

MOSSES & MAPPING TUTORIAL

Software integration for visualization of species distribution models

QGIS R Maxent Web

1. [QGIS] Set up map framework

- Download an administrative boundary shapefile from the following link:
https://gadm.org/download_country_v3.html (click shapefile)
- Don't unzip the file
- Layer-> Add layer -> Add Vector Layer
- Select zipped file -> Add

2. [QGIS] Constrain modelling area by boundary of choice

- To select our areas of interest, we will select the municipalities from the attribute table. Open the attribute table of the shapefile you just added above by right-clicking the shapefile within the Layers Panel and then selecting **Open Attribute Table** from the menu. Inside the attribute table window, click the Select features using an expression icon. Once the **Select by expression** dialog box opens, enter the expression below that creates the boundary you're looking for:

By state:

```
"NAME_1" = 'Illinois'
```

Multiple states:

```
"NAME_1" = 'Illinois' OR "NAME_1" = 'Indiana'
```

Flex:

```
"Attribute table column name" = 'Unit name'
```

- In the main QGIS window, right-click on **gadm36_USA_1.shp** and select **Save As...** from the menu. Once the **Save vector layer as...** dialog box opens, tick the Save only selected features to ensure that we save a new shapefile containing only the selected municipalities. Then, enter the file name of the output shapefile as **Illinois.shp** to your working directory, and click OK. The new shapefile should appear in the QGIS Layers Panel.

3. [WorldClim] Download environmental data (bioclimatic variables)

- Go to <https://www.worldclim.org/data/worldclim21.html>
- Download the “bioclimatic variables” for the appropriate arc minute resolution:
- Approximate Arc min to km conversions using Chicago latitude:

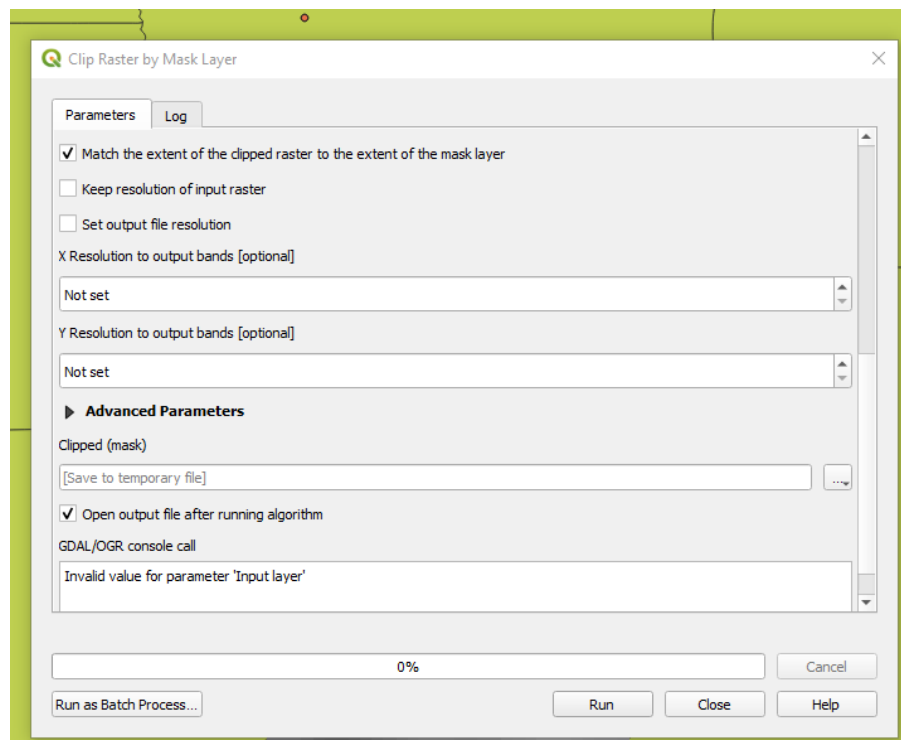
2.5 arc minutes = 4km

5 arc minutes = 7km

Choose a scale that makes sense for your modelling area. If it's all of North America, choose 10 minutes probably!

4. [QGIS] Clip environmental data to modelling area

- A helpful video if you want to visualize this step! <https://www.youtube.com/watch?v=5ftv6I7G-ys>
- Raster -> Extraction -> Clip Raster by Mask Layer
 - Raster-> Extraction-> Clip Raster by Mask Layer
 - Input Layer: Click ellipses, select the first unzipped TIFF file from WorldClim
 - Mask Layer: Illinois.shp



- Advanced Parameters -> select ellipses -> save file
 - Save in your working directory with a name that references both the mask and the variable (i.e. bioclim_1_IL)
 - change the output file type to ASC
 - Click “Run”

- d. Repeat this for all other raster layers (all bioclim TIFF files #1-19) by following the same process.

5. [Bryophyte portal] Download moss occurrences

- a. (Zoe tutorial) Search the bryophyte portal for the data you want under **Explore→Search Collections** and select the institutions you want to search.
- b. Use the search function to find your specific data. Once in the occurrence records, click the Download button.
- c. A new window should appear. Deselect Compressed ZIP file which should also automatically deselect the two Data Extensions oppositions. Most importantly, make sure your File Format is in CSV

6. [QGIS] Clip moss data to modelling area

- a. Add moss as a CSV to the map
- b. Right click moss layer-> attribute table -> select features using an expression
- c. "stateProvince" = 'Illinois'
- d. Right click moss layer -> export -> save selected features as -> Format = CSV in working directory

7. [R] Process moss occurrences

- a. Enter the following code into a new R script in RStudio:
 - i. To copy a file path on a PC:
 1. Find the file or folder whose path you'd like to copy in File Explorer.
 2. Hold down Shift on your keyboard and right-click on it.
 3. In the context menu that pops up, select "Copy As Path."
 - ii. To copy a file path on a mac:
 1. Open Finder on your Mac
 2. From the Mac menu bar, select "View"
 3. Choose "Show Path Bar" (This surfaces the path for any file selected at the bottom of the Finder window. If you try to copy the text at the bottom of the window, nothing happens. So how can you actually copy the file path name?)
 4. While holding down the "Control" button, click on the file you want to copy the path of in Finder
 5. Press the "Option" key (In the menu that appears after step one, you'll see "Copy" turn into "Copy [file path name] as Pathname".)
 6. Select "Copy [file path name] as Pathname"

```
##### MAXENT / R / QGIS TUTORIAL #####
# change file path to your working directory
# copy file path to your project folder using the instructions above (i and ii)
# change all back slashes to forward slashes
setwd("C:/Users/emcla/Documents/FMNH Botany/Workshop")

# This line reads the CSV file and stores it in a variable
data <- read.csv(file="Illinois_AA.csv", header=TRUE, sep=",")

# subset the sheet to only the species name and coordinates using the column names
mossoccurrence <- data[,c("scientificName", "decimalLatitude", "decimalLongitude")]
mossoccurrence

# take out the entries without coordinates
moss_clean <- na.omit(mossoccurrence)

# check your work!
moss_clean

# This line saves the selected species in a CSV file
write.csv(moss_clean, file="clean_moss.csv", row.names=FALSE)
```

8. [Maxent] Run species distribution model

- a. Open MaxEnt and load the Samples and Environmental Layers by navigating to the respective directories of those files. Ensure that the tick boxes of all files are checked, and that the Environmental Layers files are all 'Continuous' types.
- b. Also, in the main MaxEnt window, check tick boxes or select the following options:
 - Linear/Quadratic/Product/Threshold/Hinge features
 - Create response curves
 - Make pictures of predictions
 - Do jackknife to measure variable importance
 - Output format: Logistic
 - Output file type: asc
- c. Select working directory for model outputs

9. [QGIS] Map layout

- a. Select the .asc file “maxent results” and add as a raster:
- b. Load the resulting ASC file in QGIS from the **Layer > Add Layer > Add Raster Layer...** menu. Then, change the styling of the raster layer by going to **Layer > Properties...** menu, or double-clicking on the layer under the Layers Panel. Change the styling of the raster layer as shown on the image below. Alternatively, you can also load the layer styling using this [QML](#) file (only applicable to the logistic model output).
- c. Feeling brave? Head to layout mode and add a (concise and legible!) legend, title, scale bar, and north arrow.

