

ArcGIS geoprocessing project summary

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Project Objective: Generate a two-dimensional table (Excel Spreadsheet or Dbase format) containing species range and environmental parameters spatially associated with approximately 50 species collection sites in central and South America. Table will in turn be used to generate ArcGIS thematic maps.

Use these geographic data sets for this study:

- ArcGIS Point Shapefile: 44 species collection sites
- ArcGIS Polygon Shapefiles: 153 species range map polygons.
- ArcGIS Point Shapefiles: 23 species range map points (single species observation).
- Raster grid files: ~50 global (whole world) images depicting meteorological and environmental parameters (e.g., evapo-transpiration).

Step 1: Select correct ESRI mapping product

ArcMapGIS is most appropriate selection because the ***Spatial Analyst*** package Raster Calculator feature has processing tools for both raster and shape file data, and because ArcMapGIS is generally more efficient at processing large raster data sets e.g., the bathymetric data).

Step 2: Construct an ArcMap Map (.mxd) File and add all of the required shape files to the Table of Contents.

Step 3: Reduce number of columns in the Species Range Map polygon database files

Remove all but the scientific name (SCI_NAME) column in the database file (.dbf) component of each of the species range map polygon and range point shape files. Reason: the Spatial Join operation appends the Collection Site point shape file with the contents of each Species Range Map shape file. The SCI_NAME column will suffice to indicate whether each species occurs at the site. If the unneeded columns are not deleted before the spatial join, the table width will eventually exceed the maximum acceptable Excel file width. Procedure: Move through the Table of Contents entries, right-clicking and selecting Open Attribute Table. Delete all unneeded columns, and then close the Attribute Table file. Alternatively: Save the ArcGIS Map, close ArcGIS, and use Microsoft Excel to edit the unnecessary columns from each .dbf file in the shape file directory. (MS Excel editor has more powerful edit capabilities).

Step 4 Perform 'Point in Point' Spatial Joins:

Determine which of the species range map point sightings intersect each Site Map point. Perform a Spatial Join operation between the Collection Site Map point file and each Range Map point file. This can be done interactively through the ArcGIS Table of Contents. Repeat the following procedure for each Species Range Map point shape file:

1. Right-click the Site Map point file name in Table of Contents, select 'Joins and Relates / Join...'.
2. Select the point shape file to join to the Site Map point file. Note that you are joining 'Points to Points'. Select the second radio button: Each point will be given all the attributes of the point in the layer being joined.
3. Select an output shape file name, and press OK.
4. Note that the output shape file name is added to the top of the TOC. Right-click on the filename, select 'pen Attribute Table', and remove the duplicate 'FID_x' field.

Repeat Steps 1 through 4 for all Species Range point files, selecting the last Site Map file added to the Table of Contents during Step 1.

Step 5 Perform 'Point in Polygon' Spatial Joins:

Determine which of the species range map polygons intersect each Site Map point. Perform a Spatial Join operation between the Collection Site Map point file and each Range Map polygon file. This can be done interactively through the ArcGIS Table of Contents. Repeat the following procedure for each 'reduced' Species Range Map shape file:

- 1) Right-click on the last Collection Site Map shape file added to the Table of Contents, then select **Joins and Relates**, then select **Join...** Ignore the 'Selections will not be enabled...' warning message (continue).
- 2) Within the **Join Data** dialog box: Select 'Join data from another layer based on spatial location' in the top text drop-down box. In the second drop-down box, select the next Species Range Map polygon file to be joined to the point file. Note that you are joining *Polygons to Points*. Select a NEW output shape file name; the spatial join process for each subsequent Range Map file will generate a new 'appended' Site Map file that will be the input to the next spatial join operation. Click OK to complete the spatial join operation. Note that the new Site Map file appears at the top of the Table of Contents.

Repeat Steps 1 and 2 for all Species Range map files, selecting the last Site Map file added to the Table of Contents during Step 1.

Step 5: Clip each Raster Environmental Data to match the study area. (NOTE: this is an optional step, probably unnecessary in the present case as the processing time with the entire raster file is acceptable. Proceed to Step 6).

The environmental files are raster datasets that contain measured environmental parameters for each cell of an image-like grid of the entire Earth. The objective of this step is to join the value of each environmental file that coincides with the location of each Site Point to each record in the Site Point shape file. We will use the Raster Calculator and Spatial Join features to execute this step.

The procedure: draw a rectangle around the desired subimage, convert the rectangle to a polygon shapefile, and use it to 'clip' (extract) a bathymetric subimage. This is known as 'Clipping a Raster Dataset': Use the ArcGIS drawing/editing tools to draw a rectangle around the desired subimage, convert it to an Arc shapefile, and use this shapefile as a 'clipping rectangle' to extract the

desired subimage from the larger image. Here are the instructions from the ESRI Web Site.

1. Start the **ArcCatalog** application.
2. Right-click your destination folder and select **New > Shapefile**.
3. Name your shapefile and specify:
 - Feature Type = Polygon (Spatial Reference input is optional).
4. Note: Prior to starting Editing and Clipping make sure that the raster grid, shapefile, and map layer data are projected into the same coordinate system:
5. Use the ArcToolbox Projection Wizard to assign the map layer and shapefiles to the projection coordinate system assigned to the raster dataset (See Step 3).
6. Add the shapefile layer and raster layer to your new map in ArcMap. Activate the Editor Toolbar (Tools/Editor Toolbar) within your ArcMAP user interface. Invoke the Editor (icon in upper left corner of screen).
7. Click: Editor > Start Editing and specify: a. **Task = Create New Feature**, b. **Target = Shapefile**. To use the Editor, click the 'pencil' icon to the right of the Editor menu, then the next 'pencil' icon (sketch tool). Draw and close a 'stretch box' polygon around the region of interest, then go to the Editor menu and click **Stop Editing** and then **(Step 7, Continued) Save Edits**. Your polygon shape file is complete.
8. Select Options in the dropdown menu of Spatial Analyst.
9. Switch to the General tab and specify Analysis Mask = Shape file.
10. Switch to the Extent tab and specify Analysis Extent = Shape file.
11. Select Raster Calculator in the Spatial Analyst dropdown menu.
12. Double-click the raster under layers.
13. Evaluate. The resulting Calculation file will appear in the Table of Contents.
14. Save this as a layer by right-clicking on the Calculation entry and selecting 'Save As Layer' file option.

Step 6: Perform 'Point to Raster' spatial join for each Environmental File.

Now that the environmental files have been clipped, we will use the Raster Calculator and Spatial Join features to join the environmental data files to the Site Map file. :

1. Activate **Spatial Analyst / Options**. On the **General** tab, Select the Site Point file as the Analysis mask. On the **Extent** tab, select the same Site Point file as the Analysis extent. Click OK.
2. Select **Spatial Analyst, / Raster Calculator**. Double-click the appropriate (clipped, if appropriate) environmental file in the Layers: window to copy it into the Expression Building window. Move the mouse cursor into the Expression Building window, and left-click to activate the text edit capability. Construct a grid-to-shape conversion function by surrounding the selected **[filename]** with the text: **gridshape([filename])**. Press Evaluate. This creates a polygon shape file containing the selected file subset coinciding

with the (Site Point file) Analysis mask. The temporary output file will be named **Calculation** or **Calculationn** (where *n* is a sequence number).

3. Export the temporary **Calculation(n)** file to a permanent polygon shape file: Right-click on the filename in the Table of Contents, then **Data**, then **Export Data**. Accept the dialog box defaults, and select a new filename.
4. Right-click / select the latest appended Site Point shape file, then **Joins and Relates**, then **Join...** Select as the 'join layer' the polygon shape file created in **Step 3**, above. You are joining Polygons to Points. Select the second radio button ('is closest to it'), and specify an output shape file name. Press OK to perform the join operation. NOTE: Not all Site Points will have associated points in each of the environmental files; therefore, the GRIDCODE column entries for some Site Points may contain zeros.
5. Rename the GRIDCODE column to describe the environmental parameter (e.g., ENV_TRANSP for transpiration) contained in the column.

Repeat steps 1 through 4 for each (clipped) environmental file, until each has been joined to the master Site Point file. The end result is an (extremely wide) attribute table with many species sighting and environmental parameters joined as columns to the Site map file.