Exercise 04   **Name:** _____

DIVA-GIS: Distribution and Diversity of Wild Potatoes
(Heavily modified from www.diva-gis.org by C.R. Hardy, Feb 2009)

This plus a WORD document is to be done as homework for 10 pts. Due Feb 23, 2009 at the beginning of class.

You should have gone through the tutorial and at least glanced through the manual before starting this exercise.

Wild potatoes (family Solanaceae; genus *Solanum* section *Petota*) are relatives of the cultivated potato. There are nearly 200 different species that occur in the Americas. Their geographic distribution was recently described by Hijmans and Spooner (Hijmans, R.J., and D.M. Spooner, 2001. Geographic distribution of wild potato species. *American Journal of Botany* 88: 2101-2112). In this exercise, we analyze some of the same data that were used in this paper.

NOTE: If at any time DIVA-GIS appears unresponsive during this exercise, make sure your project is saved (as a .div file), close DIVA-GIS and then reopen it and your file to pick up where you left off.

A. Grab the potato data from the course website (http://herbarium.millersville.edu/471.php).

> Unzip the zipped folder "potato-exercise-data" and load it onto your flash drive or the desktop of your computer.

B. Open DIVA-GIS and Build a Map of the Americas

> *Layer > Add Layer* to add the 'pt_countries.shp' shapefile to the map. This shapefile contains the administrative boundaries for American countries.
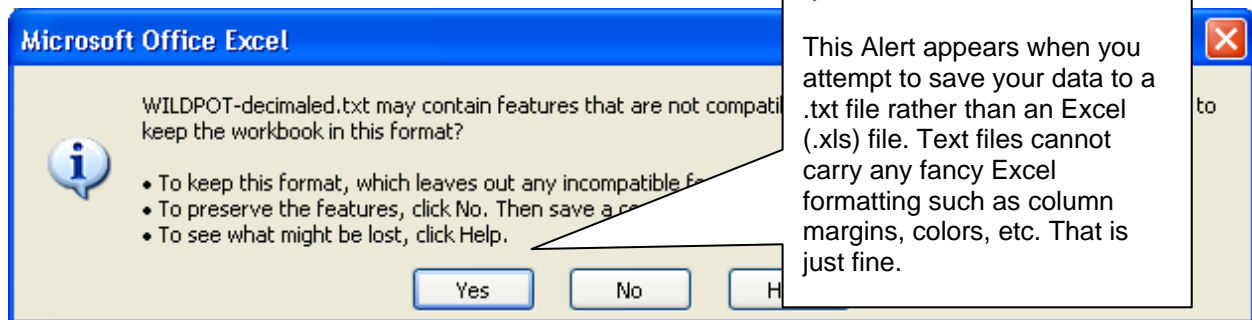
C. Import specimen data

1) Open MS Excel and open the file 'wildpot.txt' from the "potato-exercise-data" folder. The file is a tab-delimited txt (.txt) file.

Convert the DMS (degree, minute, seconds) coordinates to decimal degrees using the appropriate formulaic mathematical expression into two new columns in Excel (one for Longitude, the other for Latitude). [See Chapter 2 of the DIVA-GIS manual or your lecture notes.]

Pay attention to the heading (N vs. S, E vs. W) as these will determine the sign (- or +) for the decimal degrees.

Format the new latitude and longitude columns to represent the numbers to 5 decimal places (5 decimal places translates to an accuracy of less than 1 m at our latitude; 4 places to less than 10 m).

Save the file in tab delimited text format (as "wildpot-decimaled.txt"). Make sure that you do not lose the decimal numbers of the coordinates as you save the file.

Microsoft Office Excel

WILDPOT-decimaled.txt may contain features that are not compati... to keep the workbook in this format?

• To keep this format, which leaves out any incompatible f...
• To preserve the features, click No. Then save a c...
• To see what might be lost, click Help.

[Yes] [No] [H...]

If you get this Alert Box, click "yes".

This Alert appears when you attempt to save your data to a .txt file rather than an Excel (.xls) file. Text files cannot carry any fancy Excel formatting such as column margins, colors, etc. That is just fine.

2) Having saved the file, close Excel (you cannot open your new file in DIVA-GIS until you close it in Excel).

3) *Import* wildpot-decimaled.txt *to points* (i.e., make it a shapefile) and name the shapefile "wild potatoes", save it in your folder. The shapefile will automatically be added to you map as the top layer.

4) Are there any specimens that appear to be positioned oddly in the an ocean?

If so, how many? _____

Do you think this is in error?_____

Retrieve (view) the data associated with such a point to determine whether or not its position seems appropriate using the information (i) tool as follows:

With the new specimen layer "wild potatoes" active (selected), click the information (i) tool from the tool bar at the top of the default data view window (see below). Click on that "outlier" point.

Which island was this specimen collected on?   _____

5) Prepare a figure of this plot of specimens—i.e., a "distribution map" for *Solanum* sect. *Petota*.

In DESIGN view (lower right tab of program window), click "OK" to show the map you just created. Add a scale bar and a North directional from the tool bar (see below).
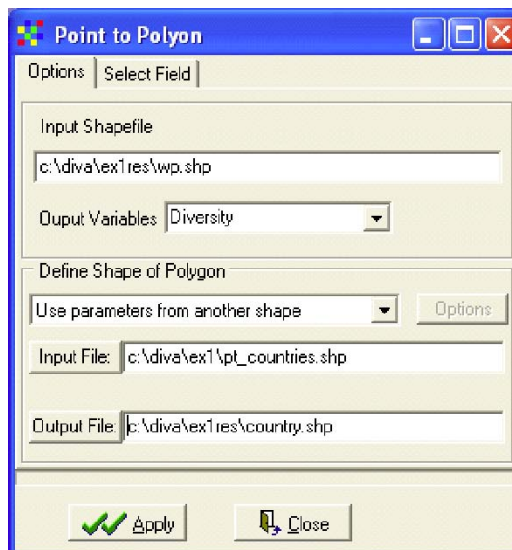
Then copy this image to the clipboard and paste it into a WORD document. Label this figure "Figure 1" along with a descriptive caption at the bottom of the figure. Save your WORD document as "wildpot-YOURNAME.doc".

B. Determine which country has more species.

1) Switch from DESIGN view back to DATA view.

2) Summarize the data by country as follows:

Make the "wild potato" shapefile layer the active layer/file and click on *Analysis > Point to Polygon* (see figure below). Select 'species' as the <u>field</u> of interest. Add the shapefile of countries ("pt_countries.shp") in the '<u>define shape of polygon</u>' box.
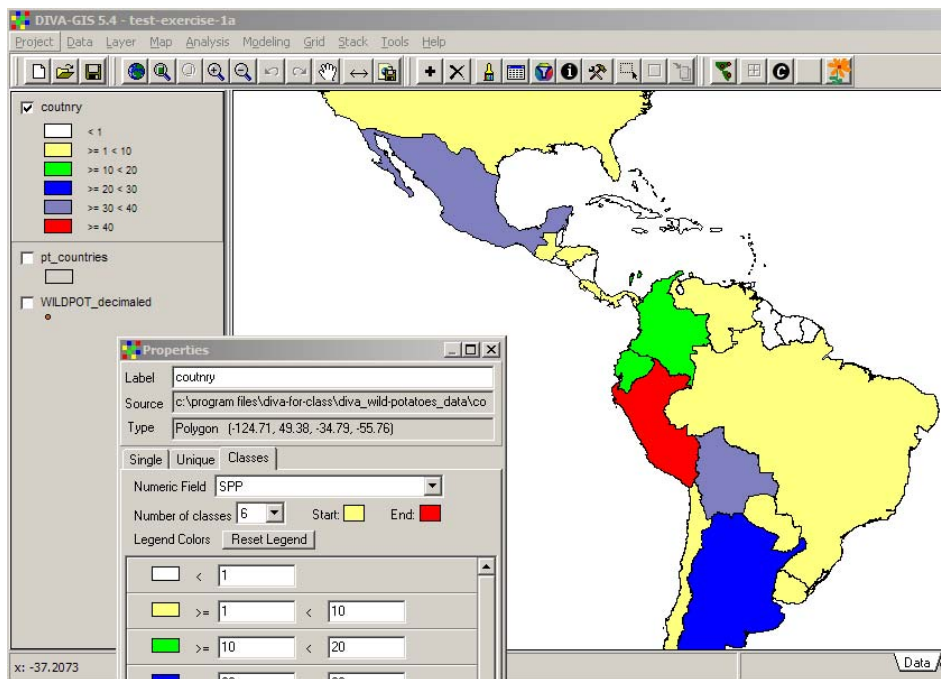
Select an output filename (call it "species-by-country") and press *Apply*. Be patient while the computer generates a new layer that color codes the countries according to the number of wild potato species they have.

3) Make this new layer visible and the other two layers invisible. Double click on the new layer and change its legend attributes.

First, on the *single* tab, double click on the symbol and change its style to 'solid fill' if is not already. Then go to the *classes* tab, select the "SPP" field, 6 classes, and reset the legend. SPP stands for the number of distinct species. See figure below. Don't worry about the other fields (however, the manual will give you this information).

Manually change the values (and colors) of the different classes to get something like this below, where countries with no potato species are white, those with 1<10 are yellow, those with 10<20 are green, 20<30 are blue, 30<40 are purple, and >=40 are red.

Which country has the most species and with how many? _____

Which country is second and with how many? _____

Which country is third and with how many? _____
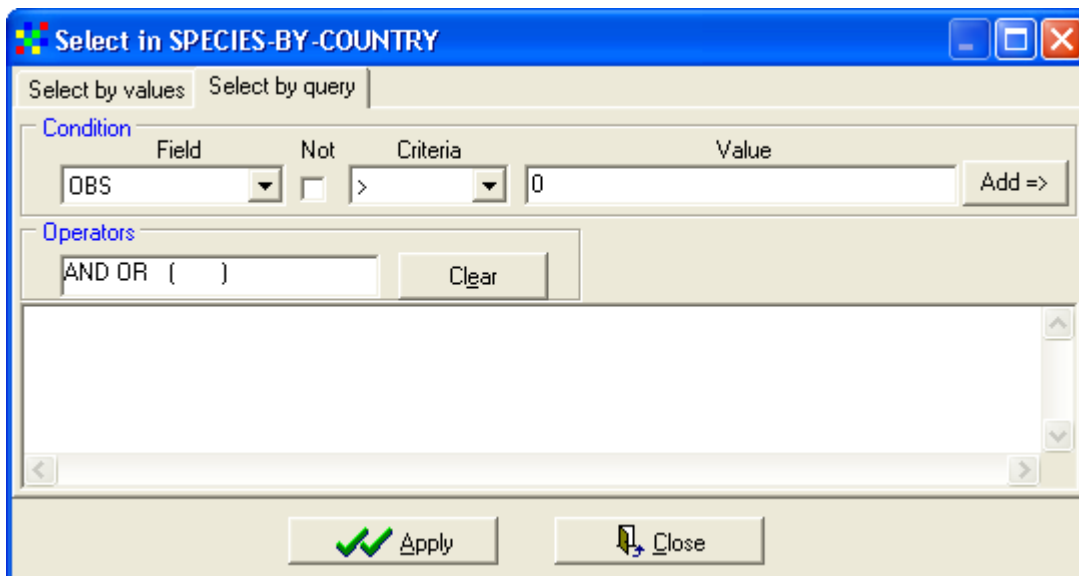
Fourth? _____

Fifth? _____

Sixth? _____

Move the shapefile of wild potato collections to the top and make it visible if not already.

In DESIGN view, add legend (to explain the color coding), add a scale bar, and add a North directional to the map.

> Copy to the computer clipboard and paste it into your existing WORD document as Figure 2, along with a descriptive figure caption.

4) Back in DATA view, open the table associated with the shapefile, you will see that there are records for many countries that have no potatoes at all. To simplify our table, we first <u>select</u> the records with more than 0 observations (OBS). Using *Layer > Select Records* and the *select by query* tab (see below). *Add* your query and click *Apply*.

After entering the appropriate query all countries with potatoes will be colored yellow on the map (they are 'selected'). Now save the selection to a new shapefile as "countries-with-wildpotatoes" in your personal potato data folder ("*DATA > Selection to new shapefile*"): it should be added to the map automatically. If not, then add it using the *LAYER > Add layer function*.

> Make the species-by-countries layer active and unselect the countries using *LAYER > Clear selection*.

Make the new "countries-with-wildpotatoes" layer the active layer and open the table of data associated with it. The table should look something like this:

COUNTRY	DIVAID	OBS	SPP	MARGALEF	MENHINICK	SHANNON	SIMPSON
ARGENTINA	1	1473	28	3.7	0.7	0.001	11.94
BOLIVIA	5	985	38	5.37	1.18	0.03	19.7
BRASIL	6	17	3	0.71	0.48	0.24	3.09
CHILE	7	94	3	0.44	0.21	0.58	2.06
COLOMBIA	8	104	13	2.58	1.18	0.04	6.66
COSTA RICA	9	24	1	0	0	1	1
ECUADOR	13	139	14	2.64	1.1	0.15	7.28
GUATEMAL/	17	58	6	˙.23	0.66	0.02	4.05
HONDURAS	21	1	1	0	0	1	-1
MEXICO	24	846	36	5.19	1.2	0.02	15.42
PANAMA	26	13	2	0.39	0.28	0.46	2.17
PARAGUAY	27	19	2	0.34	0.23	0.05	1.12
PERU	28	1042	89	˙2.66	2.73	0.004	20.74
UNITED ST/	37	157	3	0.4	0.16	0.01	2.01
URUGUAY	38	4	2	0.72	0.5	0.5	3
VENEZUELA	39	14	3	0.76	0.54	0.14	2.84

Record: 1 of 16

Statistic   Highlight   Pan To   Zoom To

The information by country is of interest and can be useful. However, it is not very helpful for understanding the spatial distribution of wild potatoes or for guiding collection efforts because the countries have such different sizes and shapes, and because most are very large and it does tell us where in one particular country we expect to find many or few species. It is in most cases better to use grids with cells of equal area, and that is what we will do next.

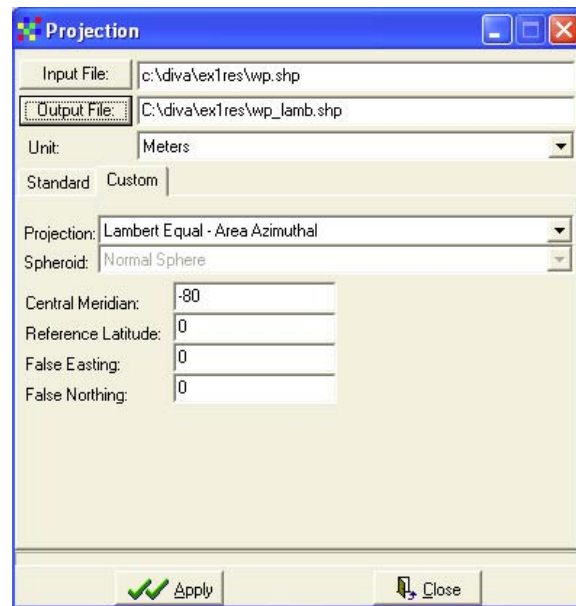5) Save the project to your personal potato data folder as 'YOURNAME-Solanum.div'.

C. Prep for producing a species richness grid: Project the data

To be able to use a grid with cells of equal area, the data needs to be projected. If the lat/long data were used, cells of say 1 square degree would get smaller as you move away from the equator: think of the meridians (vertical lines) on the globe getting closer to each other as you go towards the poles.

For small areas, the standard UTM (Universal Transverse Mercator coordinate system) would be a good projection, but in this case we will use a projection that can be used for a complete hemisphere: the Lambert Equal Area Azimuthal projection. Before you project your data, you must choose a map origin for your data. This should be somewhere in the center of your points, to minimize the distance (and hence distortion) from any point to the origin. In this case, the center could be (-80, 0). Confirm for yourself that these coordinates are roughly in the middle of your collections by running the mouse over the map image and reading the "live" coordinates in the bottom left of the program window until your approach 80 degrees west and 0 degrees (the equator).

1) Right click on each layer in the layers palette to remove all layers from the map except the *wild potato* and the original *country shapefile*.

2) Project these files using *Tools > Projection*.
   Choose "projection of hemisphere", then the "Lambert Equal Area Azimuthal (equatorial)" projection.

   On the *custom* tab, change the central meridian to -80. Using the "OUTPUT" button, browse to your personal folder and save the files with filenames such as 'wild potatoes lambert' and 'countries lambert'. Press *Apply.* Be patient…
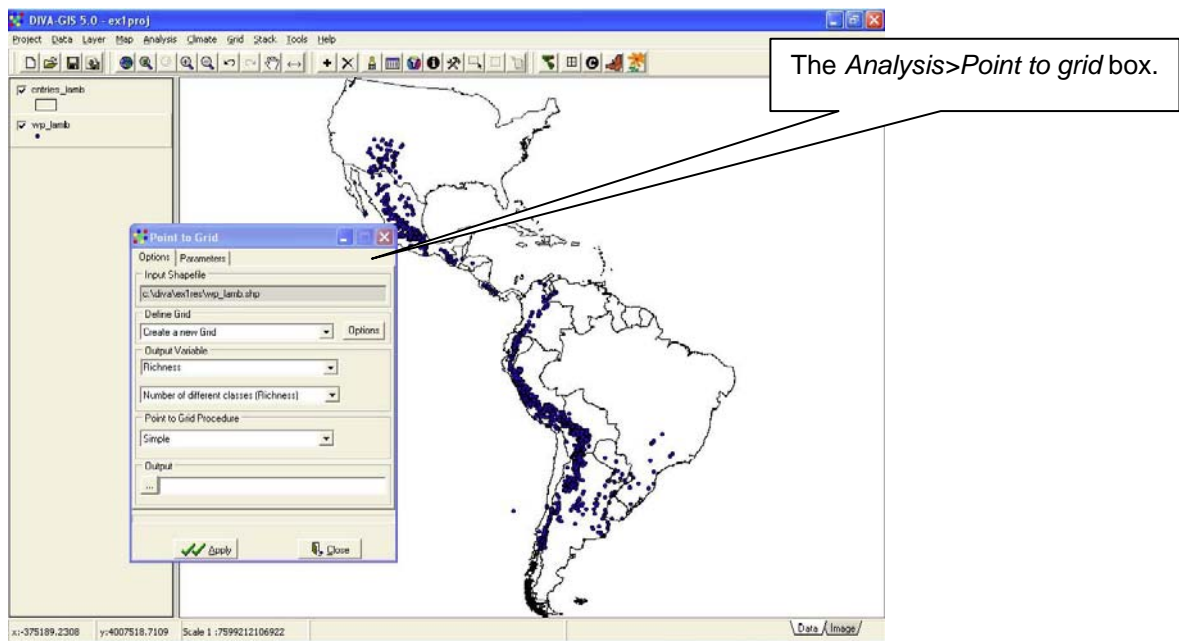

3) Make all layers visible.

4) Zoom to the maximum extent (right click on data-map window, then "full extent), you see the projected data. Note that the shape of the countries is much more similar to their shape on a globe than before projecting. In the bottom left corner you can see that the coordinate system has changed. You likely see very large numbers now: these express the distance from the origin (-80,0 degrees) in meters rather than in degrees. If you make the projected potato file invisible, you will see that the unprojected data is still present on the map, near the origin of the projected data. Zoom in to that area with a click-and-drag of the *Magnifying Glass tool* from the toolbar.

   Clearly one cannot combine projected and unprojected data (or data in two different projections) on a single map. Get rid of the old, unprojected data.

5) Now go to *Map>Properties* and change the projection to "Other" and the units to 'meters'. This will allow for displaying a correct scale on the map.

6) Save the project to 'YOURNAME-Solanum'.

D. Species Richness on a grid

1) Let's determine the distribution of species richness (i.e., species per unit area) using a grid. This can be done using the point-to-polygon option that we used before, but in most cases it is more appropriate to use *Analysis>Point to grid.*

The *Analysis>Point to grid* box.

From the *Main* tab, select 'Richness' and 'Number of different classes (Richness)'.
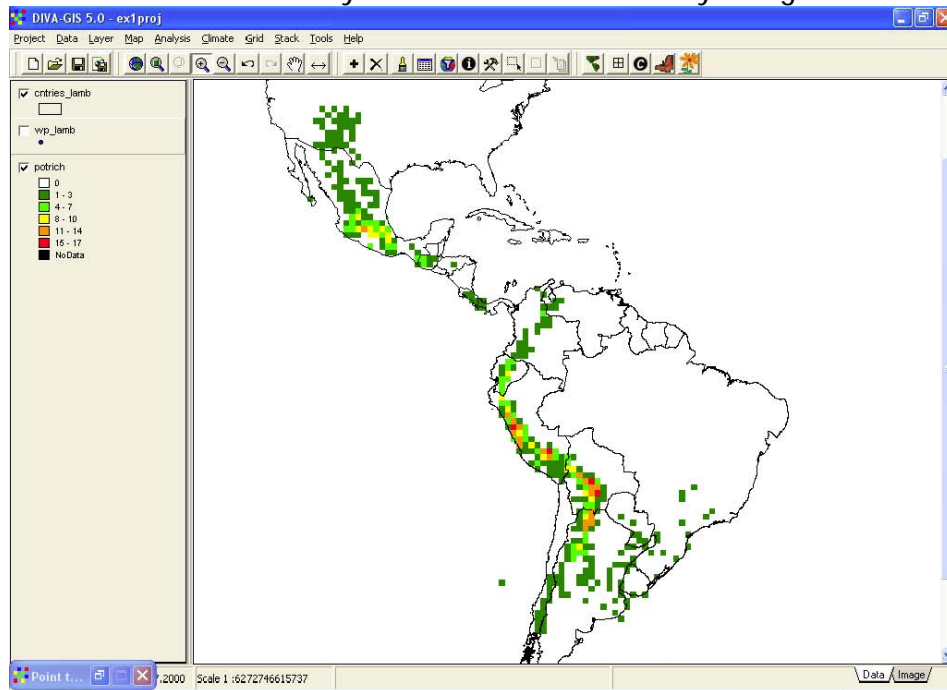From the *Parameters* tab, and select the 'Species' Field.

Create a new grid: In the *Options* window, set the X and Y dimensions of the cell size to 100,000 (as the projection is in meters this means that the cells will be 100 by 100 km). Use the default option ('simple') for the Point-to-grid procedure.

Choose an output filename and save it as 'species richness' in your personal potato data folder, press *Apply*. Play around with the cell size (try 100 by 100 meters, 10,000 by 10,000, etc.). Return to 100,000 by 100,000.

2) Prepare this richness map as a figure in your growing WORD document.

> 2a. Slide this new "species richness" layer to the top of the layers palette. You'll note that the country borders are obscured by the grid cell colors.

> 2b. Double click on the grid layer on the layers palette to alter its properties.
>
> 2c. In the properties window, remove the first row that reports grid cells with 0 species as white. This "white" is masking most of the country borders.
>
> Also check the box in the lower left to make those grid cells with no data transparent.
>
> 2d. Click *Apply*.
>
> 2e. Now the map looks better and we can switch to DESIGN view to make a map image for pasting into our WORD document. MAKE SURE THE RICHNESS GRID IS THE TOP LAYER BEFORE SWITCHING TO DESIGN VIEW.
>
> > Add a scale bar, North directional arrow, and the legend (showing the richness color scale only) to the map.
> >
> > Copy to the clip board and paste it into your WORD document as Figure 3. Give this figure a descriptive caption.
>
> Here briefly contrast the information content and meaning of the report of species by country vs. by grid cell.

Which map, species-by-country or species-by-grid would be more useful for targeting fieldwork meant to locate as many species of wild potato as efficiently as possible? Explain.

_____

_____

_____

Which map would be more useful for identify richness "hotspots" for wild potato species? Why?

_____

_____

_____

Give me this document with your answers marked onto it. Also email the entire WORD file with the three figures to me. (10 pts.).