

Geographical Information Systems-(ACCA5027)

QGIS and Data Visualisations

Aim

In this session, students will gain exposure and familiarity to using GIS software, specifically the open-source software Quantum GIS (QGIS, <https://www.qgis.org/>).

During the session, students will:

- be introduced to the QGIS Graphical User Interface (GUI),
- input example data layers (vector and raster) into the mapping environment
- import a comma-separated value (CSV) dataset
- explore attribute tables
- identify features
- add base maps
- symbology

1. Graphical User Interface (GUI)

On the next page students will find an annotated screenshot (Figure 1) of the QGIS Graphical User Interface (GUI), the visual environment used to provide access to visualised mapping of GIS data, and the toolsets for interrogation and analysis.

Note: the Figure 1 below shows data layers in the Map View window, which are example layers only. On loading QGIS initially, student's Map View will be blank (white) and, therefore, no data will be present until loaded.

Take time looking at the different components and familiarising where they are. If you are unsure, you can hover the cursor over an icon and a pop up window should emerge with a name / description.

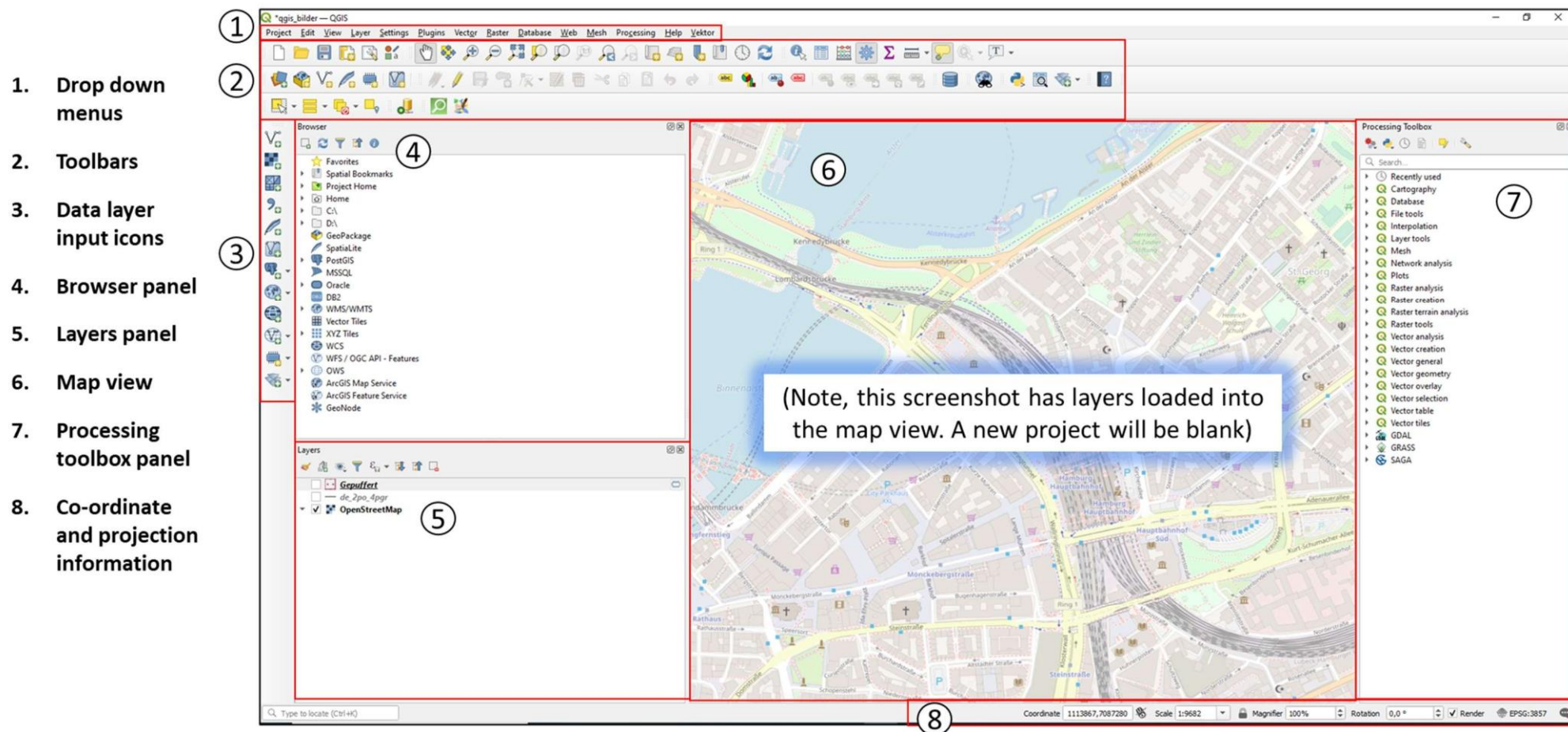


Figure 1: Annotated QGIS GUI

2. Data import

In order to visualise and analyse data, spatial datasets need to be brought (imported) into the GIS software. There are a number of ways of doing this within QGIS. These are as follows:

1. 'Layer' Drop down menu
 - ☐ Add Layer
 - ☐ Select data type you wish to import
 - ☐ Navigate to file location in Windows directory
2. Data layer input icons
 - ☐ Select data type you wish to import e.g. vector or raster
 - ☐ Navigate to file location in Windows directory
3. Browser panel
 - ☐ Navigate to file location using file directory
4. Drag and drop
 - ☐ Locate your file in Microsoft Documents window
 - ☐ Click on the chosen file and drag it into the QGIS Map Viewer

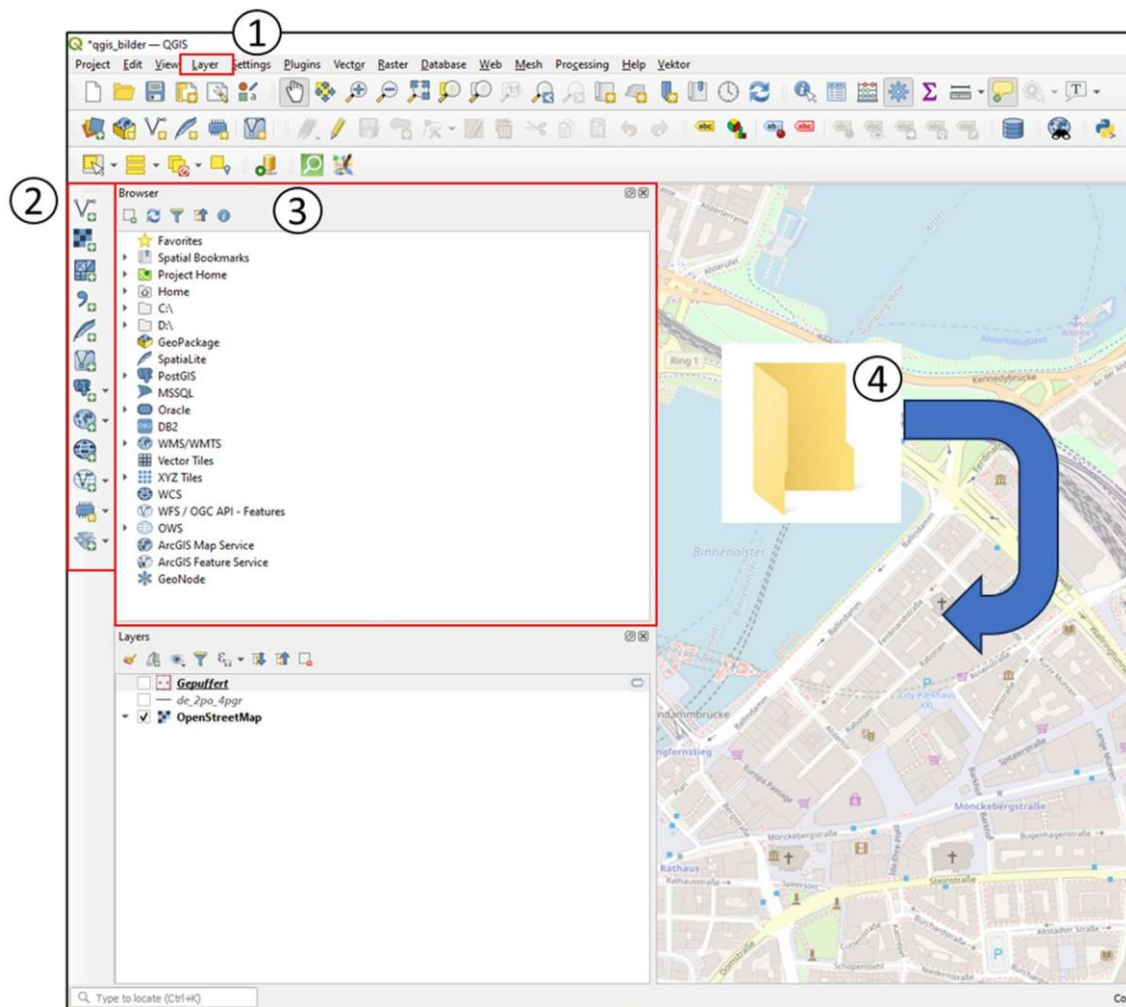


Figure 2: Methods for importing data into QGIS

Within the module Moodle page, there is a folder called 'QGIS Sample Data Oct' that contains example datasets; a raster file (a GeoTiff – '.tif') and vector polygon files (shapefile – '.shp', and Geopackage – '.gpkg'):

- The example Geotiff's are contained within a compressed folder called:
 'Over_gb.zip' o These are Ordnance Survey (OS) Overview rasters o <https://osdatahub.os.uk/downloads/open/GBOverviewMaps> o Note there are two GeoTiff's: 'GBOverview.tif' and 'GBOverviewPlus.tif' □ The example Shapefile is contained within the compressed folder called
 'NRW_SSSI.zip' o These are NRW's SSSI polygons
 o https://datamap.gov.wales/layers/inspire-nrw:NRW_SSSI o Note the Shapefile is a collection of associated files (same file name, different file ending).

-  NRW_SSSI.cst
-  NRW_SSSI.dbf
-  NRW_SSSI.prj
-  NRW_SSSI.shp
-  NRW_SSSI.shx

- An example vector Geopackage file is also provided for the NRW dataset o This is the same data, stored in a different format (Geopackage instead of Shapefile).

In order to import the data into QGIS:

1. Download the folder from Moodle
2. Extract the contents of the compressed folder downloaded from Moodle (this will be located in the 'Downloads' folder)
3. Using the four import methods detailed above, practice importing the sample datasets provided into QGIS.

3. CSV import

Some datafiles are not packaged ready for GIS. Often, point-source data collected in the field, is collected in a simple table format called a Comma-Separated Values (CSV) table.

Effectively, this is a text file, by which:

- Each row determines an individual record
- Each discrete attribute value is separated by a comma

By separating each value, the user defines the attribute (column) number. See Figure 3 for an example.

Raw text file

Raw text file, delimited by commas into a table

ID	Scientific name	Common name	Kingdom	Phylum	Class	Order	Family	Genus
1	Sturnus vulgaris	Starling	Animalia	Chordata	Aves	Passeriformes	Sturnidae	Sturnus
2	Columba livia	Rock Dove	Animalia	Chordata	Aves	Columbiformes	Columbidae	Columba
3	Leccinum scabrum	Brown Birch Bolete	Fungi	Basidiomycota	Agaricomycetes	Boletales	Boletaceae	Leccinum
4	Aegithalos caudatus	Long-tailed Tit	Animalia	Chordata	Aves	Passeriformes	Aegithalidae	Aegithalos
5	Deschampsia cespitosa	Tufted Hair-grass	Plantae	Tracheophyta	Magnoliopsida	Poales	Poaceae	Deschampsia
6	Pica pica	Magpie	Animalia	Chordata	Aves	Passeriformes	Corvidae	Pica
7	Troglodytes troglodytes	Wren	Animalia	Chordata	Aves	Passeriformes	Troglodytidae	Troglodytes

Figure 3: Example comparison between raw text (left) and derived CSV data in tabular form (right)

Within the sample GIS data folder downloaded from Moodle, an example CSV dataset has been provided for use within this practical.

The sample dataset is an output from the National Biodiversity Network (NBN) online repository of animal sightings / records, located within a 5km radius of Swansea city centre (using <https://records.nbnatlas.org/explore/your-area>)

The file is called: NBN_records_Swansea.csv

You cannot drag and drop CSV files into QGIS as they only load as unprojected attribute tables.

Instead, use the 'Add Layer' > 'Add Delimited Text File', and navigate to the CSV file (Figure 4).

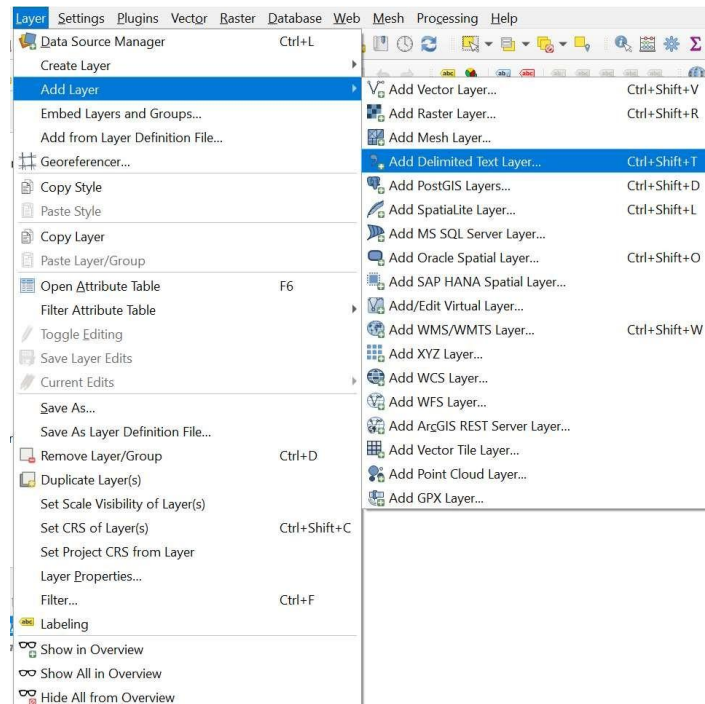


Figure 4: Location of 'Add Delimited Text Layer' tool within QGIS

This will bring up a window that allows the user to select the method for determining how to translate the text file into tabular data, and which columns to extract the geospatial coordinates from (and associated projection).

Data Source Manager | Delimited Text

File name: C:\Users\A.Cunningham\OneDrive - University of Wales Trinity Saint David\Documents\ACNA6003_Lectures_2324\Sample_Data\NBN_sample_data_Oct2023\NBN_records_Swansea.csv

Layer name: NBN_records_Swansea Encoding: UTF-8

File Format

☒ CSV (comma separated values)

☐ Regular expression delimiter

☐ Custom delimiters

Record and Fields Options

Number of header lines to discard: 0

☒ First record has field names

☒ Detect field types

☐ Decimal separator is comma

☐ Trim fields

☐ Discard empty fields

Custom boolean literals

True: False:

Geometry Definition

☒ Point coordinates

X field: Longitude (WGS84) Z field:

☐ Well known text (WKT)

Y field: Latitude (WGS84) M field:

☐ DMS coordinates

☐ No geometry (attribute only table)

Geometry CRS: EPSG:4326 - WGS 84

Layer Settings

Sample Data

	NBN Atlas record ID	Occurrence ID	Licence	Rightsholder	Scientific name	Taxon author	Name qualifier	
	abc Text (string)	abc Text (string)	abc Text (string)	abc Text (string)	abc Text (string)	abc Text (string)	abc Text (string)	a
1	ffffb805-1ae3-4fa2-9546-0d839802d599	62656415	CC-BY-NC	BTO	Sturnus vulgaris	Linnaeus, 1758		S
2	fffc3a3f-b208-486d-b687-4c02ebd89b7c	125898519	CC-BY-NC	BTO	Columba livia	Gmelin, JF, 1789		R
3	fff75e02-b3de-44d6-a868-85f987675d01	LC0002150000PEJV	CC-BY-NC	SEWBRcC	Leccinum scabrum	(Bull.) Gray		B

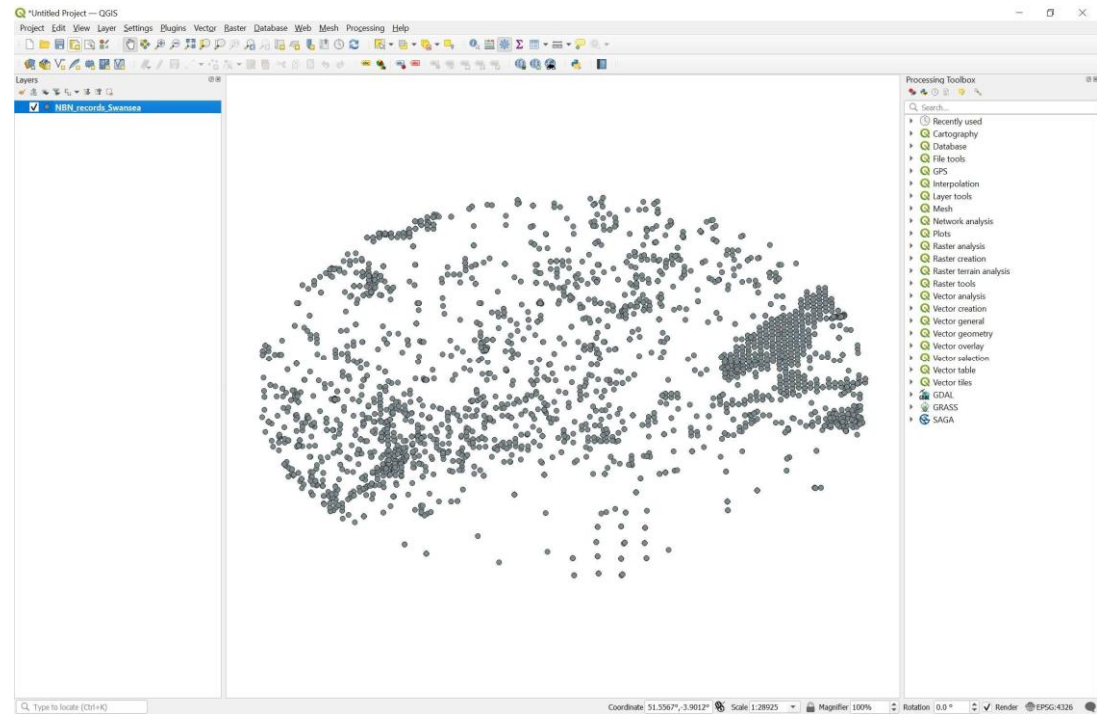
Close Add Help

Figure 5: Delimited text file import parameterisation

In order to import the CSV correctly:

1. Provide the filename (and path) by navigating within the Windows Directory to the saved file. Click on the 3 dots symbol to the right of the 'File name' box.
2. This allows the user to navigate Windows Explorer to the saved file location. Select the downloaded 'NBN_records_Swansea.csv' file
3. Under Geometry Definition, ensure that the 'X Field' and 'Y Field' are 'Longitude (WGS84)' and 'Latitude (WGS84)' respectively, and that the 'Geometry CRS' is 'EPSG: 4326 – WGS 84' (these options should autopopulate, but select them from the drop-downs if they do not).
4. Review the 'Sample Data' rows to see if the output will contain the current column headings and delimiting of rows.
5. Click 'Add' in the bottom right

On completion, the QGIS Map View should not contain points:



4. Viewing / exploring Attributes

Attribute table

Having imported data, it is useful to see what the stored attributed data is that is linked to the spatial elements (polygons or points). While not visible in the Map View window, attributes stored in tabular form can be explored in a separate window.

To access and explore this information, the user can:

1. In the 'Layers' panel (usually on the left-side of the screen), right-click on the layer you wish to see the attributes of; in this case, the 'NBN_records_Swansea' point layer
2. select the 'Open Attribute Table' option
3. a separate window will open containing the tabular attribute data (see Figure 7 below)

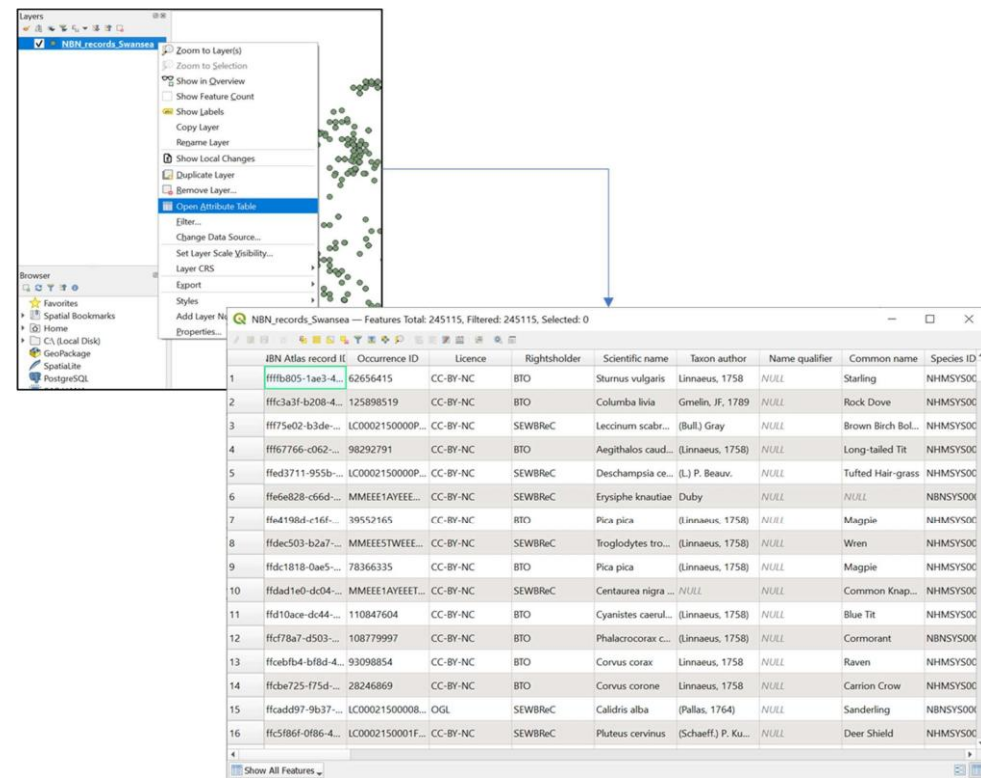


Figure 7: Example of accessing the attribute table for the 'NBN_records_Swansea' layer

Note that the attribute table contains column headings, row numbers, and a feature count in the window header.

Columns can be sorted by clicking on the column header, with the first click being to sort ascending, and the second click being to sort descending.

Clicking on a row ID number will highlight and select a row.

Note, none of these actions modify the data.

Another way to access the Attribute table is via the ‘Open attribute table’ icon () on the toolbar at the top of QGIS. Note, the example below (Figure 8) may be different for some users depending on which toolbars are active.

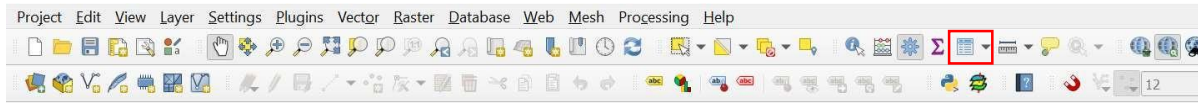


Figure 8: 'Open attribute table' icon location in QGIS toolbar

Identify features

When presented with a number of features spatially in the map view, the user may not wish to view the full attribute table to identify the attributes of just one feature.

If the user wishes to identify the attributes of a discrete feature:

1. click on the ‘Identify’ tool () situated in the toolbar.
2. The cursor will change to a black arrow cursor with an ‘i’ in the top corner, and the ‘Identify results’ panel will appear (by default, usually in the lower right corner of the GUI).
3. Click on a location in the Map View window, either a vector feature (shape, point, line) or raster pixel
4. The co-ordinates (X and Y) of the clicked location will be interrogated against any layers that overlap that co-ordinate, and the associated attributes of those features will be displayed in the ‘Identify results’ panel.
5. With the sample data provided, try clicking on an NRW_SSSI polygon (see Figure 9 below)

Note that attribute results can be displayed for multiple overlapping layers at the clicked co-ordinate (X,Y).

The attribute data can be displayed in multiple formats (tree, table, and graph), though these will be described in later sessions.

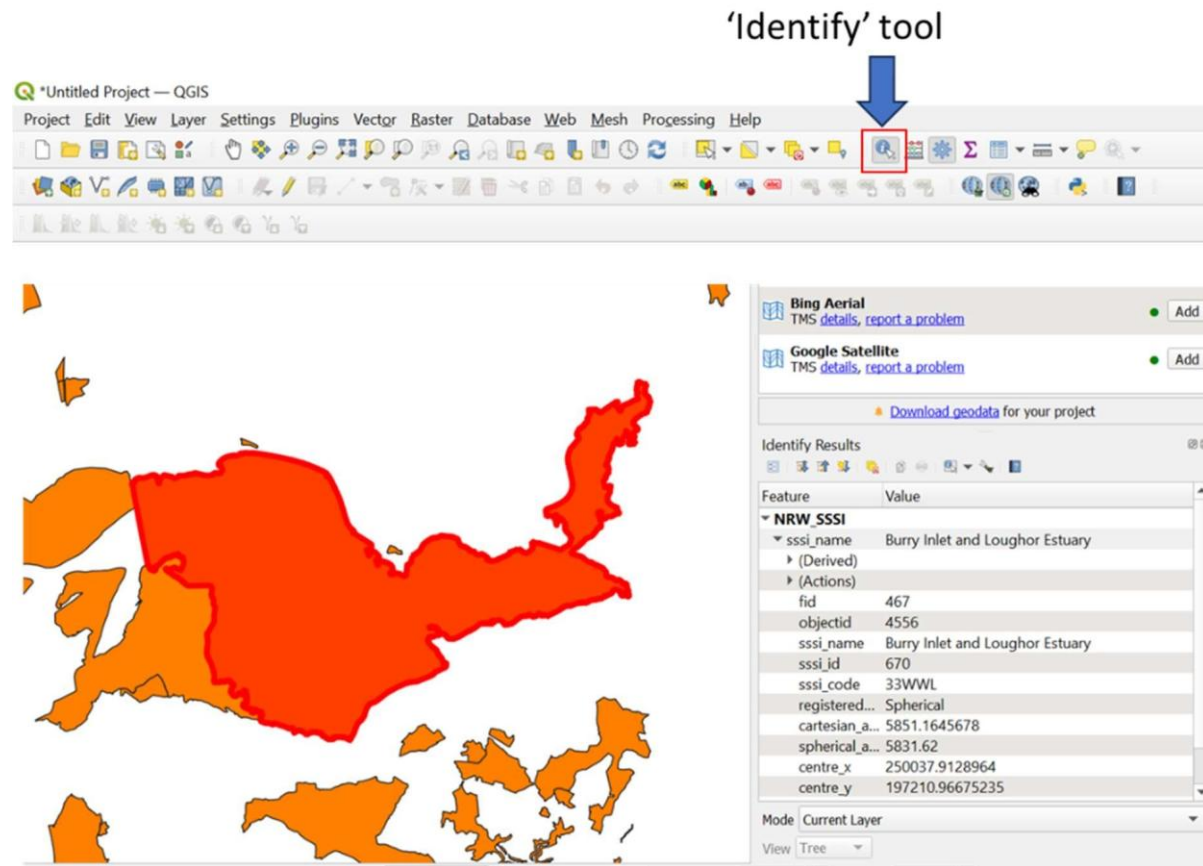


Figure 9: Example of 'Identify tool' utilised on NRW_SSSI data layer

Add base maps

In order to aid visual interpretation of the input data, it can be useful to add base maps.

Typically, base maps are datasets with thematic contextual information e.g. streets, topography, physical landscape features.

They allow the user to relate (spatially) the data they have imported into the GIS system to other features of reference within the vicinity.

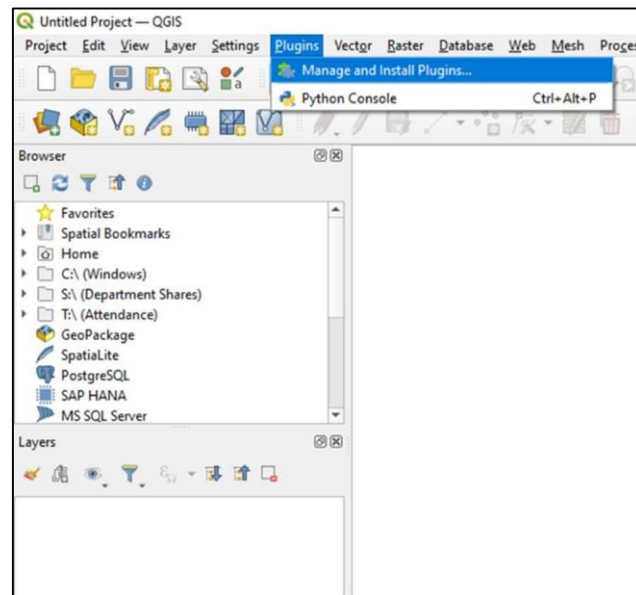
There are several ways to add base maps, in this example the 'QuickMapServices' plugin will be used.

Plugins are additional software, not included as part of the initial software package, but compatible with, that add functionality.

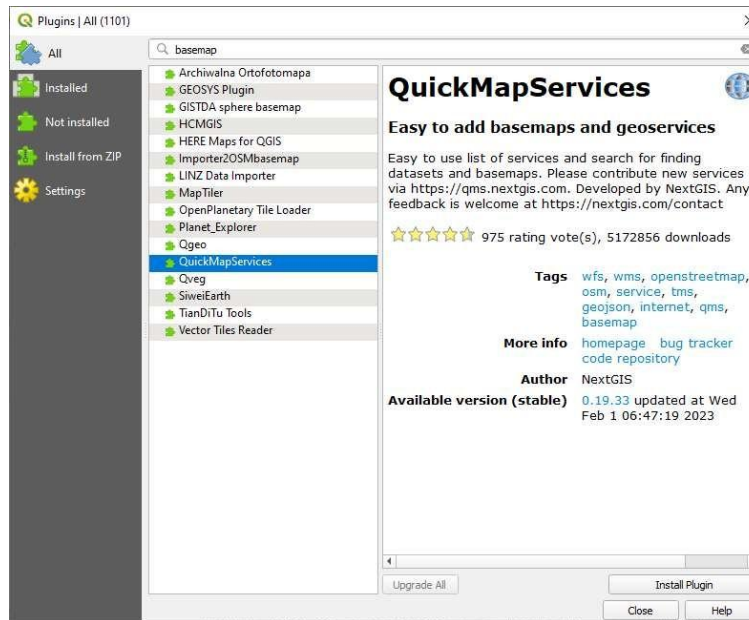
Usually, a plug-in contains a discrete set of functionality e.g. specific toolsets like a profile tool, or adding base maps

To install the QuickMapServices plugin:

1. Click on the 'Plugins' drop-down at the top of GUI 2.



3. The 'Plugins' window will emerge



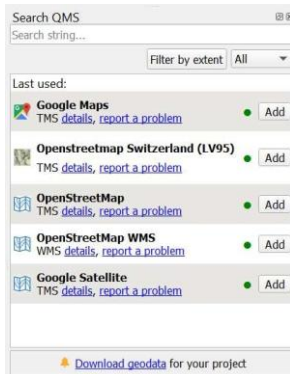
Select 'Manage and Install'

Plugins...'

4. Search for 'basemap' and several plugins will be filtered
5. Select the 'QuickMapServices' plugin
6. Click the 'Install Plugin' icon
7. Once installed, the QMS toolbar (3 icons) should emerge at the top of the GUI



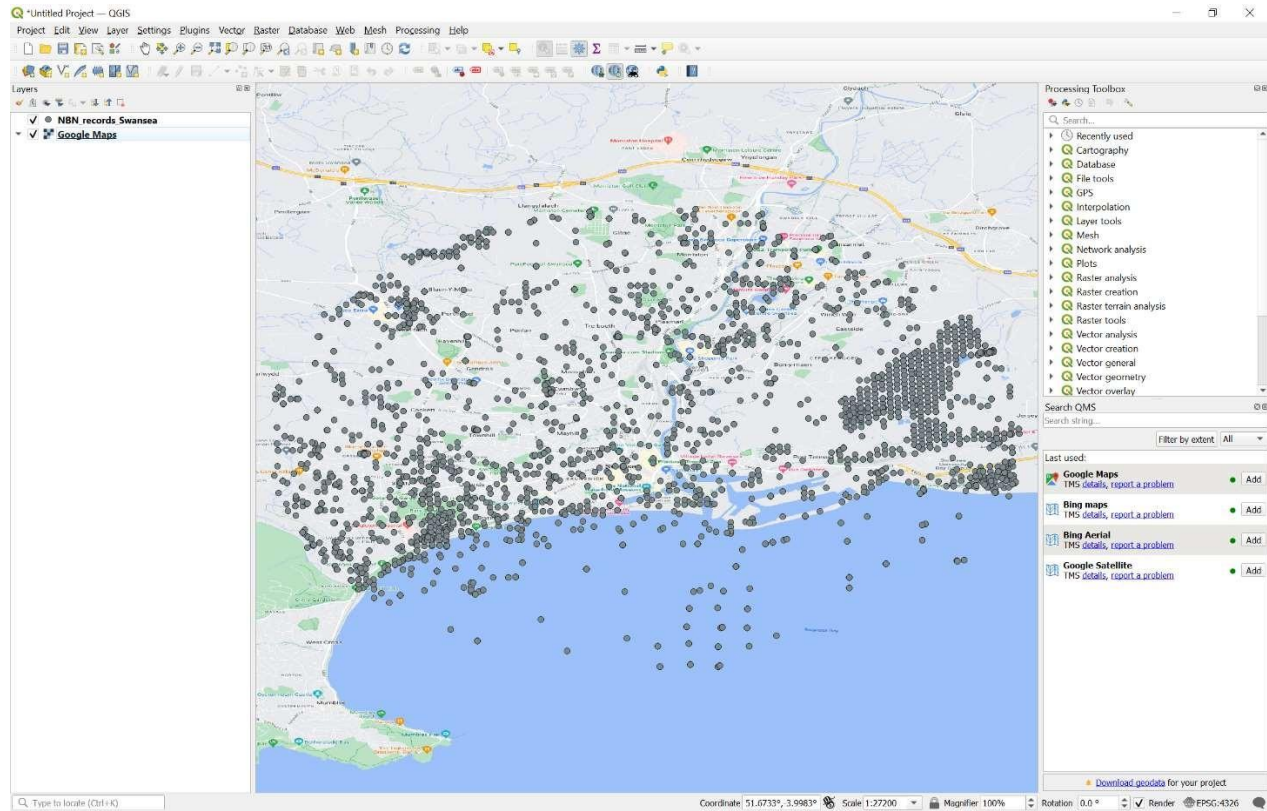
8. Clicking the middle icon will bring up the 'Search QMS' panel



9. Search for layers such as 'Bing Aerial' and 'Google Hybrid'
10. Click on the 'Add button next to the desired base map and it will emerge in the Map View (and the layer in the Layers panel).

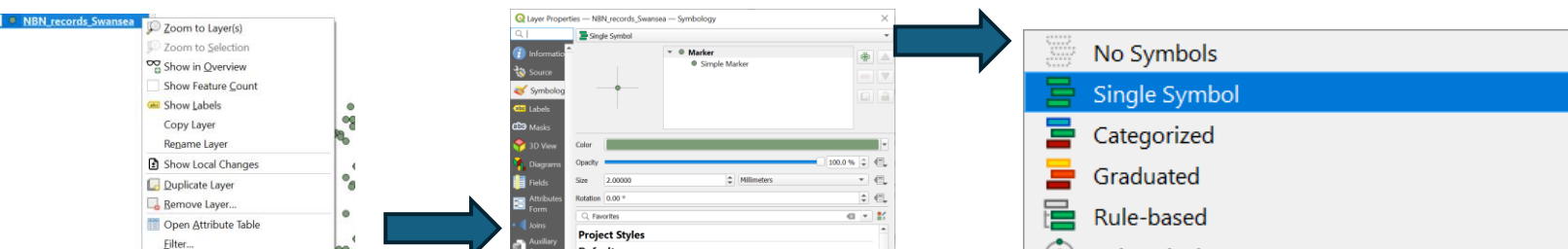
With base maps loaded, the user can now infer spatially related information:

- Absence / presence
- Distance
- Density



Symbology

- One of the key advantages of GIS is the variety of options available for visualising multi-variate information rapidly, allowing for quick visual interpretation
- Both discrete / categorical, and continuous data types can be displayed using 'categorized' or 'graduated' styles
- QGIS can also visualise the spatial characteristics of point datasets, including the number and density of points withing a given radius.
- To access 'Symbology', right-click on a layer, and select 'Properties'. 'Symbology' is the third tab.



Activity 1: Display the NBN data with Categorized symbology for the 'Class' attribute.

Activity 2: Display the NBN data with Graduated symbology for the 'Start date year' attribute.

Activity 3: Display the NBN data with Categorized symbology for the 'Start date year' attribute.

Right click on the layer file and select the 'Show Feature Count' option:

- For categorized data, this will automatically update to show how many records are within each class / category

Activity 1: Display the NBN data with Categorized symbology for the 'Class' attribute.

Step 1: Apply Categorized Symbology

1. In the Layers Panel, right-click on the new layer and select **Properties** (or double-click)
2. Go to the **Symbology** tab
3. In the top dropdown menu, change from "Single Symbol" to **Categorized**
4. In the "Value" dropdown, scroll and select **Class** (this is the taxonomic class column)
5. Click the **Classify** button (lower right)
6. QGIS will automatically create different colours for each class (Aves, Insecta, etc.)
7. Click **OK** to apply

Step 2: View the Results

- The map will now show points coloured by their taxonomic class
 - A legend will appear in the Layers Panel showing which colour corresponds to which class
-

Activity 2: Display the NBN data with Graduated symbology for the 'Start date year' attribute

Step 1: Prepare the Year Data (if needed)

1. If the "Start date year" field is text/string, you may need to convert it to numeric:
 - Open the Attribute Table (right-click layer → Open Attribute Table)
 - Check the data type of "Start date year"
 - If it's string/text, create a new integer field:
 - Click the **Field Calculator** (abacus icon)
 - Create a new field named "Year_int"
 - Output field type: **Integer**
 - Expression: to_int("Start date year")
 - Click OK

Step 2: Apply Graduated Symbology

1. Open **Layer Properties** → **Symbology**
2. Change the dropdown from "Single Symbol" to **Graduated**
3. In the "Value" dropdown, select either:

- **Start date year** (if it's already numeric)
- **Year_int** (if you created the new field)
- 4. Choose a **Color ramp** (e.g., Reds, Blues, Viridis)
- 5. Set the **Mode** (e.g., Equal Interval, Quantile, Natural Breaks)
- 6. Set the number of **Classes** (e.g., 5-7)
- 7. Click **Classify**
- 8. Click **OK** to apply

Step 3: Adjust the Classification

- You can double-click on the class ranges in the symbology panel to edit them manually
 - Older years will show as lighter/darker depending on your colour ramp choice
-

Activity 3: Display the NBN data with Categorized symbology for the 'Start date year' attribute

Step 1: Apply Categorized Symbology by Year

1. Open **Layer Properties** → **Symbology**
2. Change to **Categorized** (if not already)
3. In the "Value" dropdown, select **Start date year**
4. Click **Classify**
5. QGIS will create a unique colour for each distinct year in your data

Step 2: Manage the Categories

- Since you may have many years, you might get many categories
- You can:
 - **Sort** the categories by clicking the column headers
 - **Delete** unwanted categories by selecting them and clicking the minus (-) button
 - **Group** similar years by changing their colours to be the same

Step 3: Apply and View

1. Click **OK** to apply

2. Each year will now have a distinct colour on the map
-

Pro Tips:

1. **Save your style:** After setting up symbology, you can save it:
 - In Layer Properties → Symbology, click **Style** → **Save Style** to reuse later
2. **Create a legend:**
 - Go to **Project** → **Layout Manager** → **New Layout**
 - Add a map and insert a legend from the item's toolbar
3. **Filter data:**
 - If you only want specific years/classes, use:
 - Right-click layer → Filter
 - Enter SQL expression like: "Start date year" >= 2000
4. **Improve visualization:**
 - Adjust point size in Symbology → Symbol → Change size
 - Add labels: Layer Properties → Labels