composer click the 'Add new legend' icon and click and drag a rectangle of the approximate size of the desired legend. The properties of the legend are edited the 'Item properties' console.

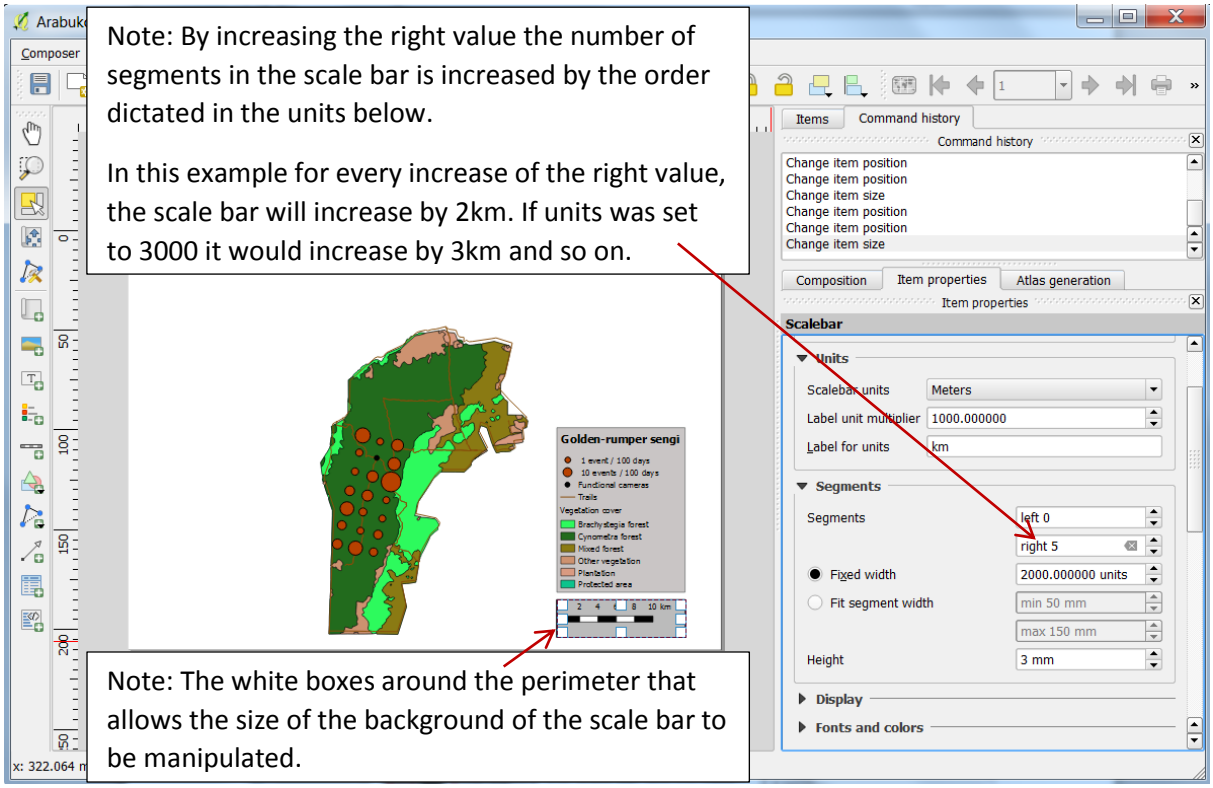
The Legend title can be changed, in this case left blank as the species name is in the layer name. Within the 'legend items' sub-section 'Auto update' should be unchecked; this allows the manual manipulation of the symbols and their properties displayed in the legend. All species other than the one having a map currently being produced need to be removed by highlighting the species and deleted using the red minus button at the bottom. The individual symbols to be displayed for each species can be displayed and edited by pressing the 'plus' button next to the layer file. In this example, we only want to display 1 event / 100 camera trap days and 10 events / 100 camera trap days. The other symbols should be removed using the same method as above, by highlighting and pressing the red 'minus' button. The labels for each item in the legend are edited by double clicking the text which will bring up the 'Item text' editing console. The labels of each layer can be removed from the legend by deleting the text in the 'Item text' editing console and clicking 'OK'.
Within the 'Item properties' console the font, size and height of categorised symbols, spacing between items, frame and background of the legend can all be edited within their respective sub-menus.

Once all these have been edited to the style desired, the legend can be positioned on the map by dragging and dropping it or using the arrows on the keyboard.

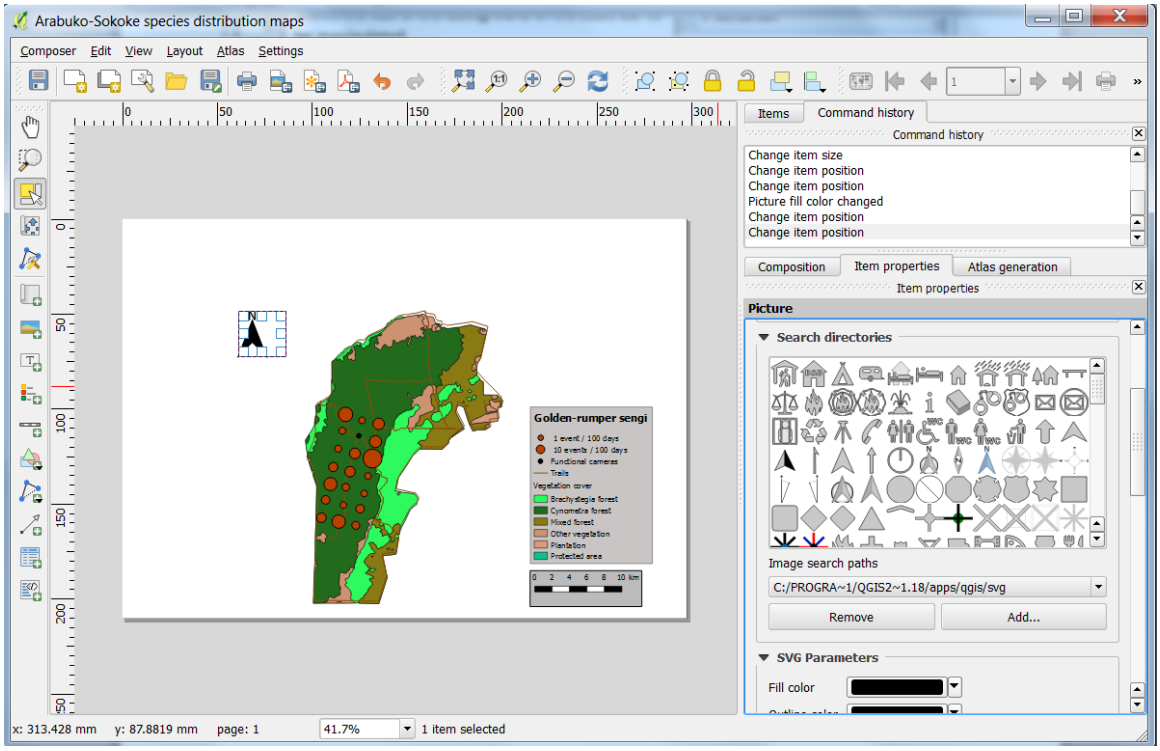


A scale bar is added by clicking the 'Add new scale bar' button, and dragging a box using the cursor the approximate size of the required scale bar. Again the features of the scale bar can be edited in the 'Item properties' console including font, background and scale. The units displayed can be selected within the units sub-menu; in this example kilometres is used which is the default setting

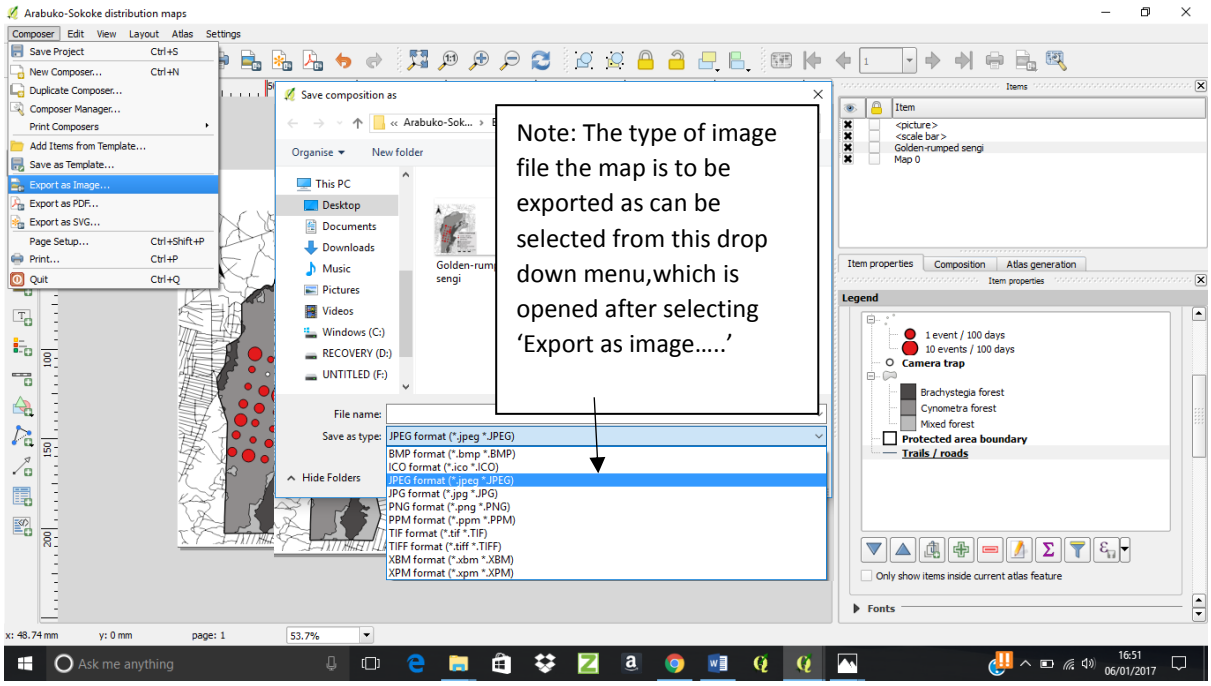
for UTM. Once edited, the scale bar can be positioned beneath the legend by dragging using the mouse and fine-tuned using the key board arrows. The width and height of the scale bar background can be edited by clicking on the bar and dragging it using the white boxes that appear around it's perimeter.

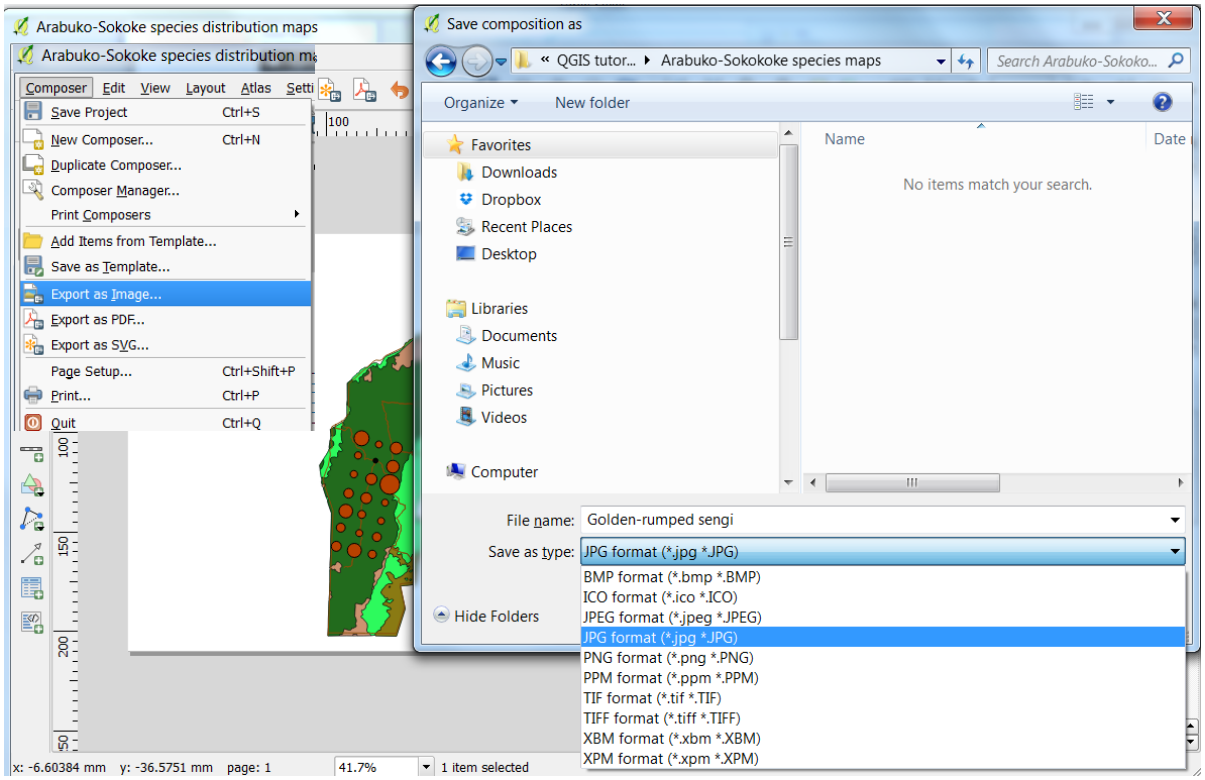
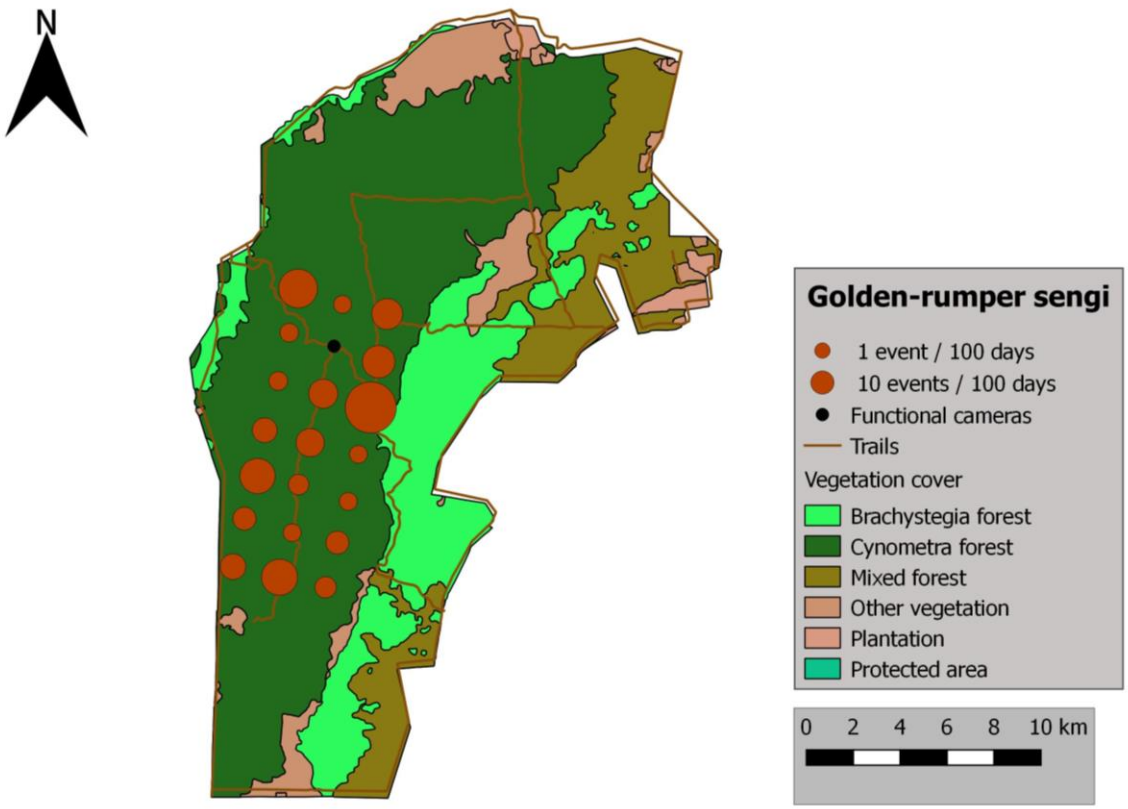


To add a North arrow to the map click the 'Add image' button to bring up the 'Search directories' sub-menu. Within the 'Search directories' sub-menu press the 'Add' button to load the default images provided by QGIS. Select the desired North arrow and drag the cursor to draw the size of North arrow that is required. This will then be inserted into the composer; the fill and size of the arrow can be edited in the same way as the other items previously imported into the composer.



Once the map has been checked it is now ready to be exported and saved. This is done by clicking 'Composer>Export as Image….'. This will open a dialogue where the location the map is to be exported to is chosen. In this example it will be saved in 'Arabuko-Sokoke species maps>Golden-rumped sengi.jpg.' The resolution, page height and page width of the map can be altered in the 'image export options' console, once the settings have been confirmed click 'OK' to export the map.





The above process needs to be repeated for every map that is going to be produced. The image below is the final map exported from QGIS using the steps outlined above.