Steps to create Washington state hydrological features in QGIS for Northern Pikeminnow Species Distribution Modeling

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1. Set the project CRS to NAD83 in Project>Properties.
2. Download the Washington State outline polygon from https://geo.wa.gov/datasets/a77ee02fab3e4793b274ec52b7a523d8_10/explore
3. Import the shapefile by selecting Layer->Add Layer->Add Vector Layer, then selecting the .shp file as the input and clicking Add. Set the Target CRS to NAD83.
4. Download National Hydrography Dataset NHDPlus HR files for the relevant Hydrologic Units (see https://hydro.nationalmap.gov/arcgis/rest/services/NHDPlus_HR/MapServer and open in ArcGIS Online Map Viewer). Import the flowline and waterbody layers from each of theOpen GDB directories by selecting Layer->Data Source Manager->Source Type is Directory and Source is OpenFileGDB. Select the correct directory, then click "Add". All layers will be displayed. Select only the two mentioned above and then click Add Layers.
5. Clip the flowlines and water bodies for each HDU to the state boundary by selecting Vector->Geoprocessing Tools->Clip and selecting the state boundary from Step 2 as the Overlay layer.
6. Join the streamlines layer with data from other layers in the NHDPlusHR dataset:
    a. Double-click on the layer to bring up the Properties pane. Select the "Joins" tab and join the NHDPlusFlowlineVAA table on NHDPlusID. The fields of interest are the stream order, TotalDrainageAreaSqKm, MinElSmo, MaxELSmo, and Slope.
    b. Join data from the monthly temperature tables (NHDPlusIncrTempMM01 and NHDPlusIncrTempMM07) on NHDPlusID. The fields of interest are the TempMA field in each table.
    c. Join data from the NHDPlusEROMMA table on NHDPlusID. The field of interest is QEMA, the gage-adjusted mean annual flow rate.
7. Calculate the mean annual temperature in July by creating a new column in the attribute table (right click layer->Open Attribute Table, then click Open Field Calculator). Divide the TempMA field you joined from the NHDPlusIncrTempMM07 table by 100 to yield degrees C.
8. Calculate the thermal amplitude by creating a new column in the attribute table (right click layer->Open Attribute Table, then click Open Field Calculator). Subtract the mean temperature in January divided by 100 from the mean temperature in July divided by 100 (temperatures are initially in degrees C multiplied by 100).
9. Calculate the stream power by creating a new column in the attribute table (right click layer->Open Attribute Table, then click Open Field Calculator). Multiply the stream slope value by 100, then multiply this by 1000, multiply again by 9.81, and then finally multiply this by the stream flow rate itself multiplied by 0.0283 to convert from cubic feet to cubic meters.
10. Calculate the mean stream elevation by creating a new column in the attribute table (right click layer->Open Attribute Table, then click Open Field Calculator). Add the MinElSmo field to the

MaxElSmo field. Divide by two, then add to the MinElSmp field to yield average elevation of the segment.

Convert vectors to rasters

1. Export each of the five features (Steps 6-9 above plus TotalDrainageAreaSqKm) to individual raster layers by Selecting Raster>Conversion>Rasterize then select the following settings:
    a. "Field to use for burn-in value" is the column in the table corresponding to the feature layer you wish to create (stream power, mean elevation, etc.)
    b. "Output raster size units" set to Georeferenced.
    c. Width and height set to desired raster resolution. Because NAD83 is in degrees, 1 arc-minute resolution is 0.0167 in each of these fields.
    d. "Output extent" should be set to "Calculate from layer", then select the layer corresponding to the vector layer you are converting from.
    e. "Assign a specified nodata value..." should be set to 0.0
2. Fill the nodata values in the raster layer that is created by selecting Raster>Analysis>Fill nodata then set the parameters as follows:
    a. "Input layer" should be the layer you created in Step 1 above.
    b. "Maximum distance (in pixels)..." for interpolation should be set to 10 if you have exported the raster at 1 arc-minute resolution. Higher resolutions may require a larger value here, as large as 125.
3. Clip the filled raster back to the state boundary by selecting Raster->Extraction->Clip Raster by Mask Layer and selecting the state boundary layer as the Overlay layer.
4. Export the final raster layer by right-clicking the temporary layer that is created and selecting Export>Save As.