Threat Modeler Instructions

Background

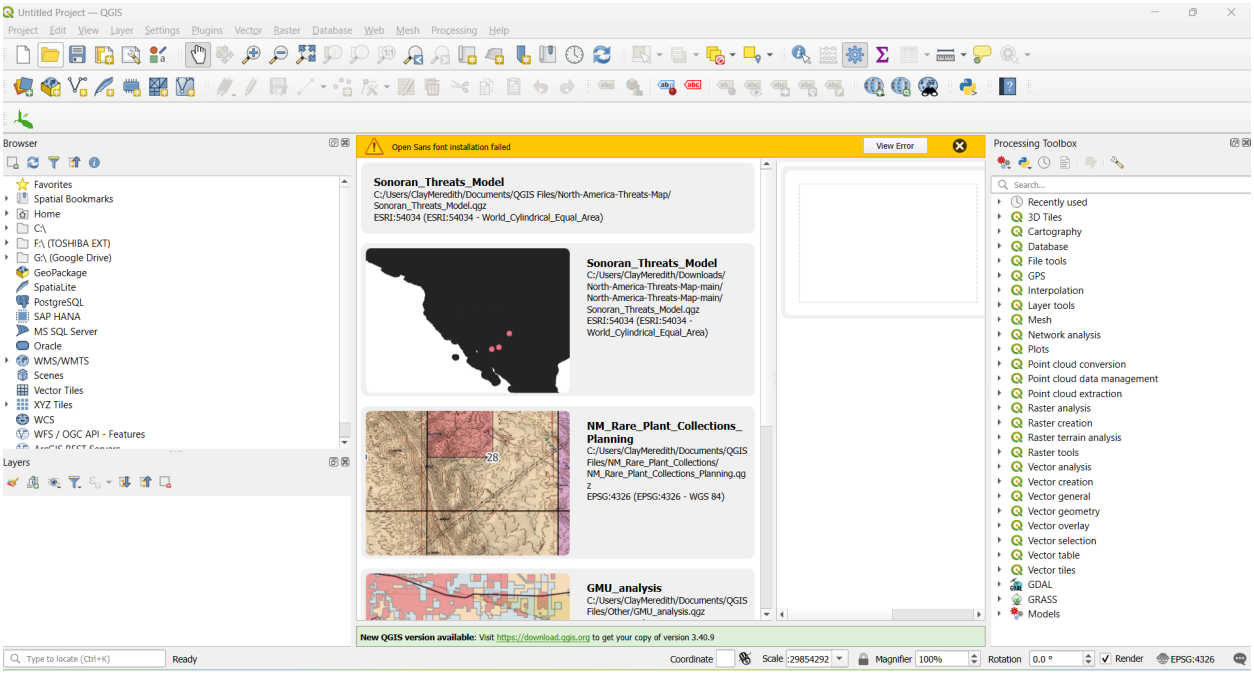
The threat modeler was developed for use in QGIS software. QGIS is a free and open source GIS package which is available online from the QGIS website. The software package functions for Windows, Mac OS, and Linux operating systems. It was developed using QGIS version 3.26.3, but any QGIS version beginning with 3 will run the analysis. Once QGIS is installed, the package can be set up quite quickly for use following the directions included below. Start by downloading the QGIS files to your computer from GitHub (https://github.com/mereclay/North-America-Threats-Map).

Extract Data Files

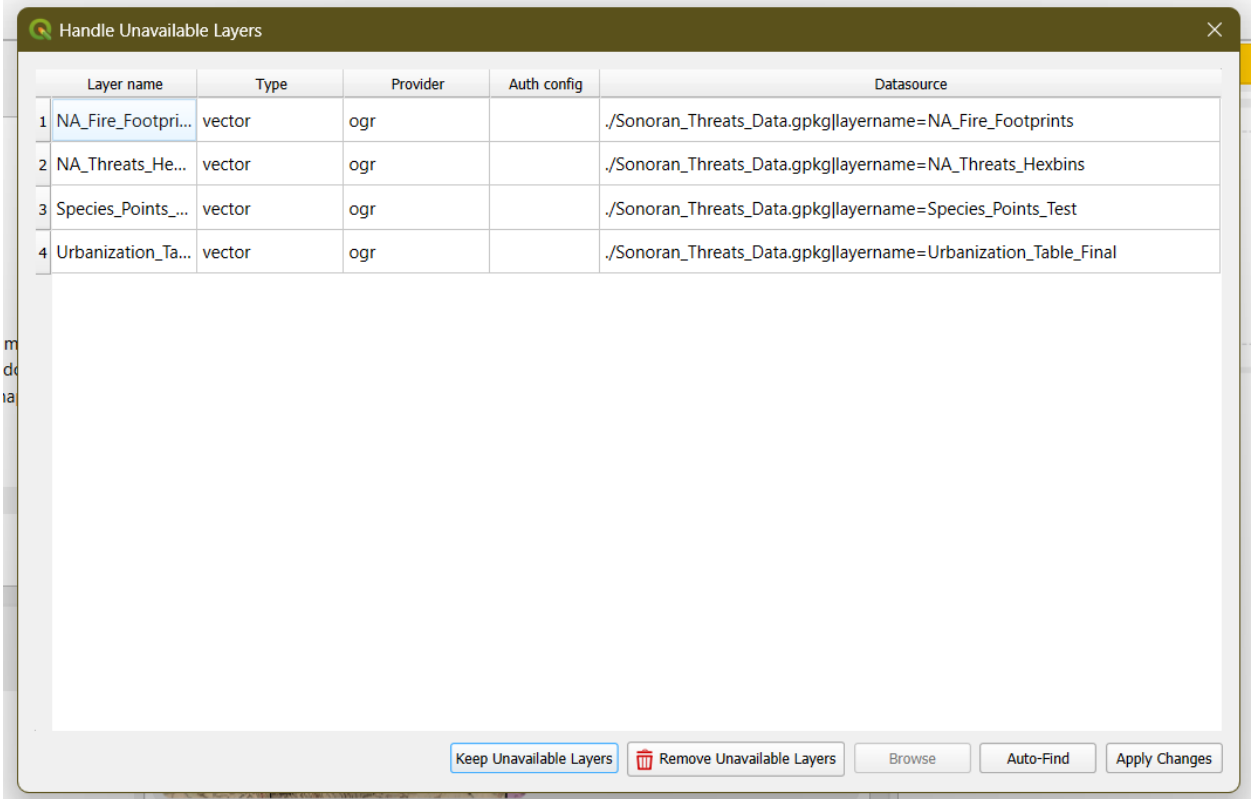
The underlying data upon which the model is built is compressed to facilitate distribution. Once the package is downloaded from GitHub, the file “Sonoran_Threats_Data.7z” can be decompressed using the free software package 7zip. Save the decompressed version in the same folder as the Sonoran_Threats_Model.qgz model file.

Open the QGIS project

Upon first opening QGIS, you’ll be presented with a screen that looks something like this.



You’ll begin by opening the QGIS project. Use the browser panel on the left side of the screen to locate the Sonoran_Threats_Model.qgz file. Double click this file and you’ll be presented with the following menu.



Link Data Sources

Click the “Auto-Find” button to link the underlying data files to the layers in the package. If this process does not function properly, ensure that the Sonoran_Threats_Data.gpkg file has been properly decompressed and is located in the same file as the Sonoran_Threats_Model.qgz model file.

Adding species points

To add new species points, first download the set of points you need to your computer in a place you can find them. On your downloaded file, open it and delete all of the columns except for the species binomial and location information. Rename the column containing species binomials to “BINOMIAL”. Rename the “DEC_LAT” column as “Latitude” and the “DEC_LONG” column to “Longitude”. Then use ”find and replace tool” to change the space between the genus and species names to an underscore. Then remove all additional spaces, also with the find and replace function. If there are spaces, it will not run.

Then, navigate to the Layer dropdown menu (located in the uppermost menu. Click on Add layer -> Add Delimited Text Layer (on the menu located at the left side). In the pop up, use the three dots to the left of the file name to navigate to your point file that you just saved to your computer. Your input should look like the image below. Then click “add”.

Adding the threat map modeler tool

Next you'll add the modeler tool which will perform the analysis. On the right side of your screen, you should see the Processing Toolbox menu. If you do not, it can be accessed by clicking the View tab at the top of the screen. Navigate to Panels and select Processing Toolbox.

Within the Processing Toolbox, you'll see an icon with red gears at the top.

Click this and select Add Model to Toolbox. Navigate to where you've saved the model data and select

Threat_Layer_Export.model3. Click Open.

Using the threats map

Within the Processing Toolbox, you'll see a list of available processes. Near the bottom, you'll see an option for Models. Clicking the arrow to the right of this icon will expand a menu with several options.

Double click Threat_Layer_Export to open the threat model input parameters. The tool requires you to input which layers to process. The input layers match the names given for files fairly closely.

Steps:

1. Species distribution points. You'll need a csv of distribution points of the species of interest saved to your computer. The only required elements are latitude and longitude.

2. Under Fire Footprint Data select the arrow on the right side to open the drop down menu. Select Fire_Footprints_Final from this menu (see figure below).

3. The tool allows users to import species point data for many species and select which species to analyze within this dataset. This allows the user to import a single file (more on this later) and is designed to speed processing. However, this also requires users to specify which species to analyze. Type the name of the species you'll be analyzing into this box. Remember that the process is highly selective. You'll need to type in species name exactly as it is in the file (capitalization, spacing, and spelling, you may cut and paste from the file for best results). For testing use of the model, you can use this file found in the GitHUB folder:

Species_Points_Test.csv. Otherwise, use the instructions above for downloading species points (above) and then cut and paste the binomial you want from that file.

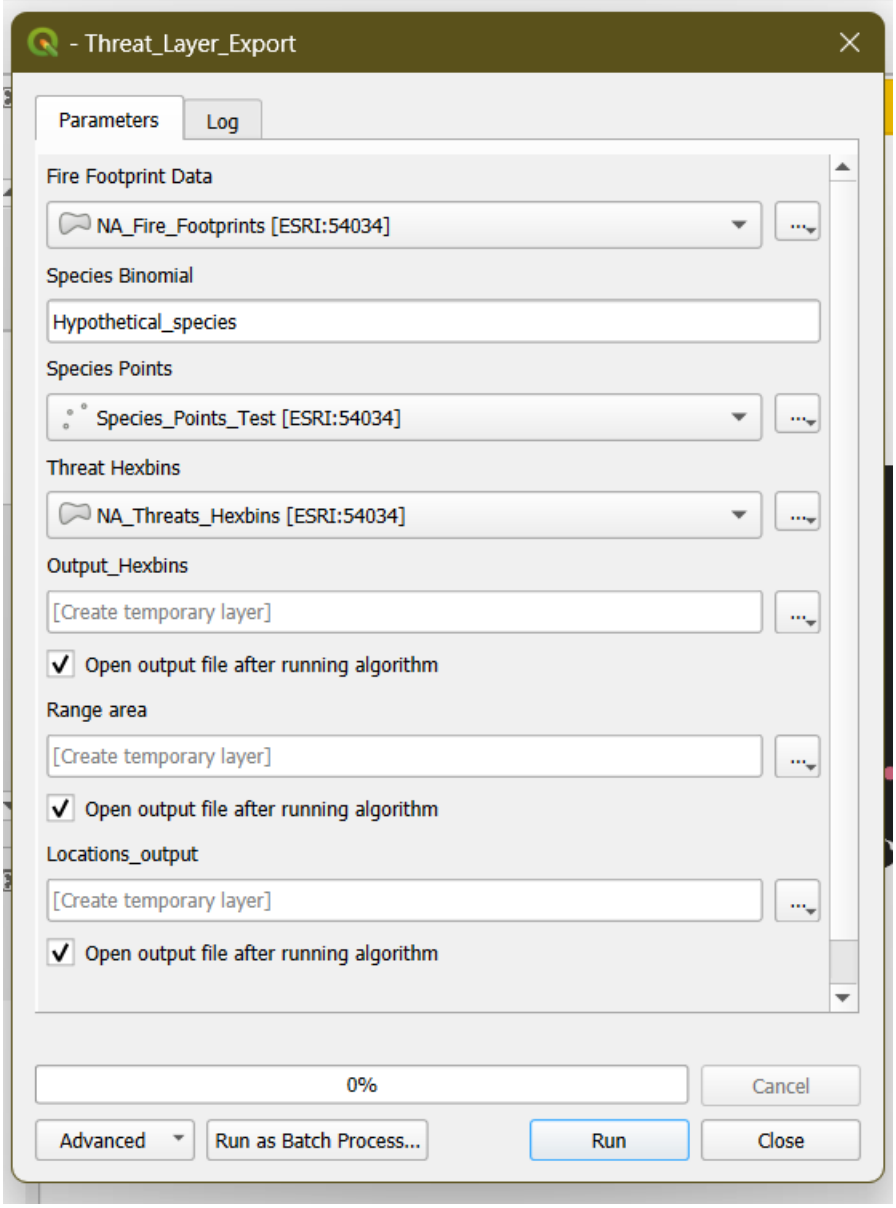
a. For the species points, select the name of the species file that you imported

b. For the Species binomial, cut and paste the name of the species from the file you chose in “a”

4. Under Threat Hexbins, choose Output_Hexbins.

5. Below this, you’ll see options for outputs. The default is to add temporary outputs for each species, but these can be permanently saved if required. [Note - doing this may not allow the model to run. But if you want to try it: Use the three dot buttons on the right to specify a location to save outputs if you need a permanent copy.]

The input should look broadly like the input below and is now ready to run. Click the Run button to begin processing. When processing completes, click Close.



Finding and downloading the threat layers

Three new layers appear at the top of the layers box found in the bottom left of the QGIS window. Three layers are added to the map following processing.

1. Threats: **Output** Hexbins contains data associated with the hexbins containing a point. This data documents the threats within the bin which may impact the species. This file can be exported using by right clicking it, selecting Export, and Save Feature As. This will open a menu allowing you to specify where the file should be saved. In the format drop down menu, select Comma Separated Value [CSV] to save a spreadsheet which can be opened in Excel. Type in a file name as

"binomial{fill in the name of the species you are working with]_threats", uncheck the box labeled Add saved file to map, then click OK.

2. **Range** area: this is a shape file of the range of species distribution, which calculates the extent of occurrence (EOO).
3. Fire: **Locations_output** is the fire threats map. You can save it the same way as was done for Output_Hexbins to export fire data. Type in a file name as "binomial{fill in the name of the species you are working with]_firelocations", This file contains measurements of the species' range and an estimate of the number of fire events which would need to occur to burn the entire range of the species.

Calculating threats on downloaded output and locations files

Use the file entitled Appendix D as an example of how to calculate threats, changes in urbanization, and number of fires.

Calculating threats:

1. Open the csv file of the "Output" file that you downloaded and saved in step 1 of the previous section
2. Insert two blank rows to the top of the spreadsheet
3. Copy and paste the headers from this Appendix E: 3.1 Threats headers into the two blank rows
4. Double check that the first row that was pasted in matches the third row of the spreadsheet. If not, adjust by deleting or adding cells so that they align.
5. At the bottom of your data, use the sum function (=sum"") to add up all of the rows of data for each column, drag and pull this across so that there are sums across until the "land area" column. Label this row as "sum"
6. On the next row, calculate the percentage of each threat by the total land area. The total land area is calculated in the "land area". Use the function = "cell above"/cell of land area sum. Add "$" to the cell of the land area (like this: =E39/U39), so that when it's dragged and pulled that it stays the same cell Drag and pull this across so that the calculation is made for each cell. Format the row as %. Label the row as "% area impacted"
7. In the next row down, calculate all of the threat percentages using =sum(). Include only the threat columns in this calculation. Label this as "Total % of species distribution threatened"

Calculating protections:

1. In the column labeled “protected” this is the amount of the distribution that is in protected areas. You should have a % from step #6 above. If not use #5 and #6 to calculate the %.

Calculating urbanization:

2. To the right of the column labeled “shape area”, there should be urbanization output. starting in 1900 to 2100. By dragging the calculations in steps 5&6 across, you will calculate the amount of the species distribution that was affected by urbanization in each decade.
3. Look from 1900 to 2020 and see if the % has changed. To do this, simply subtract the % from the 1900 urbanization to 2020 urbanization and you will see how urbanization has changed.
4. You can calculate the projected urbanization by subtracting the % urbanization in 2020 from the % urbanization in 2100.

Calculating risk of fire:

1. Open the csv file of locations output saved in step #3 in the “Finding and downloading the threat layers” section above.
2. The final column, named “locations” indicates how many fires it would take, using fire data from the past 20 years, in each ecoregion to burn the entire species habitat within that ecoregion.
3. If there are more than one ecoregion in the sheet, calculate the sum of that column and that’s the total number of fires that would be needed to burn the species’ entire known distribution.

Optional: Importing open street map to the threats map - this will allow you to see where the points are geographically with an underlying map

Press the tile that looks like this.

On the left panel, click on XYZ

On the middle panel, click on the first drop down menu and choose OpenStreetMap

Click on the “Add” button at the bottom right of the window, then click close

OpenStreetMap should now appear as a layer. Move it to the bottom layer by dragging and dropping it to the bottom of the list or right clicking and choosing “move to the bottom”. You

should now unclick everything except the points you want to see. Right click on the points and choose zoom to layer, to center on your points.

Instructions for adding threat map results to IUCN Red List Assessment in SIS

1. Be sure to conduct general literature search for the species and genus in addition to the threats map analysis and summarize your findings with citations. The threats map should not be a substitute for the literature review.
2. If the species is possibly threatened/limited distribution, use the threats map and use the language below to include.
3. The categories in the threats map (e.g. mining, fire) are used in IUCN to summarize threats across plants. There is some level of uncertainty associated with the threats map due in part because the overlap of species distribution and threats is estimated based on hexbins. Thus, we want to be cautious in labeling the threats using these drop down menus. —>The rule is that if the threat is < 5%, then do not include it as a threat. [But note, if that gets out of hand and you find yourself listing every threat, consider bumping it up to 10%, but no further.]

Example text for threats section of SIS

Roughly XX [add all threat %, exept urbanizaion, together, then round up to a whole number]% of *genus_species'* range includes known threats from [list all threats], based on a QGIS threats mapping tool (Rowe and Meredith 2024). Approximately XX [round up to whole number]% of its population is potentially affected by [first threat], and about XX [round up to whole number]% of its population is threatened by [second threat] (Rowe and Meredith 2024). [Repeat form from previous sentence for remaining threats, other than fire and urbanization.] (Rowe and Meredith 2024).

Nearly XX [add together the different urban threats (1.1 & 1.2) round up to whole number]% of its population is adjacent to existing urban areas, "but no further development is projected in these areas" [if none projected in urbanization model] OR "and urban development is projected to increase in these areas by XX% [if projected in the urbanization model]" (Rowe and Meredith 2024). It should be noted that the QGIS threats map does not include certain threats, including invasive species (other than horses and burros), legal or illegal harvesting, or climate change (Rowe and Meredith 2024). [Describe response of species to threats listed above.] Species "X" is vulnerable/ not vulnerable/ benefits from grazing or disturbance (search literature for this for the genus and species and fill in species' response to grazing and disturbance WITH CITATIONS). OR We found no information on how this plant species responds to these threats in the literature.

[Include fire as a threat only if a total of 20 or fewer fires would substantially impact the species, using the fire model] Using fire data from the past 20 years in ecoregions where the species occurs, a total of XX [note - needs to 20 or fewer to list as a threat] large fires could potentially impact the species' entire known distribution. Therefore, based on fire risk, the number of locations for this species is XX [<21] (Rowe and Meredith 2024). [Describe species' response to fire.] Species "X" is vulnerable/ not vulnerable/benefits from fire impacts (search literature for this for the genus and species and fill in species' response to fire WITH CITATIONS). OR We found no information on how this plant species responds to fire in the literature.

Example text for protection section of SIS

Using the QGIS threats map, roughly XX % of the genus_species' range is in protected areas*. Another xx % of the range occurs on indigenous lands, which may provide protection. Added detail is useful! List the specific names of the protected areas (for example, "this species is found in USFS Tonto and Saguaro National Park."). Consider using "public lands" instead of "protected lands", if applicable, and describe the actual protection provided.