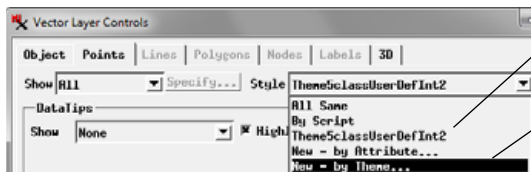


Theme Mapping Geometric Elements

Theme mapping is a style option that allows you to assign elements in a geometric object to a specified number of theme classes, each with its own drawing style, based on the values of a numerical attribute in their database records. The class range boundaries can be set automatically or manually, and you can specify color and size spreads to automatically generate the drawing styles. A View sidebar legend is automatically created with an entry for each theme class and a label showing its range of values. You can create multiple theme maps for the same geometric object and quickly switch between them in the Layer Controls window. Theme class assignments are stored in a theme style assignment table in the element database; associated style definitions are stored in a style subobject of the assignment table. You can theme map points, lines, and polygons in vector and shape objects and nodes, edges, and triangles in TIN objects. Theme mapping is not available for elements in CAD objects.

Selecting Styling by Theme

You choose theme mapping as an option from the Style menu on the relevant element's tabbed panel in the Layer Controls window. To set up a new theme, choose *New - by Theme* from the menu. The Select Table/Field window then opens to allow you to specify the database table and field containing the numeric attribute to be used to define the theme. After you save a theme for an element, the name of the theme appears as an option in the Style menu, allowing you to easily switch between multiple saved themes or other style options.



Previously-created theme maps can be selected from the Style menu.

Choose *New - by Theme* to create a new theme map.

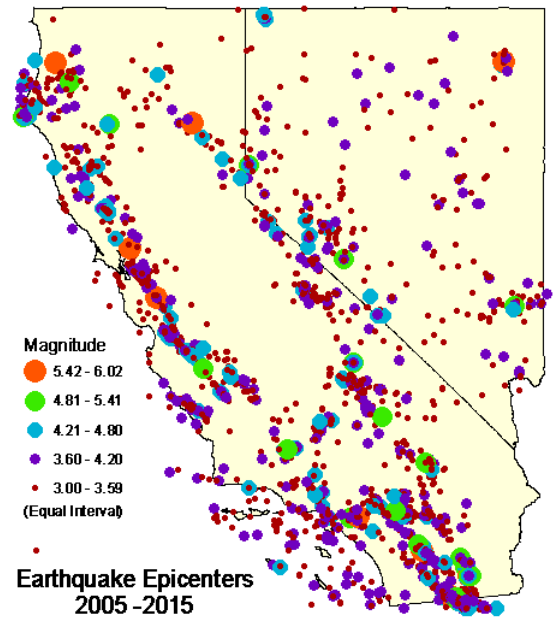
The Theme Mapping Controls window opens when you choose to create a new theme map (you can reopen it for an existing theme selected in the Style menu by pressing the Edit pushbutton to the right of the menu). The Attribute field at the top of the window shows the name of the table and field you selected that contains the numeric values. You can press the Attribute pushbutton to select a different table and/or field.

Theme Classes and Distribution

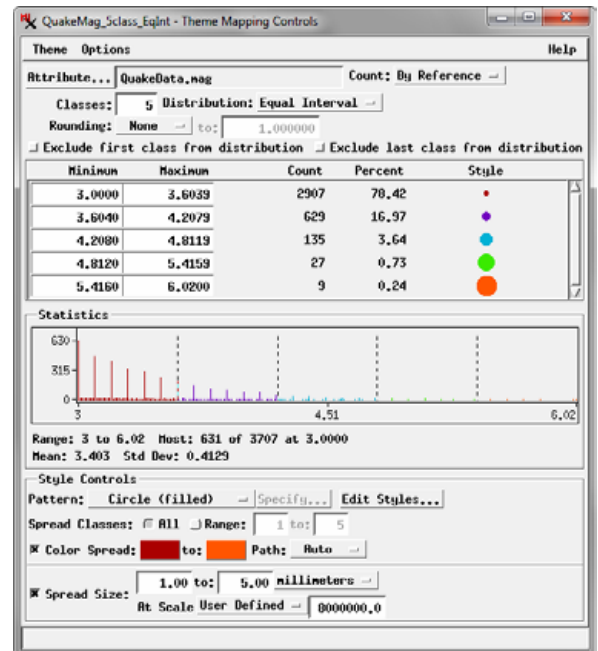
Enter a value in the Classes field to set the number of theme classes to create. The initial boundaries between theme classes are set automatically from the global value range of the selected field and the settings on the Count menu (see next section) and the Distribution menu, which provides three options (described below): Equal Count, Equal Interval, and User Defined. The tabular list below these controls shows for each class the minimum and maximum values, count, and percentage of values in the class along with a style sample. This list automatically updates when you change the number of classes or the distribution type. The Statistics pane shows a histogram of the attribute values with value on the horizontal axis and count on the vertical axis. Histogram bars are colored using the theme class color, and class boundaries are shown as vertical dashed lines. The Options menu provides Vertical Scale and Horizontal Scale submenus that allow you to choose either Linear or Logarithmic scaling for a histogram axis. The Statistics pane also lists the global range, maximum count for any value, and the mean and standard deviation of the global set of values.

Equal Count: The Equal Count distribution option attempts to assign an equal number of values to each class, without regard to the ranges over which these values fall. This goal is readily achieved if each value in the set is unique and the number of values is even-

(continued)



Points indicating earthquake locations theme-mapped by earthquake magnitude. Five theme classes were created using Equal Interval boundaries as shown in the illustration below. Point symbol size and color were both set to vary by theme class using spread settings.



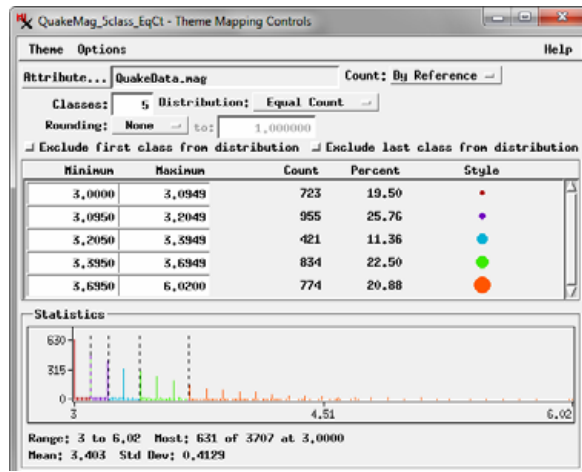
ly divisible by the number of classes. But in many cases these conditions are not met. Several or many elements in the set may have the same attribute value, for example. Because all instances of the same value must belong to the same class, some classes may have fewer than the expected number of values and adjacent classes more values. Consider an example in which a class currently has one less than the target “equal” count as values are being tabulated. If the next value is unique, it is added to the class, completing the class with the target count, and the process goes on to the next class. But if that next value occurs 10 times in the set, the class ends up with 9 more than the target count. That excess must be compensated by assigning one or more of the remaining classes fewer counts than the target number. The Equal Count method distributes values to produce classes with counts as close to equal as possible.

Equal Interval: The Equal Interval distribution method divides the overall value range into classes of equal range. There is no restriction on the number of values within a class, and some interval classes may have no members if the values occur in widely-separated clusters.

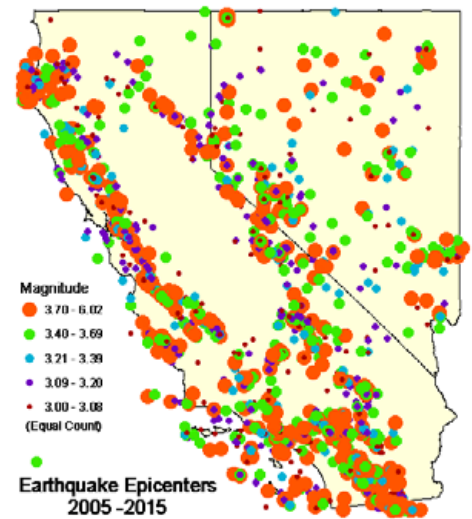
User Defined: You can modify the theme boundaries manually by editing the minimum or maximum values in the theme class list or by dragging the class boundaries in the Statistics pane histogram. Either action automatically sets the Distribution menu to User Defined and adjusts the adjacent class boundaries if necessary.

Count Method

Theme mapping can be used with geometric objects with varying attachment restrictions between elements and records. For example, there may be multiple elements attached or related to a single record; multiple records attached to a single element; or a one-to-one relationship between elements and records. The choice on the Count menu determines which records are used for tabulating the values from the designated attribute field. The



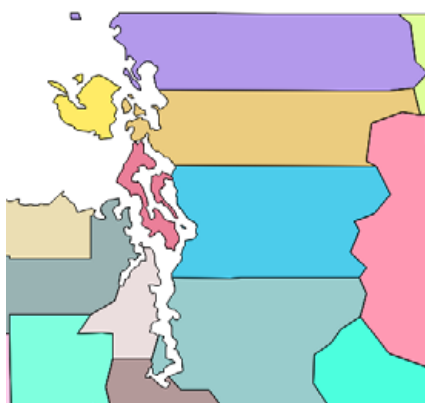
Earthquake points theme-mapped using Equal Count distribution. Compare with illustrations on the previous page.



options are By Reference, All Records, and By Element Size.

By Reference: Using the By Reference option, each geometric element is processed and the first attached (or related) record is used as the source of the element’s value. Any additional records attached to the element are ignored. If multiple elements are associated with the same record, the value from that record will be counted once for each of these elements. This count method should be used when each element is considered an independent entity even if it shares a record with other elements. In an earthquake magnitude theme map, for example, a number of earthquake points may have the same magnitude. If the attribute table includes only one record for each magnitude, all of the points that share that record should be counted separately if the theme map uses the Equal Count distribution method.

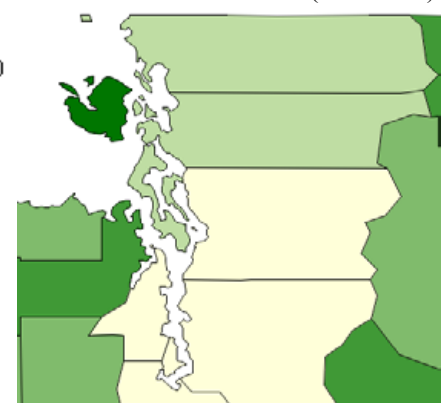
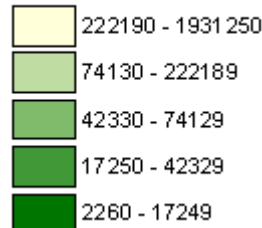
All Records: Using the All Records option, every record in the table is used exactly once, whether it is attached to zero, one, or multiple elements. If multiple elements are attached to the same record, this count method is appropriate to use when these elements are considered to be part of one entity represented by the value in the shared record. In a theme-map of political boundary polygons by population, for example, a coastal province, state, or county may include offshore islands, each of which is a polygon element with the record containing the unit population attached to each (see illustration below). The population value is a property of the set of polygons that make up the unit rather than an independent property of each polygon. Using the All Records count



Left, detail of map of counties in Washington state, USA. Several coastal counties include islands (all polygons for each county are shown in the same color).

Right, Equal Count theme map of county population. The count method was set to All Records so that the population value for each county is counted once for each county record rather than once for each polygon attached to the county record.

County Population



(continued)

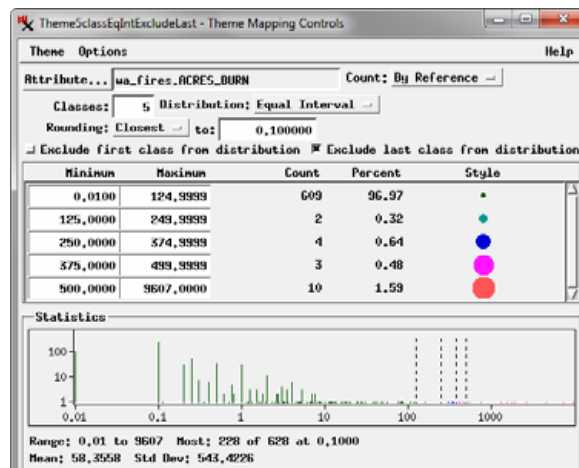
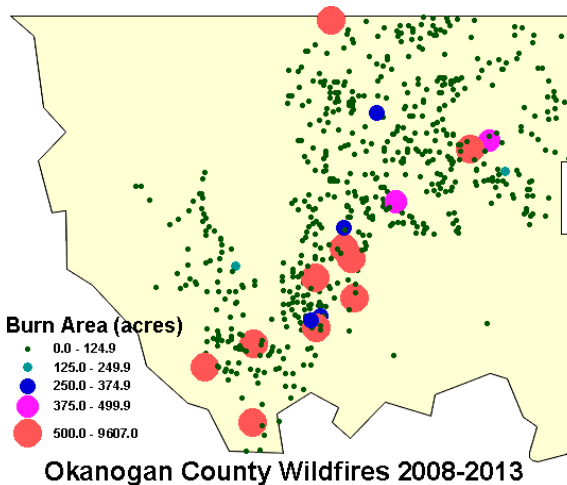
method, the population is tabulated once for the set of polygons rather than being counted separately for each polygon, as it would using the By Reference method.

Note that if there is a one-to-one relationship between elements and records, the By Reference and All Records methods produce the same count results.

By Element Size: The By Element Size option is available on the Count menu for lines or polygons if the geometric element has a standard attributes table containing element statistics. When you choose this method, each element attribute value is multiplied by the line length or by the polygon area. This count method is therefore appropriate for use when the selected attribute field contains values per unit length or area. Soil map polygons, for example, commonly include attributes with potential crop yields per unit area (e.g., bushels per acre), so the By Element Size count option allows you to produce a theme map of potential yield for each polygon directly based on its area. A standard attributes table can be computed using the Object Statistics process (Geometric / Attributes / Standard Element Attributes from the TNTmips menu) or in the Editor.

Rounding

The Rounding controls let you set the precision applied to the values when assigning them to classes. The options on the Rounding menu are None, Closest, Down, and Up. Enter the decimal value to round to in the field to the right of the menu (e.g., 0.1, 1.0, 10, and so on). Since rounding changes individual values and increases the number of replicated values in the data set, changing the rounding setting typically affects the class assignments for either Equal Count or Equal Interval distributions. Minimum and Maximum values in the class list in the Theme Mapping Controls window are always shown to four decimal places regardless of the current rounding setting, but rounding is applied to the class range values shown in the theme legend in the View window sidebar.



Wildfire point locations theme mapped by size of the burn area. A small number of fires had much larger burn areas than the majority, with the largest fire having an area of 9607 acres. (Note that the Statistics histogram in the Controls window has been set to use a logarithmic scale on both vertical and horizontal axes.) To better discriminate the differing areas of the majority of the fires, the *Exclude last class from distribution* option was turned on and the minimum value of the last class (largest fires) was set to 500 acres. This class (with only 10 out of 628 points) is therefore excluded from the Equal Interval distribution of the remaining fire areas.

Exclude First Class / Last Class from Distribution

The values you use for theme mapping may include a number of extreme values at the low and/or high end of the range. Such values can have an undue influence on the distribution of values. Equal Count distributions can be skewed by having a large number of values at one end of the range, and Equal Interval distributions can be skewed by a few extreme values, making it difficult to distinguish the differing relative values among the majority of the elements.

To deal with these issues, the Theme Mapping Controls window provides two toggle options: *Exclude first class from distribution* and *Exclude last class from distribution*. (The first class is the one with the lowest values.) Turning on one of these toggles excludes the values in that class from being used to compute the distribution of the values for the remaining classes. When you are using an Equal Count distribution, turning on one of these toggles may result in an immediate change in the remaining class boundaries if the number of values in the excluded class is significantly smaller or larger than the other classes (due to clumped values as discussed above). For Equal Interval distributions there is no immediate effect from turning on either toggle. However, with one of these toggles turned on you can manually set the boundary of the excluded class while retaining the selected distribution type for the remaining values; editing the boundary does not automatically change the distribution mode to User Defined. The illustration below shows an example in which the last theme class is set to include a small number of points with a wide range of high values, which are excluded from the Equal Interval distribution of the remaining values.

Style Controls

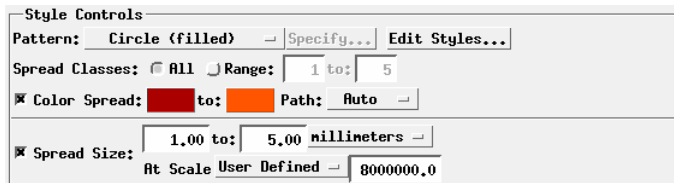
The Style Controls in the Theme Mapping Controls window let you design the drawing styles for the set of theme classes. You can automatically generate differing styles for the classes using the Spread controls or set up styles manually for any or all theme classes.

The Pattern option menu provides choices for the type of point symbol, line style, or polygon style to use, depending on the element type. The choices available for each element type are shown in the table on the next page. Simple style options include a selection of predefined symbols for points; Solid Line for lines; and

(continued)

Pattern Options by Element Type	
Points / TIN Nodes	Lines / TIN Edges
Box (outline)	Solid Line
Box (filled)	Line Pattern
Circle (outline)	By Style
Circle (filled)	Polygons / TIN Triangles
Crosshair (simple)	Solid Border
Crosshair (enhance)	Solid Filled
Symbol	Bitmap Pattern
By Style	By Style

Solid Border or Solid Filled for polygons. Choosing Symbol from the Pattern menu for points, Line Pattern for lines, or Bitmap Pattern for polygons automatically opens the Select window so you can select a symbol, line pattern, or bitmap pattern from the libraries provided in TNTgis or custom symbols or patterns you have designed. (The Specify button also becomes active with these Pattern menu selections; you can press this button to reopen the Select window.)



Theme map Style Controls for points.

Color Spread: Color Spread controls are available for all element types. Turn on the Color Spread toggle button to automatically assign a range of colors for the class styles. A pair of color buttons are provided to set the start color (button on the left) and the end color. Pressing either of these buttons opens the Select Colors window, which lets you choose start and end colors from a palette or to define custom colors using a choice of color models.

The Path option menu sets the color model and path of the color spread. The default Auto option picks the optimal spread type depending on the start and end colors in order to produce the greatest variety of colors. You can also select a specific color model and path to define the spread: RGB, HIS CW (clockwise), HIS CCW (counter-clockwise), HBS CW, or HBS CCW.

Color spread colors are applied automatically to predefined point symbols, solid lines, and solid polygon borders or fills. They are also applied to the Variable color (if any) in a custom point symbol line pattern, or bitmap fill pattern. Any specific colors defined in custom symbols or patterns are used without change.

Color spreads are applied by default to all classes, but you can restrict the spread to a selected range of classes (by class numbers) using the Spread Classes controls. Radio buttons let you choose either All or Range; when you choose the latter, the pair of Range fields to the right are activated. By default the left range field

is set to 1 and the field on the right shows the total number of classes. You can edit either field to define the numeric range of classes to which to apply the color spread. Classes outside the spread range retain their current color, but you can manually edit these class styles (see below).

Spread Size / Width: For point or line elements you can also automatically vary the symbol size or line width across classes. The relevant controls are labeled Spread Size for points and Spread Width for lines. Turn on the Spread toggle button to apply the spread values you set. Two numeric fields are provided to allow you to define the lower (field on the left) and upper values of the size/width range. The same value is shown in both fields by default for a new theme; you can change either or both values. The menu to the right sets the size units (inches, millimeters, points, or pixels).

The At Scale menu lets you choose the scale at which the size units are applied; the choices are None, User Defined, and Design. The Design option sets the styles to use the design scale specified for the group or map layout in which the geometric object is displayed. Choosing User Defined activates the numeric field to the right, allowing you to enter a specific map scale fraction. With these options the styled elements will be larger or smaller as you zoom the view in or out. With the None option the styled elements are drawn with the same dimensions on screen regardless of the map scale of the view.

Edit Styles: In addition to these automatic methods, you can press the Edit Styles pushbutton to open the Style Editor for the current element type, allowing you to manually create or edit the style for any or all of the theme classes. If you change any of the styles, the Pattern menu automatically reverts to the By Style option, and the spread controls are deactivated to show that you have overridden some or all of the previous automatic styling options.

Theme Menu

When you have finished designing your theme map, choose Save from the Theme menu to name and save the theme, then choose Theme / Close to close the Theme Mapping Controls window and return to the Layer Controls window. If you have opened the Theme Mapping Controls window for an existing theme and make changes, you can save the result to a new theme using the Save As option from the Theme menu. You can also use the New option to create a new theme with default settings, or the Open option to open an existing theme table you have saved for the current object.

The Save as Default option from the Theme menu lets you save certain current settings as defaults for creating future theme maps. The settings that are saved by this option include the number of classes, count method, distribution method, and rounding options. Parameters set in the Style Controls are automatically saved as defaults whenever they are changed and so are not affected by the Save as Default operation.

