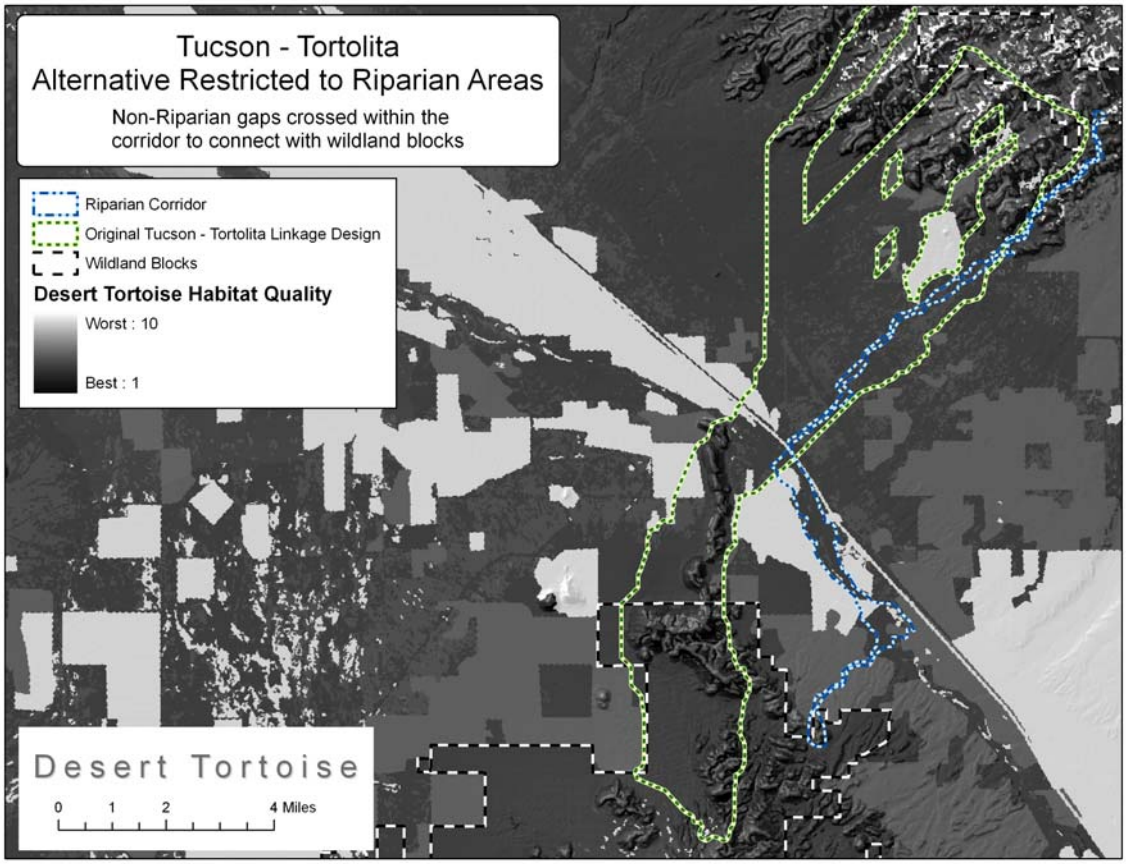
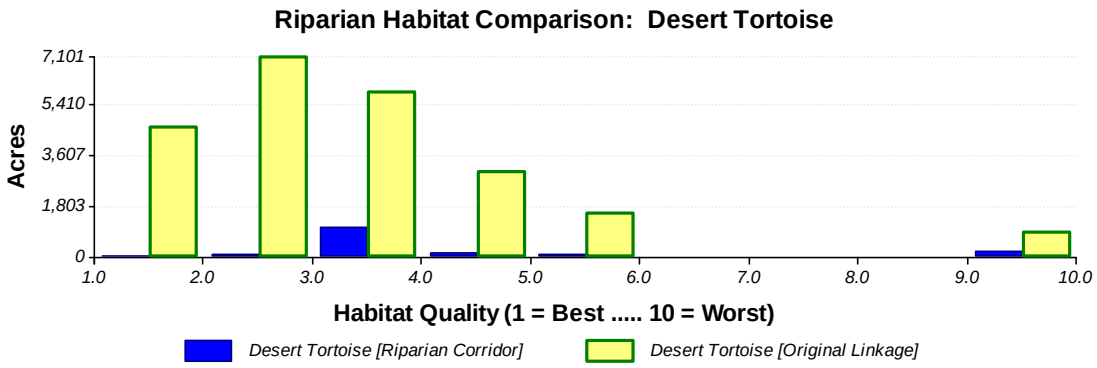
Histograms and Habitat Suitability Statistics

The Corridor Designer Evaluation tools include a variation of the general statistics tool designed to show multiple datasets side-by-side in a histogram, with simple functions to modify the aesthetic properties and export the image as a graphic. We designed this tool to compare histograms of habitat suitability (raster layers) in alternative corridor polygons, but it can be used with any raster or vector dataset.

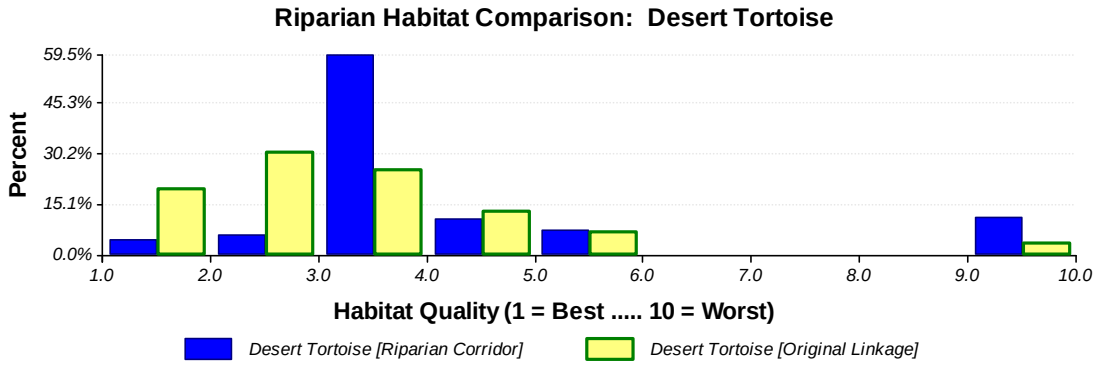
For example, given two alternatives for a Desert Tortoise corridor, you may wish to look at the distribution of habitat quality within each corridor.



The histogram below demonstrates that there are more acres of high-quality habitat in the original linkage design than in the alternative riparian corridor.



Alternatively, you may be interested in the relative proportions of habitat within each histogram bin. In this case, we see that the riparian corridor contains mostly habitat quality between 3 and 4, while the original linkage design is more evenly distributed over the range between 1 and 6.

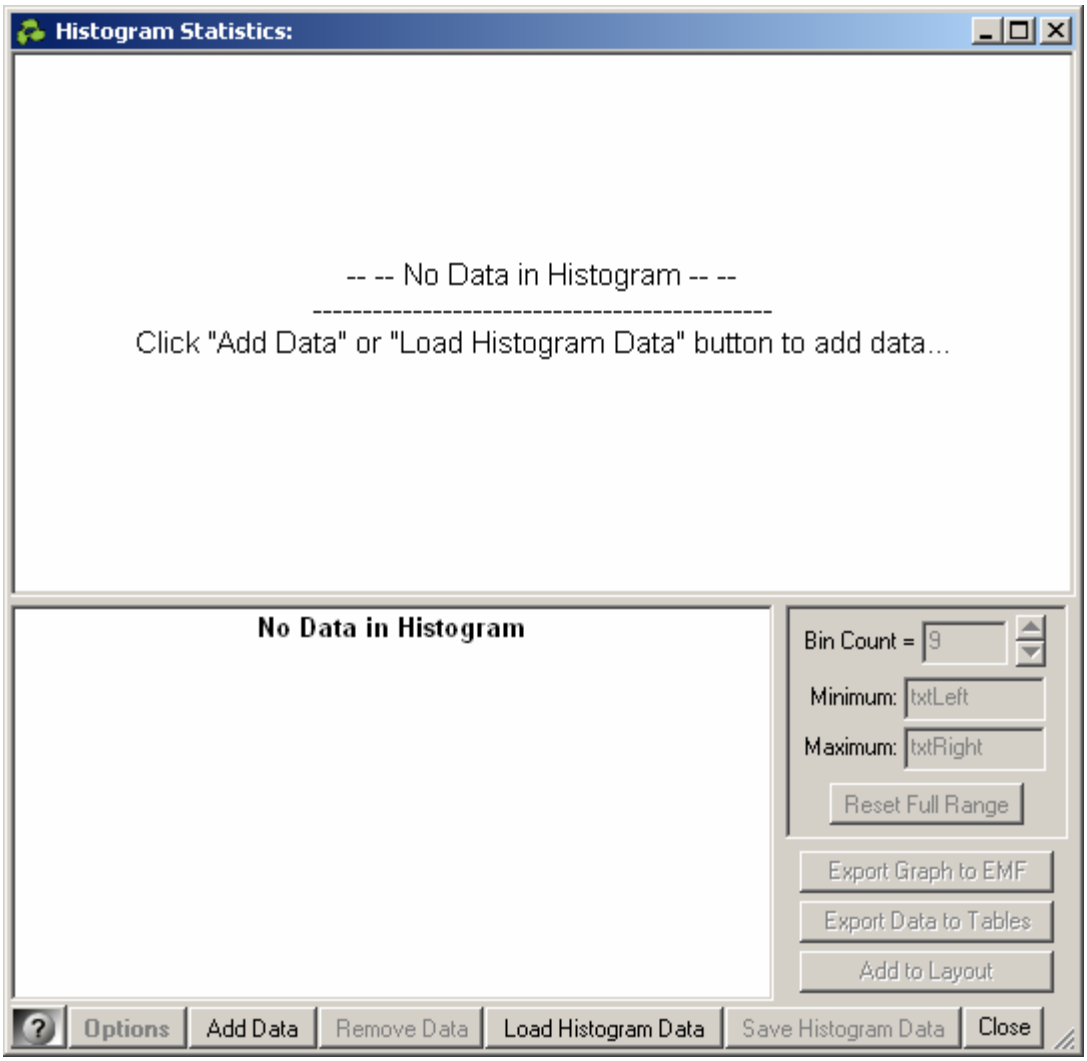


This tool also provides a standard set of descriptive statistics for all datasets depicted, including the mean, minimum, maximum, standard deviation, range, sum, count, median and standard error of the mean, as well as counts and percentages of each histogram bin.

As with the general summary statistics tool, this tool will not automatically clip a raster or feature layer to a particular polygon or area of interest. It analyzes entire datasets, and therefore you must clip any datasets to your area of interest prior to running this tool. Please refer to "Using the Clip Tool" (see p. 14) for more information on how to clip your datasets.

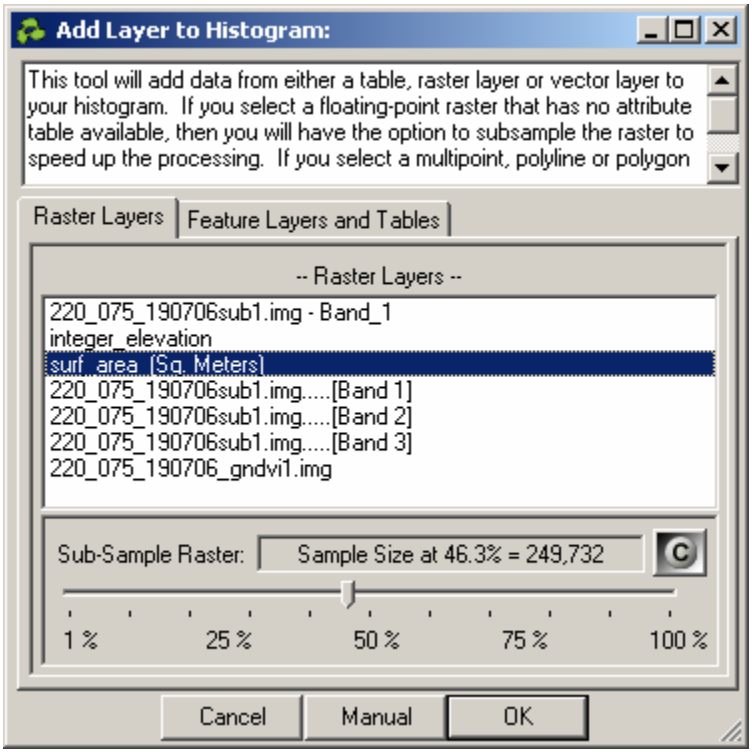
Alternatively, if you analyze feature layers or tables, then you do have the option to analyze only the selected features or rows. Therefore if you can isolate your features of interest by selecting them, then you can use this tool to analyze only those features. However, you will need to use the Clip Tool if you wish to analyze only the portions of features that lie within some polygonal boundary.

Open the histogram tool by clicking the  button:



ADDING NEW DATA:

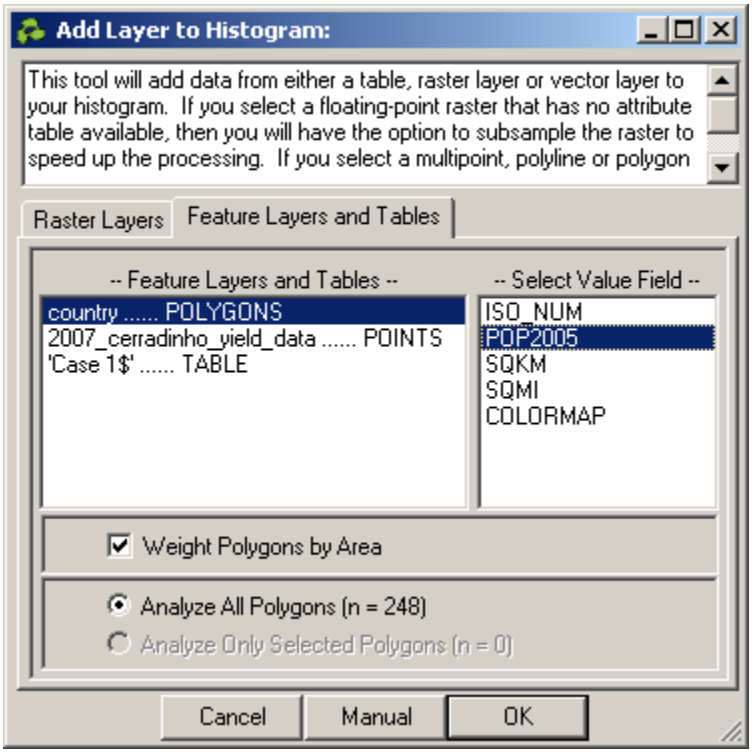
The histogram tool will be empty when it is first opened, so your first step will be to add some data. If you have a layer in your map that you would like to add, then click the "Add Data" button to open the "Add Layer to Histogram" window:



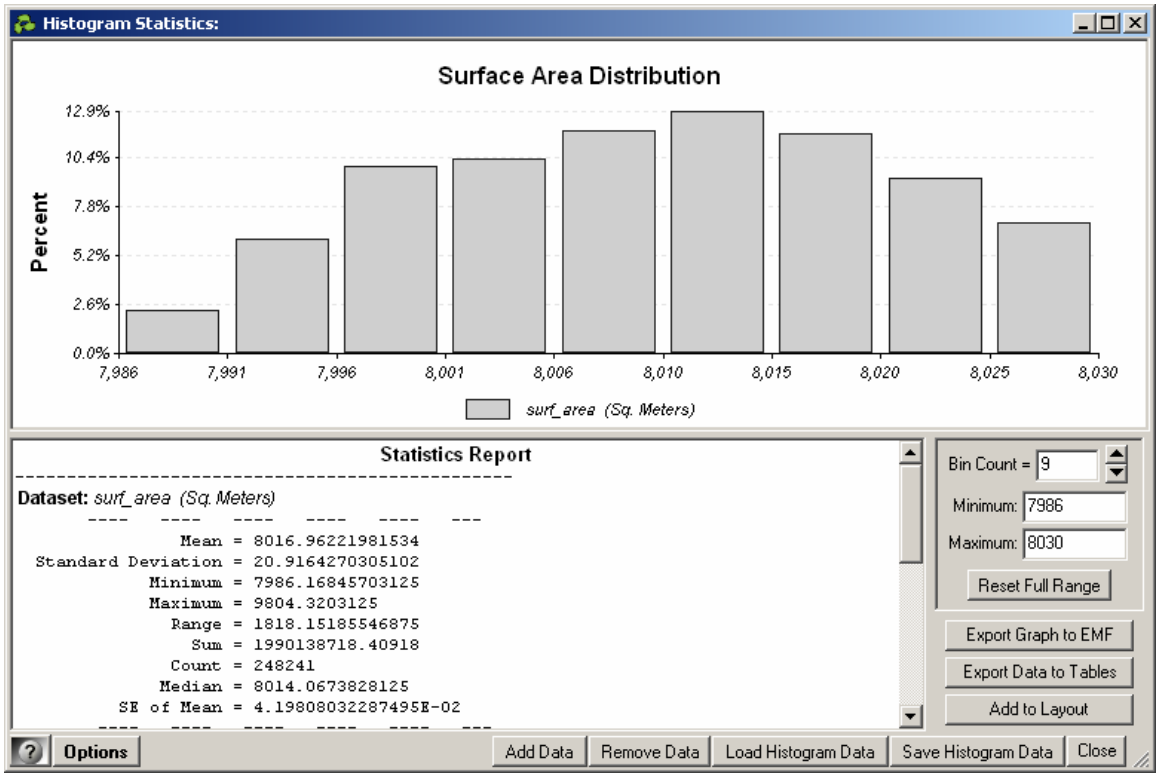
Note that you can add data from either raster layers, feature layers or tables. You have a few options for each case:

Raster Layer Options: If your raster has an attribute table, the tool will automatically get the necessary histogram data directly from the attribute table. If there is no attribute table, the tool will extract the data from the raster. This can take a long time with large rasters, so for large rasters you will want to used the option to sub-sample the raster. You can choose to sample any level between 0.1% and 100% of the total raster cell count, or you can use the default sampling option, which chooses whatever percentage represents approximately 250,000 raster cells. The "C" button will also select the percentage that produces a sample size closest to 250,000 cells.

Feature Layer and Table Options: In the case of feature layers and tables, this tool will give you the option to either analyze all records or only the selected set of records. In the case of Multipoint, Polyline or Polygon feature layers, the tool will give you the option to weight the feature value according to the size of the feature. For example, a polygon measuring 100 sq. meters would count twice as much as a polygon measuring 50 sq. meters.



Click "OK" to add the layer. You may continue to add as many layers as you wish. Each layer will be added to both the graphic histogram and to the statistics report.

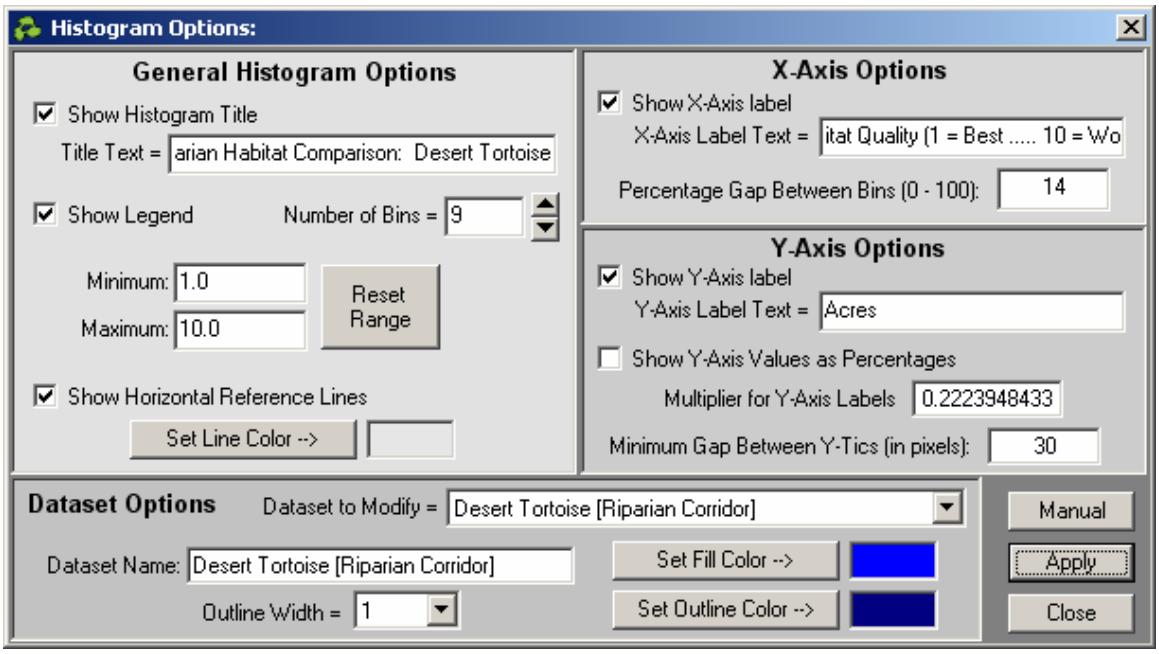


SETTING HISTOGRAM PROPERTIES:

There are several functions available to modify the visual appearance of the histogram. The size and shape can easily be altered by dragging a corner to resize the entire dialog. The histogram itself will automatically resize itself to fit within the available space.

You can set the number of bins, and the minimum and maximum values, in the histogram window. This is useful if you want the histogram to cover the full range of possible values regardless of the minimum and maximum values of each individual raster. For example you might want two histograms of habitat suitability to span the full range of possible suitabilities, rather than the range represented in the data. The histogram will change automatically as you change these values.

More advanced settings are available by clicking either the "Options" button, or by double-clicking on the histogram itself, to open the "Histogram Options" window:



Change as many options as you wish, then click "Apply" to apply your settings to the histogram.

General Histogram Options:

1) Histogram Title: Set the title text here, and specify whether or not you want the title to appear on the histogram.
2) Legend: Specify whether or not you want the legend to appear on the histogram.
3) Number of Equal-Interval Bins and Minimum and Maximum Values.
4) Horizontal Reference Lines: Set the color for these lines and specify whether you want them to appear. Set the color by either clicking the "Set Line Color" button or by double-clicking in the color box.

X-Axis Options:

1) X-Axis Label: Set the label text here and specify whether you want the label to appear on the histogram.

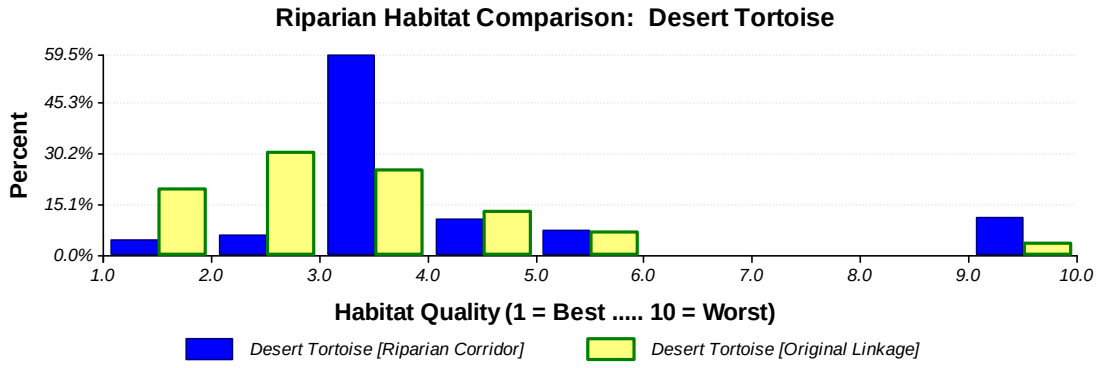
2) Percentage Gap Between Bins: This number represents how much space is left between vertical histogram rectangles. The value is defined as the percentage of the total bin width that is allocated to the gap between histogram rectangles. Set this to 0 to make all the rectangles adjacent to each other. The default value is 14%, and the maximum is 100%. Use trial and error to pick a gap that is visually pleasing. **Note:** If multiple datasets are shown on the histogram, the rectangles for each dataset within a single bin will always be adjacent to each other. This value only represents the gap between each bin, such as the gaps at 2.0 and 3.0 in the figure below.

Y-Axis Options:

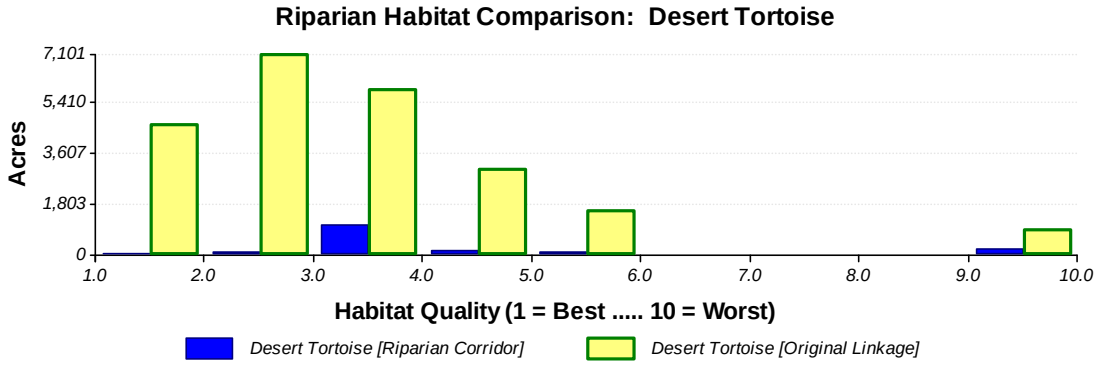
1) Y-Axis Label: You can set the label text here, and specify whether or not you want the label to appear on the histogram.

2) Show Y-Axis Values as Percentages: This option will cause the dataset rectangles to be resized so that each bin represents the percentage of the dataset that lies within the bin. Using this option, the total area of all the dataset rectangles will be equal among all the datasets (i.e. they will all total to 100%). If this option is not set, then the total area covered by the combined rectangles of each dataset will be proportional to the actual area on the map, or the number of records in the table.

   For example, you may wish to compare habitat quality for desert tortoise in a very narrow corridor to habitat quality in a much larger corridor. If you set the option to show the data as percentages, then the narrow corridor looks relatively good for tortoises:



   The histogram of area tells a very different story, namely that the wide corridor has a great deal more high-quality habitat:



Each option is useful in different circumstances.

3) Re-scaling Multiplier for Y- Axis Labels: This option re-scales the Y-axis label values by multiplying them by a constant. This is useful in cases where the actual units in the data are not intuitive. For example, if your raster has a cell size of 30m, then each cell therefore covers an area of 900 square meters. If you wish to show your Y-axis in units of Acres, then you would need to apply a multiplier value of approximately 0.22 because 1 raster cell (900 square meters) is approximately equal to 0.22 acres. You can therefore set the multiplier value, and then set the Y-axis label to "Acres" to make the Y-axis units more intuitive to viewers.

   The following table summarizes some common cell sizes and corresponding multipliers for common output units:

Y-Axis Multiplier Values for Common Raster Cell Sizes				
Desired Y-Axis Units	**Actual Raster Cell Size, on Edge**			
	10m	**30m**	**90m**	**1km**
Square Meters	100	900	8100	1000000
Square Feet	1076.391042	9687.519375	87187.67438	10763910.4
Acres	0.0247105381	0.2223948433	2.00155359	247.105381
Hectares	0.01	0.09	0.81	100
Square Miles	0.000038610	0.000347492	0.003127427	0.386102159
Square Kilometers	0.0001	0.0009	0.0081	1

   The following table summarizes some common linear units and corresponding multipliers for common output units.

Y-Axis Multiplier Values for Common Linear Units		
Desired Y-Axis Units	**Actual Data Units**	
	Meters	**Feet**
Meters	1	0.3048
Feet	3.280839895	1
Miles	0.000621371	0.000189394
Kilometers	0.001	0.0003048

   The following table summarizes some common areal units, and corresponding multipliers for common output units.

Y-Axis Multiplier Values for Common Areal Units		
Desired Y-Axis Units	**Actual Data Units**	
	Square Meters	**Square Feet**
Square Meters	1	0.0929030400
Square Feet	10.7639104167	1
Hectares	0.0001	0.0000092903
Acres	0.0002471054	0.0000229568

Square Miles	0.000000386102	0.0000000358701
Square Kilometers	0.000001	0.0000000929030

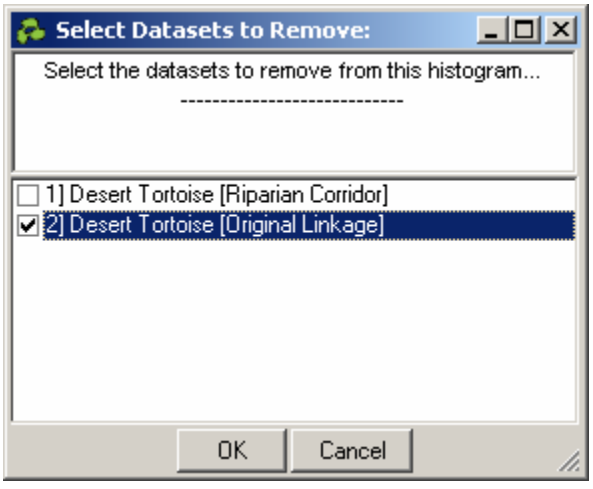
Note: This option is only available if the option to show Y-axis values as percentages is turned **off**. Also, this option (as well as the histogram in general) assumes that all datasets shown in the histogram share the same basic measurement unit. For example, this option is valid if the histogram shows multiple raster layers which all have the same cell size. If the histogram includes a mix of rasters with different cell sizes, or a combination of feature layers with different projections or different dimensions (i.e. a mix of polygons and polylines), then the base units of one layer will not be comparable to the base units of another layer. They can still be shown on the same histogram, but you have to remember that a polyline layer may be in values of "meters' while a polygon layer may be in values of "square meters".

4) Minimum Gap Between Y-Tics (in pixels): The histogram generates the Y-axis labels and background reference lines automatically based on the range of the data and the current size of the histogram window. This option lets you force the histogram to generate more or fewer Y-axis tics. By setting a larger minimum gap, you will force the histogram to draw fewer Y-axis labels and lines. With trial-and-error, you can force the histogram to display tic marks in "even" units, e.g., every 1,000 acres, or every 20%.

Dataset Options: These options allow you to change the appearance of each individual dataset depicted in the histogram. You must select which dataset to modify in the "Dataset to Modify" dropdown list. As you choose a particular dataset, its current name, outline width, fill color and outline color will automatically appear. You may make changes to any or all datasets before saving the changes. The changes will not be saved and applied to the histogram until you click the "Apply" button. You may change the fill or outline colors by either clicking the appropriate button or by double-clicking in the color boxes.

REMOVING DATA:

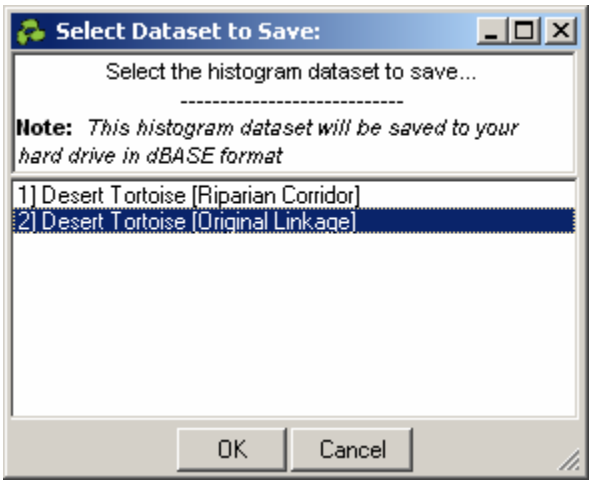
Use the "Remove Data" button to remove one or more datasets from your current histogram.



SAVING HISTOGRAM DATASETS:

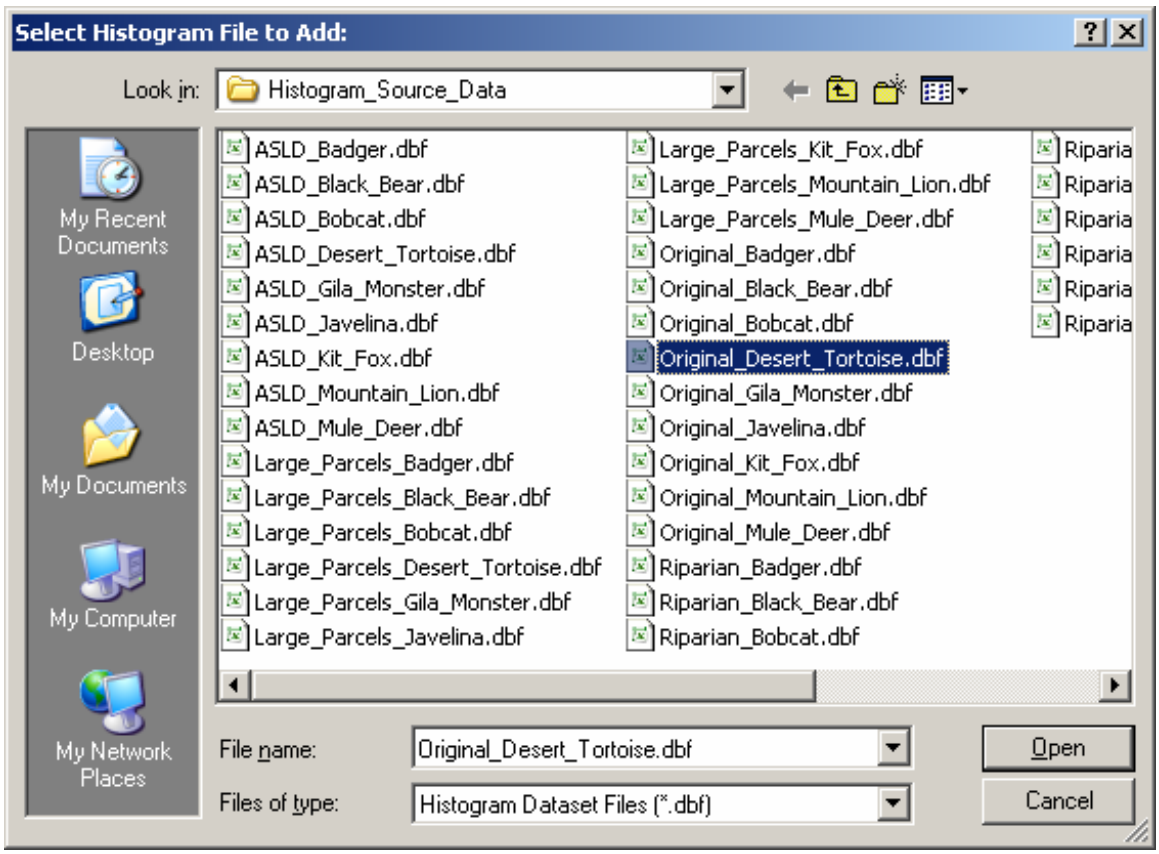
Each dataset is represented in the histogram with a particular fill color, outline color, outline width and name. The histogram also contains all the data necessary to draw the dataset bins

correctly. The "Save Histogram Data" button allows you to save all this information to a dBASE table where it can be easily reloaded in the future. This greatly simplifies the process of examining various combinations of datasets.



LOADING HISTOGRAM DATASETS:

Use the "Load Histogram Data" button to load datasets you have previously saved with the "Save Histogram Data" function.

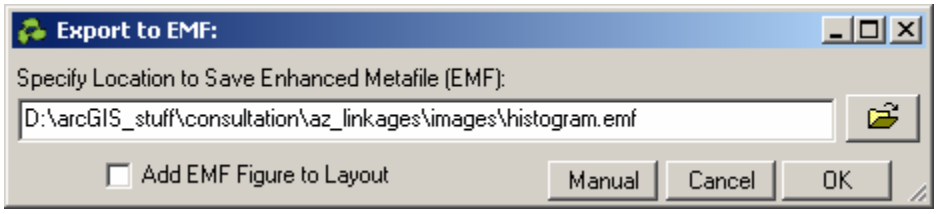


Note: This function will list all dBASE files, not just those that represent valid saved histogram datasets. If you attempt to load a non-histogram dBASE table, the tool will alert you that the file is not compatible.

SAVING GRAPHIC IMAGE OF HISTOGRAM:

You may save your histogram as an Enhanced Windows Metafile (or *.EMF file) for use in reports or presentations. Many programs such as Microsoft Word and PowerPoint (and ArcGIS) can load these EMF files.

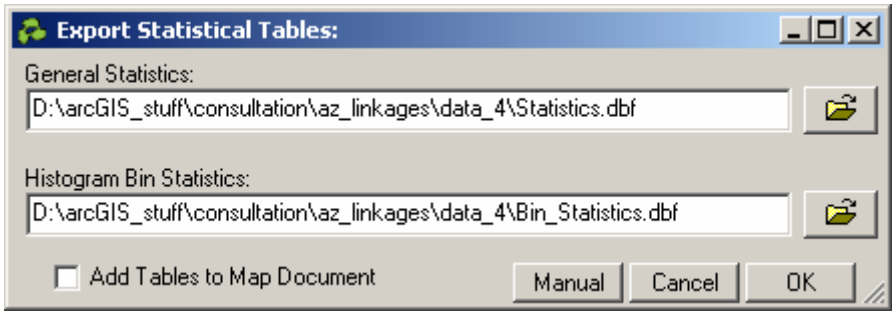
Click the "Export Graph to EMF" button to save the graphic image:



Warning: The tool will warn you if a file with the specified name already exists. It will attempt to overwrite the existing file if you tell the tool to do so, but it will fail if that file is open in some other program. ArcGIS might also crash in this case.

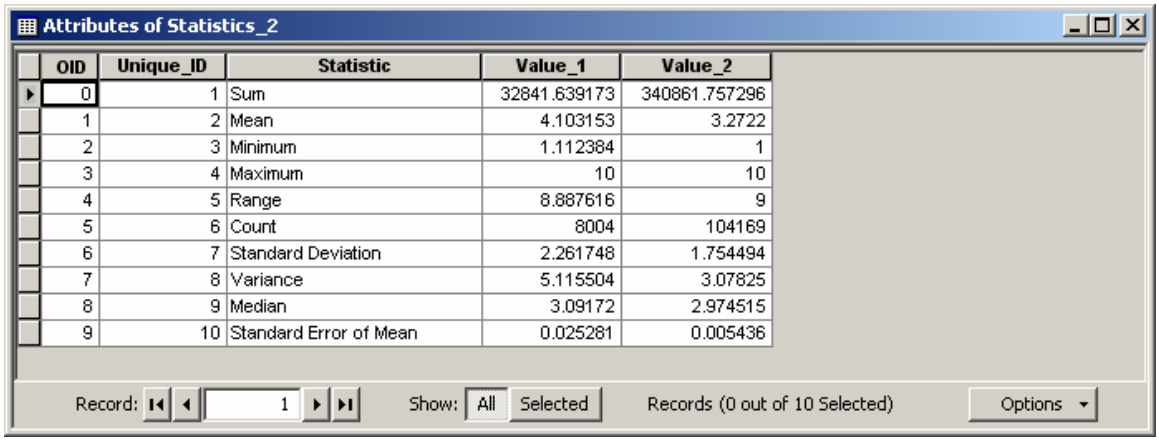
EXPORTING STATISTICAL TABLES:

Click the "Export Data to Tables" button to export statistical data.



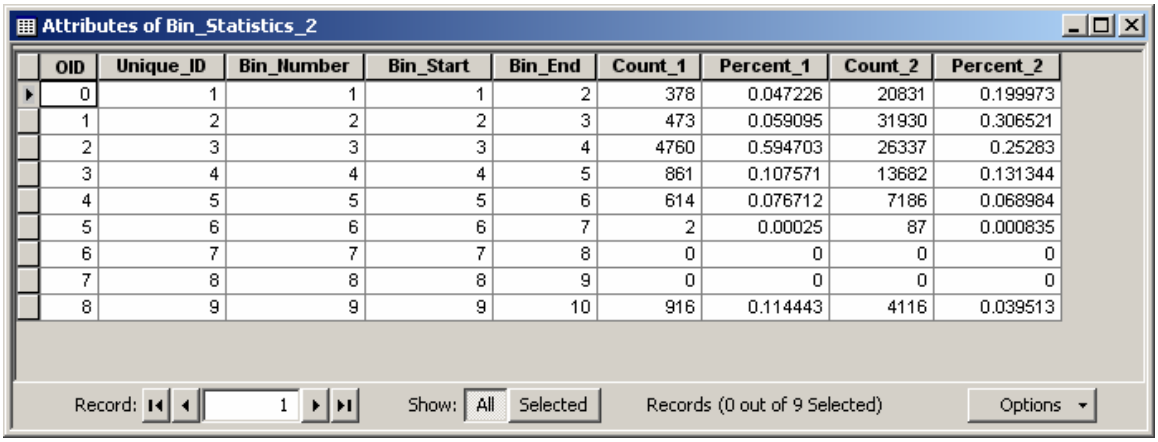
This function creates two dBASE tables on your hard drive containing statistical data for each dataset in the histogram.:

1) General Statistics Table: Contains the sum, mean, minimum, maximum, range, count, standard deviation, variance, median and standard error of the mean for each dataset in the histogram.



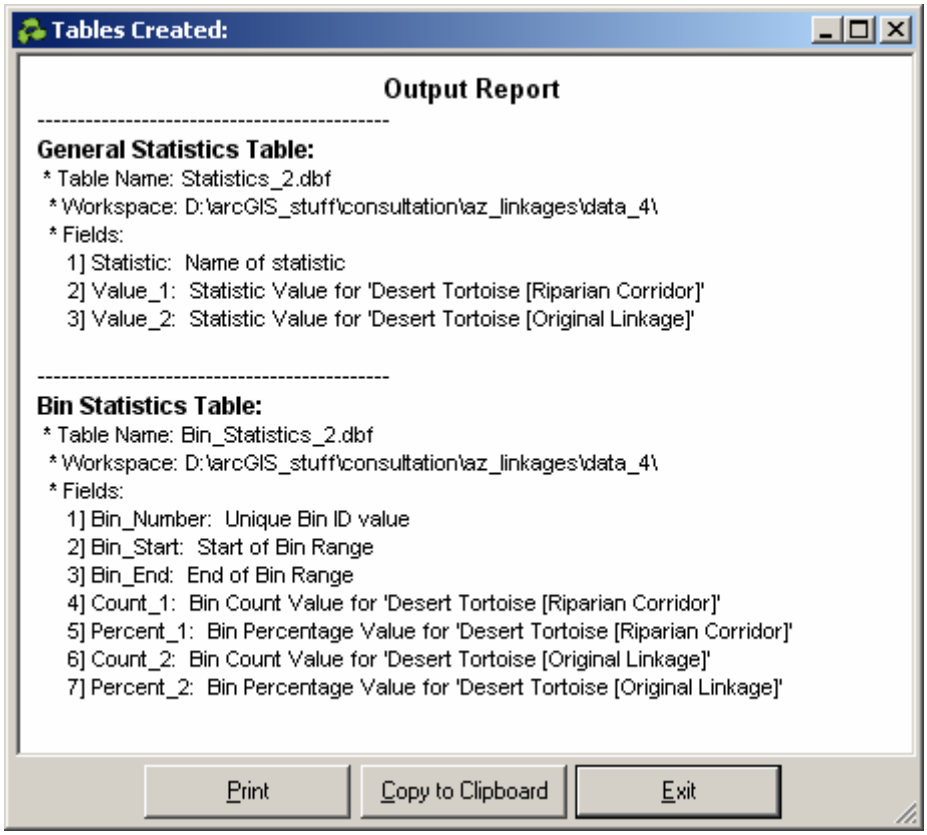
OID	Unique_ID	Statistic	Value_1	Value_2
0	1	Sum	32841.639173	340861.757296
1	2	Mean	4.103153	3.2722
2	3	Minimum	1.112384	1
3	4	Maximum	10	10
4	5	Range	8.887616	9
5	6	Count	8004	104169
6	7	Standard Deviation	2.261748	1.754494
7	8	Variance	5.115504	3.07825
8	9	Median	3.09172	2.974515
9	10	Standard Error of Mean	0.025281	0.005436

2) Bin Statistics Table: Contains the count and percent of each bin in the current histogram.



OID	Unique_ID	Bin_Number	Bin_Start	Bin_End	Count_1	Percent_1	Count_2	Percent_2
0	1	1	1	2	378	0.047226	20831	0.199973
1	2	2	2	3	473	0.059095	31930	0.306521
2	3	3	3	4	4760	0.594703	26337	0.25283
3	4	4	4	5	861	0.107571	13682	0.131344
4	5	5	5	6	614	0.076712	7186	0.068984
5	6	6	6	7	2	0.00025	87	0.000835
6	7	7	7	8	0	0	0	0
7	8	8	8	9	0	0	0	0
8	9	9	9	10	916	0.114443	4116	0.039513

The tool also produces a report detailing which dataset corresponds with each attribute field:



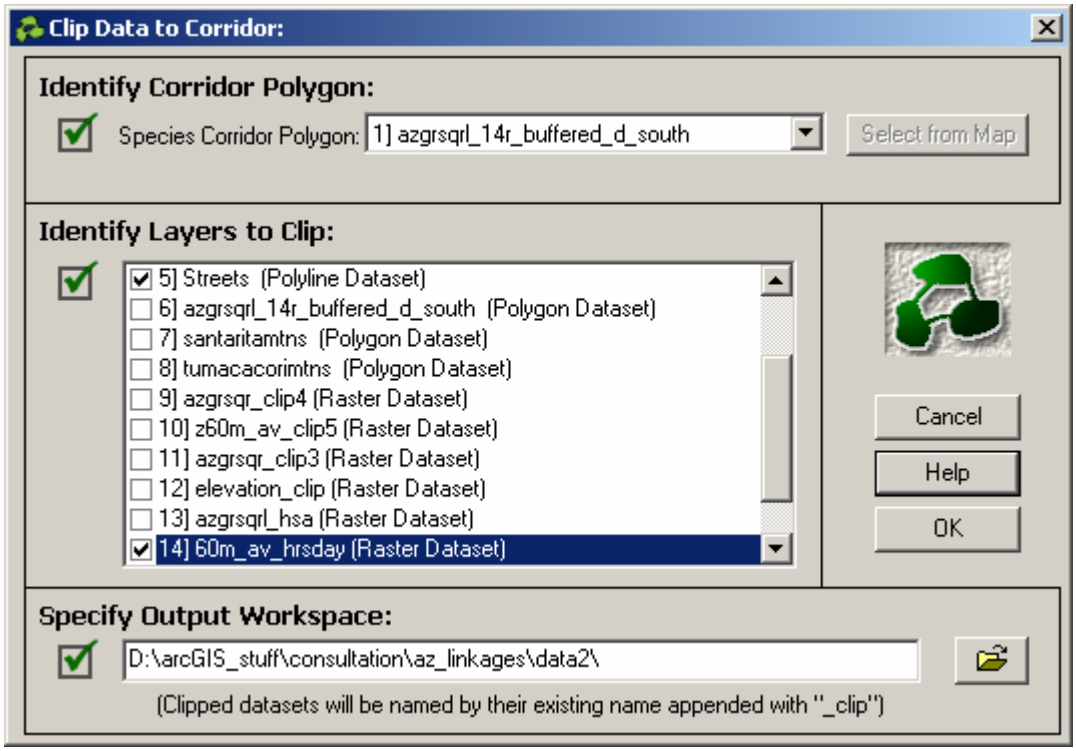
ADDING DATA TO LAYOUT:

The "Add to Layout" button will create an Enhanced Windows Metafile graphic of the image and automatically add it to your layout. It will also create a text report of the Statistics Report and add that to the layout.

Using the Clip Tool

The Corridor Designer Evaluation tools include functions to calculate a large variety of statistics on vector and raster data, including a specialized tool intended specifically for habitat suitability grids. However, these tools require that the vector or raster datasets be clipped to the polygon or area of interest before using them. The statistical tools themselves analyze the entire dataset and do not automatically clip the datasets as part of the analysis. Therefore we have provided a tool specifically designed to clip both raster and vector datasets to polygons.

Click the  button to open the "Clip Data to Corridor" dialog:



You must identify 3 parameters before the "OK" button will become enabled:

1) The polygon to clip to,
2) The layers to clip, and
3) The folder to save the new clipped datasets to.

As you identify each parameter, you will see green checkmarks appear in the respective boxes.

SELECTING THE CLIPPING POLYGON:

You have several options for selecting a corridor to clip to. You may:

1) Select a polygon layer from the map, IF that layer contains only a single polygon feature.
2) Select a single polygon from an existing polygon layer.

3) Select an existing polygon graphic.
4) Draw a new polygon graphic.

The drop-down list box at the top of the dialog lists all polygon layers currently in the active frame of your map document. If any of these contains only a single polygon, then you may simply select that layer and be done. However, the clipping tool is designed to work with a single polygon so you will receive an error message if you have multiple polygons in that polygon layer.

If you need to select a single polygon from a polygon layer, or if you need to select or draw a polygon graphic, then choose the option "Select by clicking on map". This will enable the button "Select from Map", from which you can access an interactive tool to directly select or draw your polygon. For more information on using the interactive polygon selection tool, please refer to "Selecting or Drawing Polygons" (see p. 16).

NOTE: This tool will not let you use several separate polygons for your clipping boundary. If you wish to use several polygons for this purpose, you will need to combine them into a single entity first. We have a separate stand-alone tool available which will do this function, available for free download at http://www.jennessent.com/arcgis/shapes_graphics.htm (see especially the discussion of the "Combine Features" tool).

IDENTIFYING THE LAYERS TO CLIP:

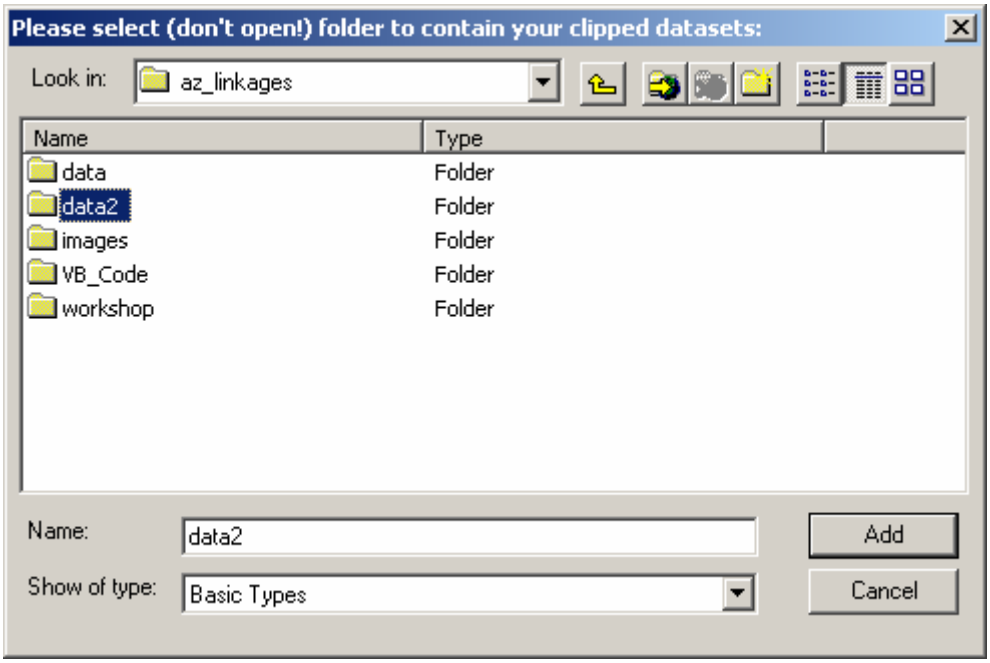
Select one or more layers to clip. Layers should be selected by clicking the check boxes to the left of each layer name.

This function will check to make sure the layers actually intersect the polygon before clipping them, and will also make sure the polygon is projected to the same coordinate system as the clip layer before the clip is executed. Therefore all clipped datasets will be in the same projection as the original dataset.

SPECIFY OUTPUT WORKSPACE:

Finally, make sure the clipped datasets are saved to the correct workspace. All clipped datasets will be named according to the layer name, appended with "_clip". In the case of clipping grids, new grid dataset names will also conform to grid naming rules (i.e. ≤ 13 characters, no spaces and does not start with a number).

If you need to select a different folder to save clipped datasets to, then click the  button to open the standard ArcGIS file browser folder:



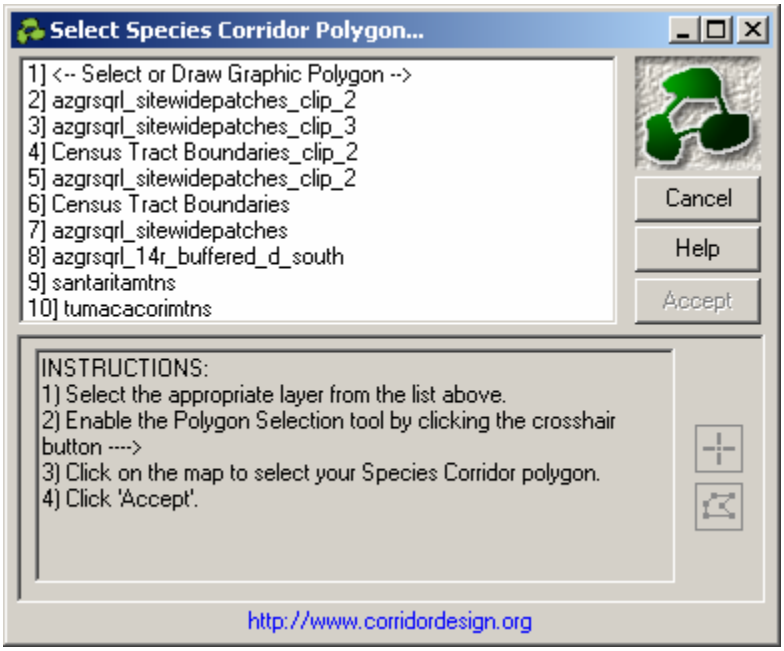
IMPORTANT: Do not open the folder you wish to select. Simply click on it once to select it, then click the "Add" button.

NOTE: This tool is an improvement over the standard ArcGIS clipping tools, in that it works equally well on raster and vector data and handles multipart polygons and polygons with holes or islands, or even multiply nested holes and islands. When clipping grids, it also maintains the full raster attribute table provided that there was one to start with. Finally, it will clip to non-standard shapes such as circles, ellipses and polygons containing curved segments.

NOTE: If you used a graphic polygon to clip with, and if you wish to save your graphic into a new polygon shapefile, you can use the "Create Shapefile" tool to do so (see p. 21).

Selecting or Drawing Polygons:

Four functions allow the user to do something based on a selected polygon graphic or polygon feature, and therefore all three tools needed a way to select or draw that polygon. The Patch Analysis, Bottleneck Analysis, Cross-Tabulation Table and Clip tools all provide access to the following dialog:

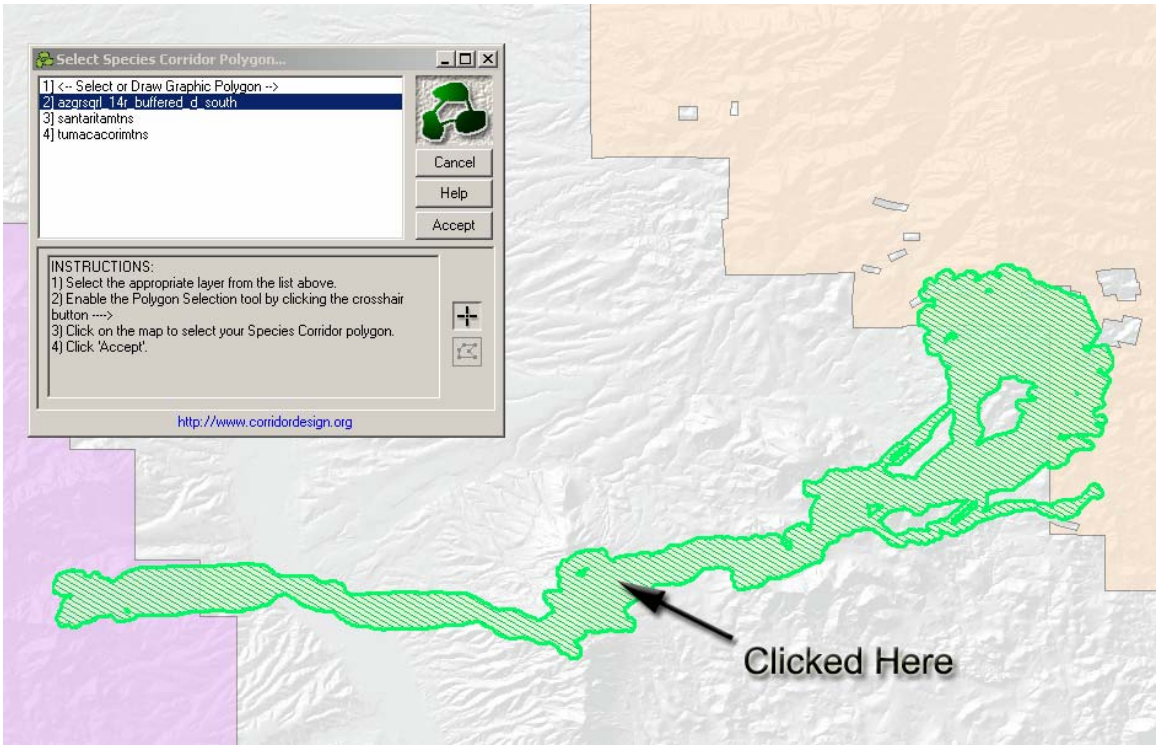


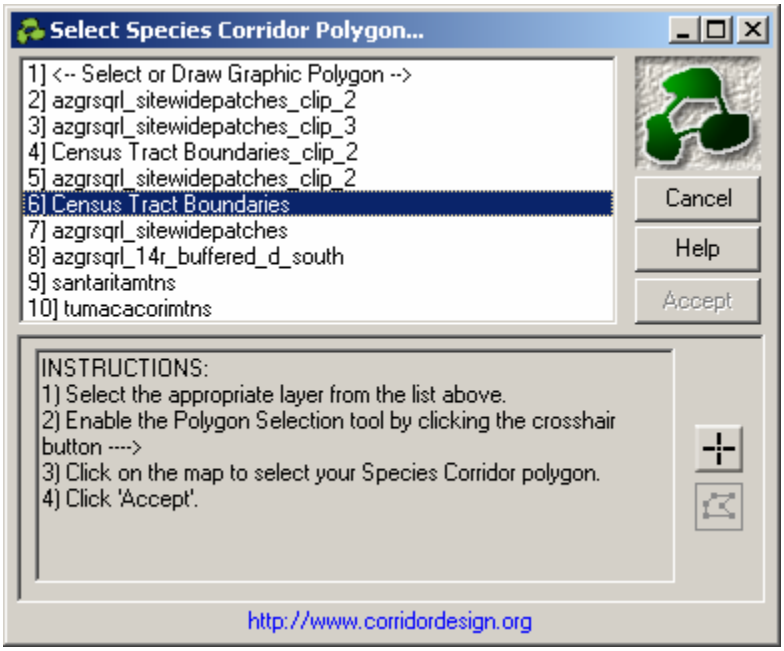
NOTE: The title of this dialog will change depending on whether the user is searching for a corridor polygon or a wildland block.

This dialog allows you to:

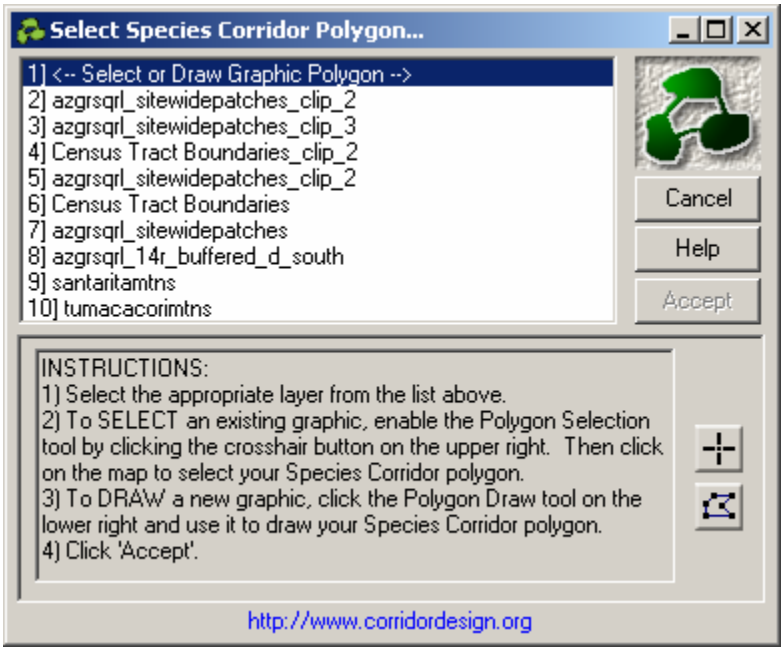
1. Select a single polygon from a polygon feature layer, or
2. Select a single graphic polygon, or
3. Manually draw a graphic polygon on the screen.

If you select a polygon theme from the list at the top of the dialog, then the "Select Polygon" button  will become enabled and the corresponding tool will become enabled on the Corridor Designer toolbar. Click this button and then select a polygon from the theme. After you click on a polygon, it will turn a green color with a crosshatch fill:



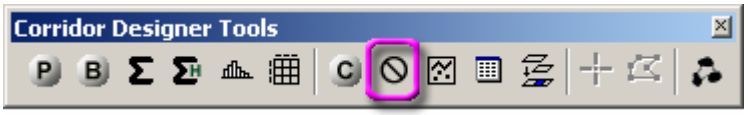


You may also select or draw graphic polygons, rather than selecting polygons from a polygon layer. If you select the first item in the list, "Draw or select graphic polygon", then both the "Select Polygon"  and "Draw Polygon"  buttons will become enabled. Use the appropriate button to either select or draw a graphic polygon. Note that the instructions change if you select this option:

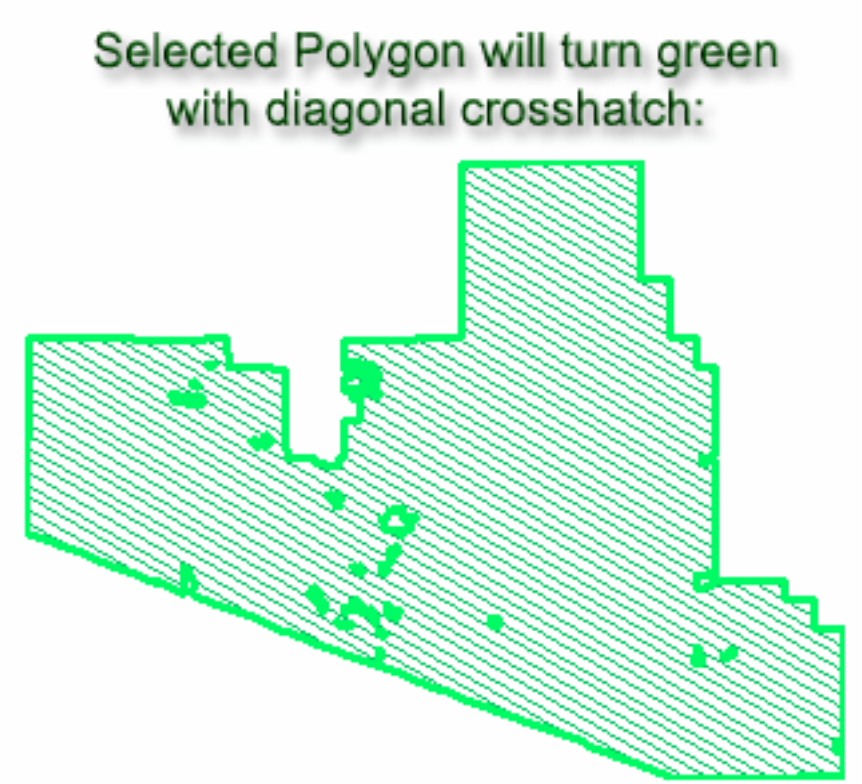


In all cases, selected polygons will be shaded green with a crosshatch pattern. If any of these graphics remain in your view after you no longer need them, you can quickly clear them out using the "Delete Corridor Designer Graphics" tool (p. 20). You may also convert any graphics to a shapefile using the "Create Shapefile" tool (p. 21).

Delete Corridor Designer Graphics:



Several of the Corridor Designer Evaluation functions create graphics on the screen. For example, the Clip tool and the Polygon Selection tool both produce polygons with a particular fill pattern:



The bottleneck and patch distance tools will also produce distinctive graphics.

This button simply clears out any CorridorDesigner-produced graphics, leaving any other user-created graphics untouched.

Create New Shapefile:

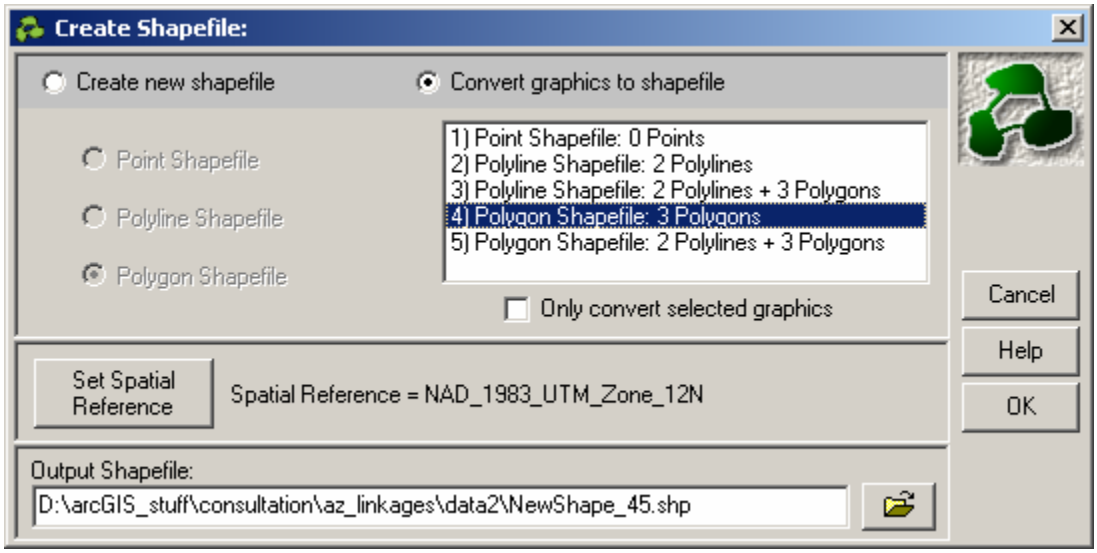
This function allows you to either create a new empty shapefile or convert graphic shapes to a shapefile. You may create either point, polyline or polygon shapefiles with this tool.

- Polygon shapefiles will include attribute fields for [Unique_ID] and [Area].
- Polyline shapefiles will include attribute fields for [Unique_ID] and [Length]
- Point shapefiles will include attribute fields for [Unique_ID], [X_Coord] and [Y_Coord].

NOTE: If you are converting graphics to a shapefile, and if those graphics have names (right-click the graphic and check the properties to see if it has a name), then these names will also be added to the attribute table in a [Name] field.

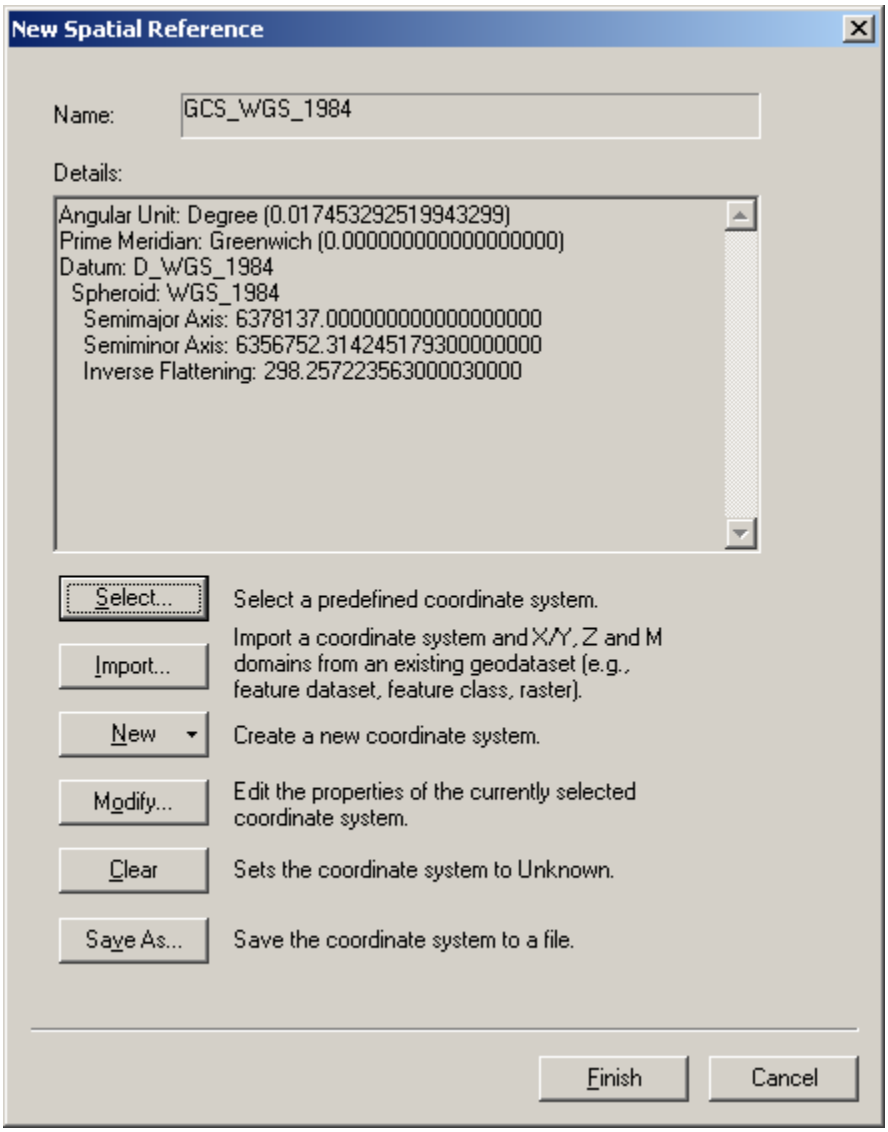
This function also allows you to convert polyline graphics to polygons, or polygon graphics to polylines, if you wish. When opened, the tool will examine your map to see how many point, polyline or polygon graphics are available, and whether any of them are selected. The tool will show you how many of each type are available to convert. If you attempt to create a shapefile from existing graphics when there are no graphics to convert, you will be notified of this and asked if you would like to try a different shape type.

NOTE: Certain linear or areal graphic shapes are not technically polylines or polygons. Polygons that are defined by a circle or elliptic arc are not really "polygons" in the sense that they are not composed of a series of straight-line segments. This is also true for linear features that are constructed of Bezier curves. It is not possible to add true curves such as circles, ellipses or Bezier curves to a polyline or polygon shapefile, so this function will convert these shapes to standard polygons or polylines before adding them to the shapefile. It does this by generating 200 evenly-spaced points along the length or perimeter of the curve, and connecting these points with straight segments. Therefore, if the original graphic feature is composed of true curves, then the actual shape in the shapefile will be slightly different than the original feature.



You must set a spatial reference for the new shapefile. If your map has a spatial reference set, then the map spatial reference will be the default value. You may easily change the spatial

reference by clicking the “Set Spatial Reference” button and identifying the spatial reference you want:



NOTE: This function adds the new shapefile to map, but does not delete existing graphics so you may not see the new shapefile when the shapes lie behind the graphics.