FEATURE MAPPING

Tutorial

Feature Mapping

with

TNTmips®

Before Getting Started

This tutorial booklet introduces the Feature Mapping process, which lets you classify multiband images by using your visual interpretation skills to guide automated classification operations. Using Feature Mapping's interactive tools, you indicate image locations that are representative of a particular feature class, then let the tool automatically find image cells that have similar sets of band values. You can then decide which highlighted areas to assign to the class. This booklet leads you through a series of exercises to familiarize you with all of the basic tools in Feature Mapping.

Prerequisite Skills This booklet assumes that you have completed the exercises in the tutorial booklets entitled *Displaying Geospatial Data* and *TNT Product Concepts*. Those exercises introduce essential skills and basic techniques that are not covered again here. Please consult those booklets for any review you need.

Sample Data The exercises presented in this booklet use sample data that is distributed with the TNT products. If you do not have access to a TNT products DVD, you can download the data from MicroImages' web site. This booklet uses objects in the WHITECAPMTN and WHITECAPMTNFEATURES Project Files in the FEATMAP data collection.

More Documentation This booklet is intended only as an introduction to the Feature Mapping process. Additional documentation on the process can be found in a variety of Technical Guides and Quick Guides, which are all available from MicroImages' web site.

TNTmips® Pro and TNTmips Free TNTmips (the Map and Image Processing System) comes in three versions: the professional version of TNTmips (TNTmips Pro), the low-cost TNTmips Basic version, and the TNTmips Free version. All versions run exactly the same code from the TNT products DVD and have nearly the same features. If you did not purchase the professional version (which requires a software license key) or TNTmips Basic, then TNTmips operates in TNTmips Free mode. All the exercises can be completed in TNTmips Free using the sample geodata provided.

Randall B. Smith, Ph.D. and Merri P. Skrdla, Ph.D., 14 March 2014

You can print or read this booklet in color from MicroImages' web site. The web site is also your source for the newest tutorial booklets on other topics. You can download an installation guide, sample data, and the latest version of TNTmips Free.

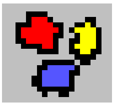
http://www.microimages.com

Welcome to Feature Mapping

Classification of information contained in remotely-sensed imagery is one of the major applications of image interpretation. The human brain is a tremendously powerful analytical engine that automatically classifies visual information without conscious effort. Visual interpretation of images on a computer screen, however, is limited to at most three image bands translated into a color image in the visible portion of the electromagnetic spectrum.

Remotely sensed images often contain more than three bands, including some that cover portions of the spectrum outside the visible range, all of which may be important in distinguishing one ground cover type from another. Any set of three bands can be translated into a screen image in the RGB color space for visual interpretation. A common example is a “color-infrared” image, which depicts near-infrared, red, and green bands as red, green, and blue components (respectively) of the screen image. But visual interpretation of such a display omits information from the other image bands. The Automatic Classification process in TNTmips provides fully automatic classification (both supervised and unsupervised) of any number of image bands. However, these classifiers do not take advantage of your visual interpretation skills.

The Feature Mapping process lets you visually interpret a reference image to guide automated classification procedures applied to any number of image bands (analysis rasters). You evaluate the results of each classification operation to decide which results to retain. Using a variety of interactive tools, you can perform a step-wise classification of all or portions of an image into a set of spectral categories, or *feature classes*. Feature Mapping is especially useful for interpreting poor-quality images that would be a challenge for fully automatic classification procedures.



☑ select Image / Interpret / Feature Map from the TNTmips menu

Vocabulary:
A **feature class** is a set of image cells that you indicate belong to a particular surface material or land cover type. You assign a name and color to each feature class.

A **feature** is a distinct cluster or patch of spatially contiguous cells belonging to a particular feature class.

Pages 4-6 introduce you to the Feature Mapping process interface and the sample image we will analyze. The basic techniques of defining samples, classifying, and marking features are covered on pages 7-12. Use of the Draw Features tool to manually draw features, unmark or reassign features, and create protected areas is covered on pages 13-16. Pages 17-19 introduce the use of the Grow and Mark Features tool to map compact, well-defined features. Defining a Region of Interest and creating text reports are discussed on pages 20-23.

Analysis and Reference Rasters

STEPS

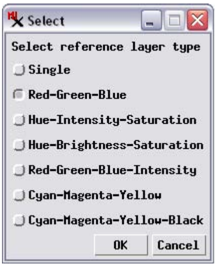
☑ in the first selection window that appears, navigate into the WHITECAPMTN Project File in the FEATMAP folder

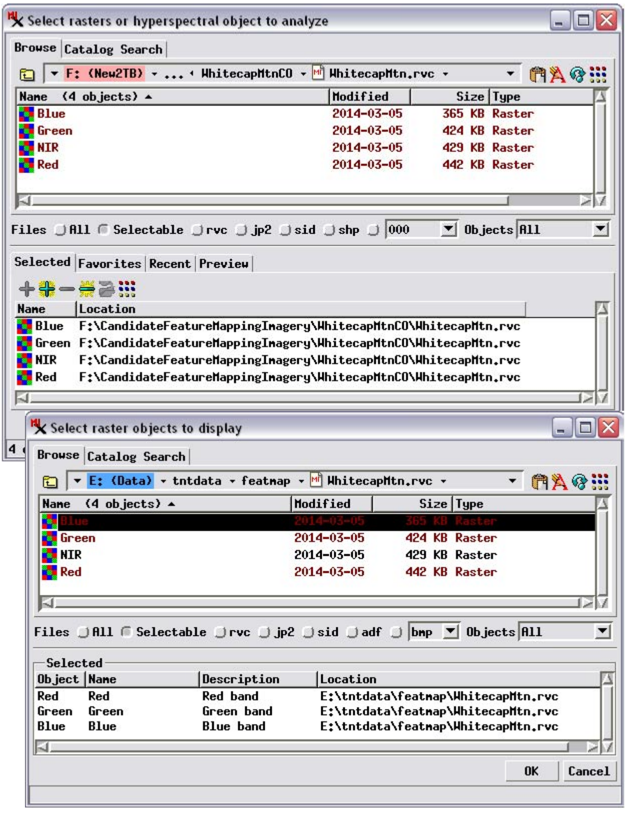
☑ press the Add All icon button on the Selected tabbed panel to select all four image band rasters for analysis, then press [OK]

☑ in the window that prompts you to select the reference layer type, turn on the toggle labeled Red-Green-Blue and press [OK]

When you launch Feature Mapping, you are immediately prompted to select analysis rasters. We will analyze a four-band aerial orthoimage that includes three visible bands and a near-infrared band. You can use images with a larger number of bands; the only restriction is that all analysis rasters must have the same row-column dimensions.

Next you are prompted to choose the type of reference layer to display, and then the raster or rasters to use for the layer. We will use the Red, Green, and Blue bands of our analysis image as a natural-color reference image. The reference layer is not used by automatic analysis operations, so it can be any image that covers the analysis area.





☑ in the next Select Objects dialog, navigate again into the WHITECAPMTN Project File

☑ choose raster objects Red, Green, and Blue in that order for the R-G-B reference layer and press [OK]

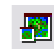
Feature Mapping Window

After you complete your initial selections, the reference layer is displayed at full view in the Feature Mapping window. Also in the sidebar layer list are the Features and Feature Outlines raster layers, both of which are initially blank (transparent). The Features raster will record the feature class locations that we create in the following exercises.

STEPS

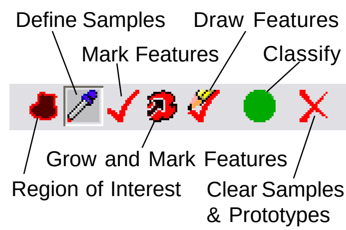
☑ if the sidebar is not visible in the Feature Mapping window, press the Show Sidebar button

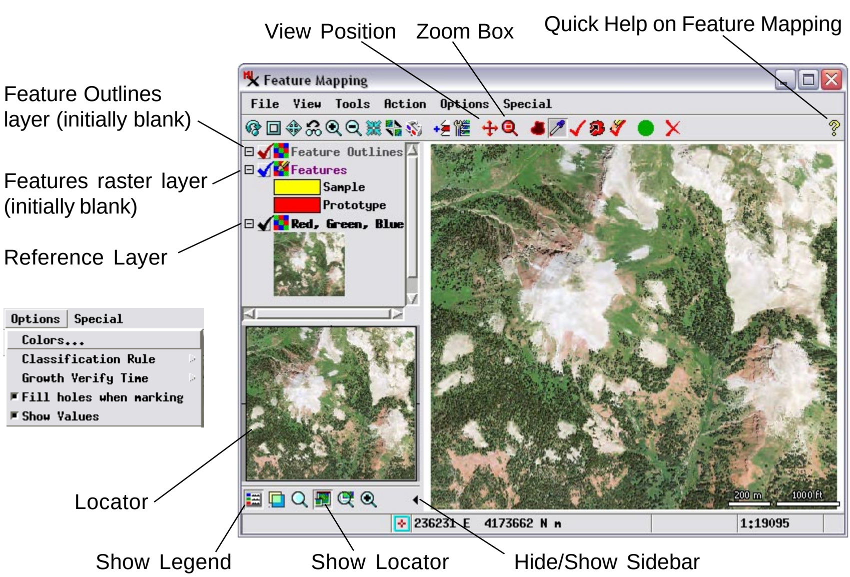
☑ if the Locator is not shown in the sidebar, turn on the Show Locator icon button at the bottom of the sidebar



☑ if no Sample Values window appears, open the Options menu and turn on the Show Values toggle option

The Feature Mapping window's toolbar includes icon buttons that should be familiar from standard View windows, including Zoom In and Zoom Out buttons and the View Position and Zoom Box tools. The icon buttons to the right of the Zoom Box tool are specialized tools and action buttons used for Feature Mapping. The Define Samples tool is intially active by default. The other icon buttons are labeled to the right (remember that each icon button also has a ToolTip to identify it). The Classify button is associated with the Define Samples tool. Other icon buttons will appear in its place when we use other Feature Mapping tools.





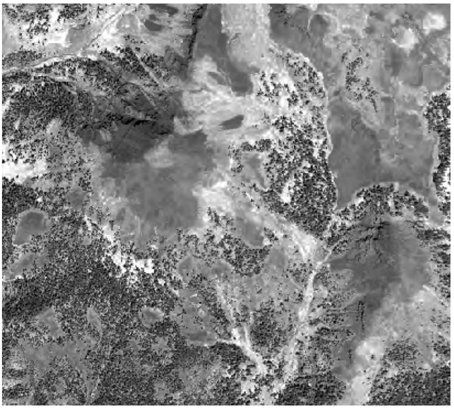
Four Feature Classes

The sample image is an extract from orthoimagery collected with a cell size of 1 meter by the U.S. government's National Agricultural Imagery Program. However, the image was distributed with lossy JPEG2000 compression, resulting in noticeable loss of spatial and spectral detail. The sample image has been resampled to a cell size of 2 meters, which is appropriate to the actual detail visible in the original compressed image.

The image we are analyzing covers a small area in southwestern Colorado, USA and was acquired during the summer months. As you examine the natural-color reference image, you can readily see that it includes both areas of dense green natural vegetation and patches of bare soil and rock. The vegetated areas include both dark green patches (coniferous trees) and brighter green areas (meadows with grass and other low vegetation). Likewise, the bare areas can be divided into two broad categories by color: reddish-colored soil and rock, and light gray to white soil and rock.

Natural-color reference image

Near-infrared image band



These are the four feature classes we will work with in these exercises. Our image analysis set also includes the near-infrared image band, shown to the left. Note that meadow areas have very bright tones in this band, while the areas of coniferous trees are much darker. The two rock/soil types also have somewhat different tones. Obviously the near-infrared band will help in distinguishing our four feature classes.

Define Sample Cells

Although we can readily recognize examples of these four feature classes in our reference image, manually mapping out the distribution of each class would be very tedious due to their patchy distribution at several scales. Feature Mapping makes this a much easier task. You can use its tools to indicate representative areas of a particular feature class, then use an automated classification procedure to identify similar cells elsewhere in the image as candidates for assignment to the class.

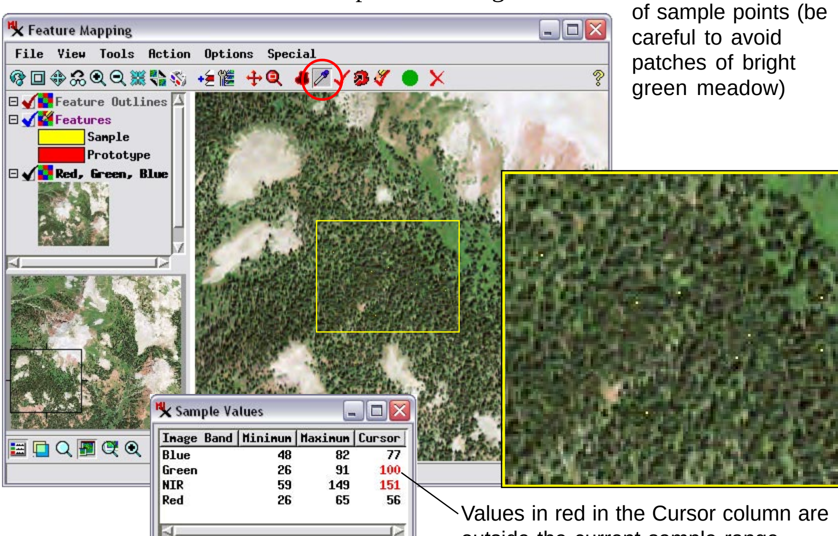
We will start by using the Define Samples tool, which has already been activated by default, to map out the distribution of the dark green coniferous trees. With this tool you click on representative locations of a feature class to build up a set of sample points, which are shown in yellow in the view. The Sample Values window shows the numeric range in each band for the set of sample locations. The Cursor column shows the band values at the current cursor position, with values outside the current sample range shown in red so that you can easily identify locations that will extend the sample value ranges.

Vocabulary:
A **sample** is a cell you identify as representative of a particular feature class.

A cluster of connected cells classified as similar to the current set of samples is called a prototype feature, or simply a **prototype**.

Once you confirm that a prototype belongs to the same class as the samples, it becomes a **marked feature**.

STEPS
- ☑ move the cursor to the middle of the large area of dark green trees in the southwest quadrant of the image and press <1> to zoom to 1:1
- ☑ left-click on a number of the trees to define a set of sample points (be careful to avoid patches of bright green meadow)



Values in red in the Cursor column are outside the current sample range.

Classify from Samples

STEPS

☑ press the Classify icon button in the toolbar

☑ look for areas of trees that are not included in the current prototype feature set (red)

After you have placed a few tree sample points, press the Classify icon button. The Define Sample tool's classifier identifies all image cells that have a cell value within the range of the sample set in all of the image bands. These prototype cells are indicated in red in the view. As you can see in the Locator, prototype cells are found throughout the image, not just in the portion visible in the main view.

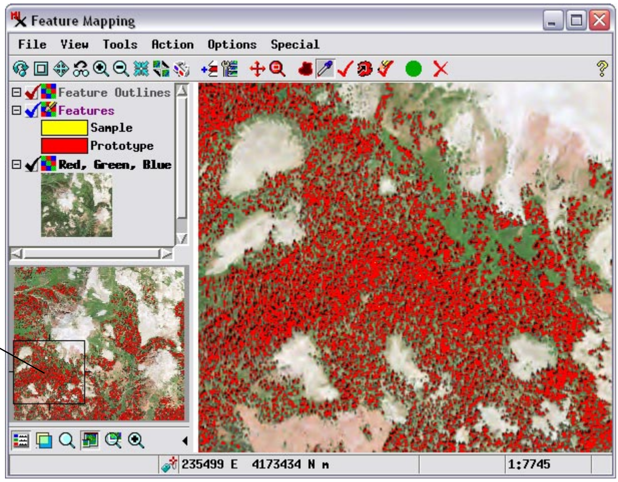
View Hotkeys

Zoom In	**+**
Zoom Out	**-**
Zoom to 1X	**1**
Full View	**0**
Recenter to cursor	**space**

Locator

Drag box or left-click outside box to reposition a zoomed view

Drag an edge or corner of box to change zoom



☑ in the sidebar legend, toggle the visibility checkbox for the Features layer on and off to check locations of unclassified trees

☑ left-click to place additional samples for trees

☑ right-click to classify (or press the Classify icon button)

Target Sample Ranges for Trees:

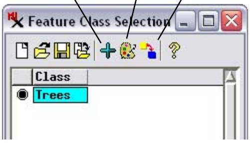
Blue:	43 - 96
Green:	4 - 88
NIR:	7 - 186
Red:	5 - 75

The prototype set found from your initial set of samples probably does not cover all of the trees in the image. Move around the image looking for additional unclassified trees. Although you might normally do this using the View Position and Zoom tools, you can use keyboard shortcuts and the Locator to zoom and reposition the view without switching from the Define Samples tool (see box in sidebar). In order to identify additional trees you may find it helpful to toggle the Features layer off and on using its Show/Hide checkbox in the sidebar legend. As you find more trees, place additional sample points and reclassify. The target sample value ranges are shown to the left. If a sample expands the range too much, press the Shift or Ctrl key while clicking on the sample point to remove it.

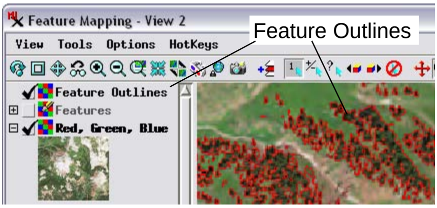
Add a Feature Class

The Classify operations you run using the Define Samples tool may result in prototypes covering cells outside of our intended feature class. The band value ranges for different surface feature types can vary over the area of an image due to actual variations in the materials, differences in atmospheric conditions across the image, and illumination effects, such as shadowing. These variations can result in overlapping feature class band value ranges. Rather than accepting all of the prototype cells, we can examine the prototypes and determine which ones to assign to the tree class. This class assignment step is performed using the Mark Features tools.

But before we can mark prototypes, we must define a feature class. When you turn on the Mark Features icon button, the Feature Class Selection window opens. Each feature class is given a name and assigned a color to be shown in the Features raster. We will use the color cyan for our Trees class so that it contrasts with natural colors in the image (you can easily change a class color or class name at any time using the Feature Class Selection window). When we save the Features raster, the feature class name and color will be saved automatically along with it.



To help with the task of identifying and marking class prototypes, you can open a second Feature Mapping view that by default shows the Feature Outlines. This raster layer, updated automatically from the Features raster, displays only the outer boundaries of the individual prototype and feature patches.

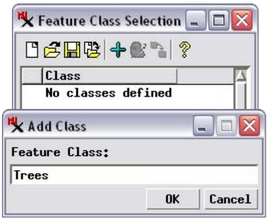


STEPS

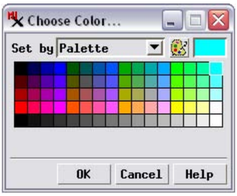
☑ turn on the Mark Features icon button in the Feature Mapping toolbar

☑ in the Feature Class Selection window that opens, press the Add Class icon button

☑ in the Add Class window that opens, enter “Trees” in the Feature Class text field and press [OK]



☑ in the Choose Color window that opens, choose Palette from the Set by menu



☑ click on the cyan color sample in the upper right corner of the color palette and press [OK]

☑ choose View / Open Additional View from the Feature Mapping window

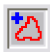
Mark Features

STEPS

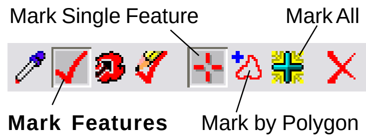
☑ pan the zoomed-in Feature Mapping view to the southeast corner of the image

☑ with Mark Single Feature as the marking tool, left-click on the largest patch of prototype cells in the image corner to mark it

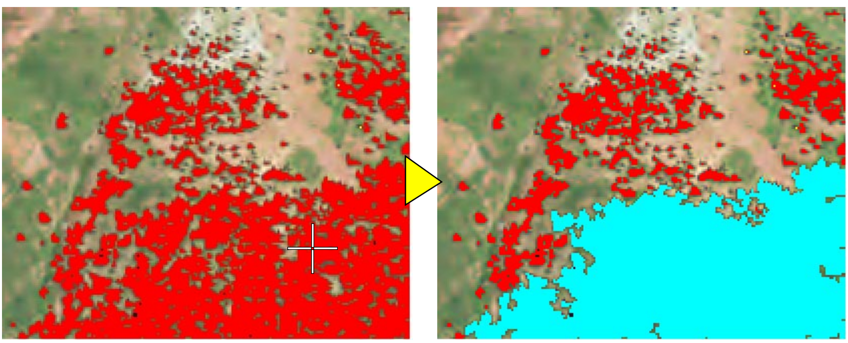
☑ turn on the Mark by Polygon tool



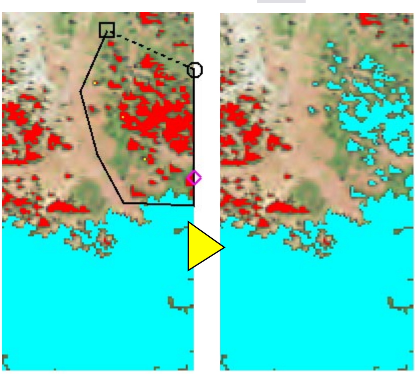
☑ draw a polygon around a group of separate prototypes and right-click to mark them



Now that we have defined the Trees feature class, we can begin marking features to assign them to this class. When you turned on the Mark Features icon button, the Classify icon button was replaced by three buttons associated with marking operations. Using the Mark Single Feature tool, you left-click on an individual prototype to mark it. The red prototype color is replaced by the color of the selected feature class (cyan in this exercise).




Mark Single Feature



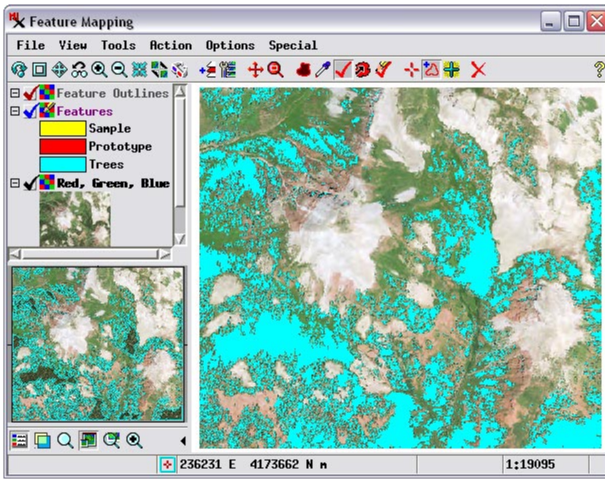

Mark by Polygon

Using the Mark by Polygon tool, you draw a polygon around a group of distinct prototypes and right-click to mark them.

Because there are a large number of scattered tree prototypes, evaluating and marking them individually or in small groups would be time-consuming. In the next exercise we will use the short-cut Mark All option and later deal with areas that were incorrectly assigned to the Trees class.

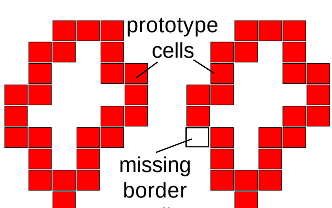
Mark All and Fill Holes

Unlike the Mark Single Feature and Mark by Polygon icon buttons, Mark All is an action button. Pressing it immediately marks all remaining prototype cells, assigning them to the selected feature class. It marks all prototype features over the entire image, not just those currently visible in the view. You can use the Mark All button any time that the Mark Features button is turned on and a feature class is selected in the Feature Class Selection window.



When you marked the first group of prototype cells in the exercise on the previous page, you may have noticed that some interior patches that were not highlighted as prototype cells were also marked. This "hole filling" behavior when marking is an option that is turned on by default. (You can turn it off on the Options menu).

A hole can be any size or shape, but must be completely surrounded (including at cell corners) by prototype cells in order to be filled. If there is a diagonal path through the prototype border to the outside, the unhighlighted patch is not treated as a hole and is not filled.



Hole (will be filled)

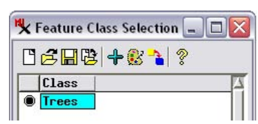
Not a hole (will not be filled)

STEPS

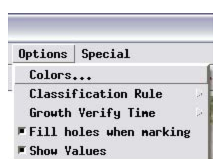
☑ press the Mark All icon button to mark all remaining prototypes 

☑ press the Full icon button to zoom to full view 

All prototypes marked as Trees.



☑ open the Options menu and note the setting for *Fill holes when marking*



Save Results and Resume the Process

STEPS

☑ to save the Features raster, choose File / Features / Save

☑ in the Select Raster dialog, press the Up One Level icon button to navigate out of the Project File containing the input rasters

☑ enter a name in the New File Name field and press Create File

☑ accept the default name and description for the Features raster and press [OK] on the selection dialog

TO RESUME AFTER EXIT:

☑ launch the Feature Mapping process

☑ select the same four analysis rasters from the WHITECAPMTN Project File (see page 4)

☑ select Red-Green-Blue as the reference layer type and select the corresponding rasters

☑ choose File / Features / Open and select the Features raster you saved

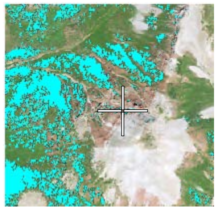
To save feature definitions and styles separately from the Features raster and reuse them for other images, use the icon buttons on the Feature Class Selection window.

Before moving on, let's consider saving the Features raster we have created. Only marked features can be saved, so using the Mark All function is a good strategy when you're ready to end a session without first deciding which of the current prototypes is a member of the desired class. If you'd like to take a break from this tutorial, this would be a good place to do so.

To save or reopen the Features raster, use the File / Features submenu. The first time you use the Save option, you are prompted to create a Features raster in a Project File. The object selection dialog for this operation initially defaults to the Project File containing the input objects. Although you can save the Features raster in the same Project File as the input image rasters, here it is suggested that you save it in a separate Project File. This will enable you to continue to use the Add All option when prompted to select the analysis rasters when you relaunch the Feature Mapping process. Once you have saved a Features raster, you can simply use the Save option to save further changes (or Save As to save a different version of the Features raster).

As mentioned previously, the feature definitions and styles are automatically saved with your Features raster and are loaded when you select this raster when you resume the process. You also have the option to save the feature styles separately as a main-level object in a Project File if you will be using the same set of feature classes for a number of separate images. The Feature Class Selection window provides icon buttons allowing you to save and open an independent feature class style object.

Unmark Features



The target sample value ranges for the Trees class included some very low band values generated by shadows cast by individual trees. But some small togographic features in the scene also cast rather dark shadows with band values in the same range. Some of these topographic shadows were therefore included in the Trees class when we applied the Mark All action.

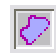
We can use the Draw Features tool set to “unmark” the incorrectly-classified topographic shadows. Turning on the Draw Features mode opens a Draw Features window with two menus. The *Change from* menu sets the Features cell type to change and the *Change to* menu sets the result type. Here we want to change cells assigned to Trees back to Unclassified. We use the Polygon tool provided in the Draw Features tool set to indicate the class features to change back to Unclassified.

STEPS

☑ move the mouse cursor to the position shown at left (in the northwest quadrant of the image) and press <2>

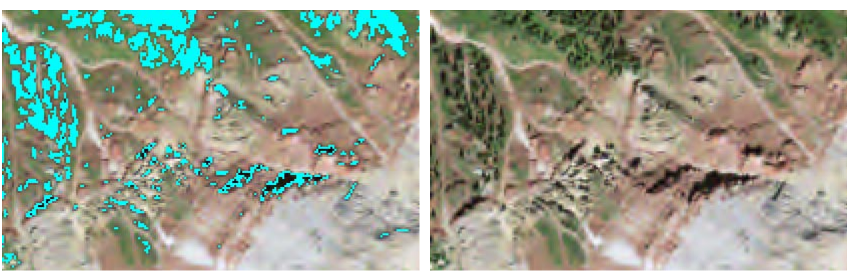
☑ toggle the Features raster off/on to see the shadowed areas misclassified as Trees

☑ turn on the Draw Features icon button 

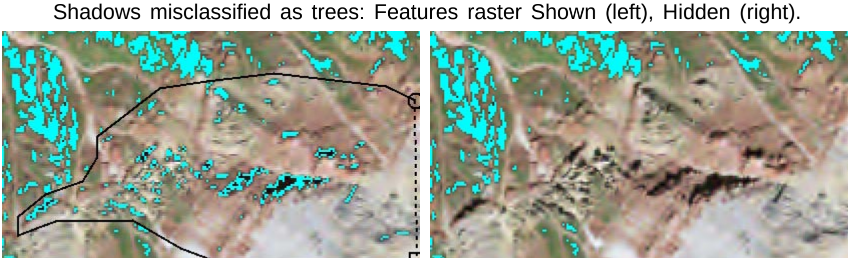
☑ turn on the Polygon tool 

☑ in the Draw Features window, choose Trees from the *Change from* menu

☑ draw a polygon around the misclassified shadows as shown below, then right-click to change to Unclassified



Shadows misclassified as trees: Features raster Shown (left), Hidden (right).

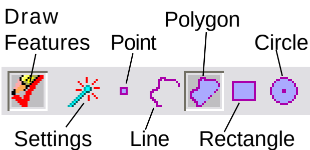


Polygon drawn around misclassified shadows (left) and changed to Unclassified (right).

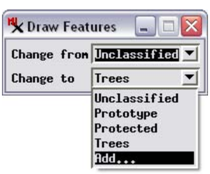
Draw Features

STEPS

☑ find other shadows marked as Trees and use the Draw Features tools to change them back to Unclassified



☑ in the Draw Features window, choose Unclassified from the *Change from* menu and choose Add from the *Change to* menu



☑ in the Add Class window, enter WhiteRock in the Feature Class field and press [OK]

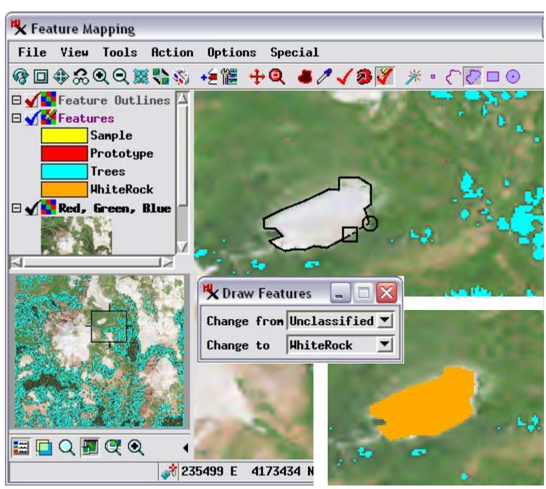
☑ in the Choose Color window, pick the yellow-orange color from the palette and press [OK]

☑ zoom in to the small white patch in the north-central part of the image

☑ use the Polygon tool to draw around the edge of the patch and right-click to mark it

You can easily find other areas in the image where topographic shadows have been misclassified as trees. You can use any of the drawing tools provided in the Draw Features tool set to indicate the Tree cells to unmark. This tool set includes Polygon, Rectangle, and Circle tools to draw areas, and a Line tool. Each of these tools requires a right-click after drawing to apply the change. With the Point tool, simply left-click on a particular cell to change it. Clicking on the Settings icon button in the Draw Features tool set opens a menu that lets you clear the drawing tool if needed, and to change the line drawing mode (Draw or Stretch).

You can use the Draw Features tool set to manually draw the outline of a feature and assign it to a class. First set the Draw Features window to change cells from Unclassified to the desired class. (Note that you can add classes directly from the *Change to* menu.) Then draw and mark the feature. This technique is most useful when you need to assign an area with a highly variable spectral signature (such as a pond with different water depths and colors) to a particular material class.



Draw Protected Areas

The automatic classification operations in Feature Mapping only operate on cells that have not yet been classified; areas already assigned to a feature class are automatically excluded from consideration. You can also use the Draw Features tool set to designate local unclassified areas to be excluded from any manual or automated classification procedures. Such areas are designated as *Protected* and are shown in the Features overlay in green. Protected areas are temporary and are not saved when the Features raster is saved.

To create protected areas using the Draw Features tool set, choose Protected from the *Change to* menu in the Draw Features window before outlining the desired area. One application of protected areas is to prevent islands (real or virtual) within an otherwise uniform area from being assigned to the surrounding feature class by the optional hole-filling procedure when the surrounding area is marked. In this exercise we protect several areas of vegetation and red soil within one of the areas of “white” rock and soil.

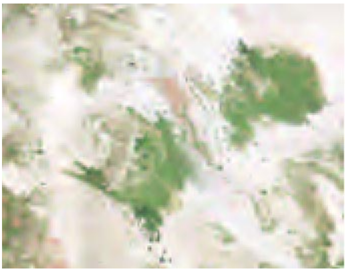
STEPS

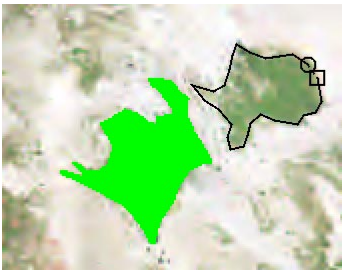
☑ click on the Full icon button to zoom to full extents

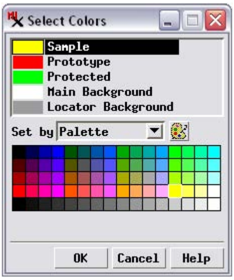
☑ place the mouse cursor over the two green patches nearest the northeast corner of the image and press <2>

☑ in the Draw Features window, choose Protected from the *Change to* menu

☑ use the Polygon tool to draw around each of the enclosed areas of green vegetation and red soil as shown below and right-click to designate them as Protected

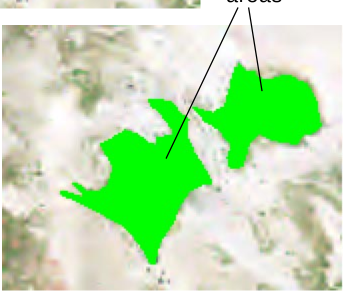






NOTE: You can open the Select Colors window (Options / Colors) at any time to change the colors used to indicate Sample, Prototype, and Protected cells in the Feature Mapping window.

Protected areas



Map Feature Around Protected Areas

STEPS

☑ turn on the Define Samples tool 

☑ left-click to place samples at the locations labeled 1 and 2 in the illustration below

☑ right-click or press Classify to create prototypes 

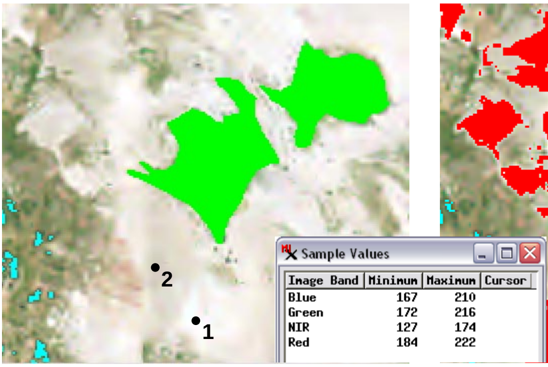
☑ add some additional samples in the unclassified "white rock" area and reclassify

☑ click on the Mark Features icon button 

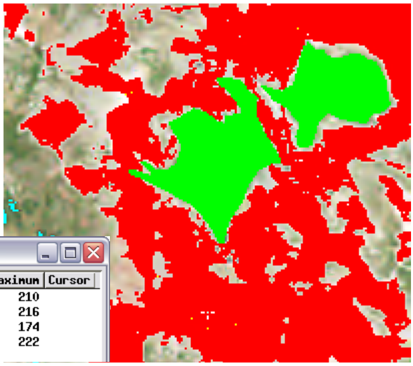
☑ select the Mark Single Feature tool 

To demonstrate the effect of the protected areas, in this exercise we return to the Define Samples tool to create a feature prototype for the surrounding "white rock" area. The initial sample locations, shown in the illustration below left, bracket much of the band value range for this large patch. After classifying, you can place some additional sample points to produce ranges similar to those shown in the Sample Values window illustrated below, then reclassify to produce a prototype feature that completely surrounds the protected areas.

When you mark this feature as WhiteRock, the holes in the prototype (including those around the protected areas) are filled, but the protected areas are excluded from the feature.

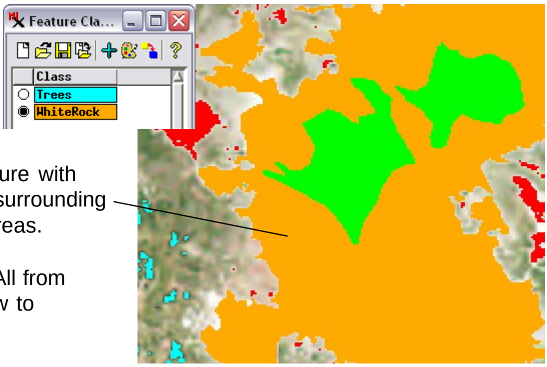


Initial sample locations



Prototype surrounding protected areas

☑ left-click on the prototype surrounding the protected areas to assign them to the WhiteRock feature class



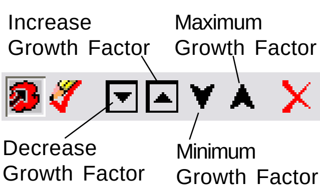
Marked feature with holes filled surrounding protected areas.

☑ choose Special / Unprotect All from the Feature Mapping window to clear the protected areas

Grow a Feature Prototype

We now clear the remaining samples and prototypes to introduce the use of another tool for designating prototypes, Grow and Mark Features. This tool lets you create a single prototype patch of connected cells and vary the size and variability of the patch before choosing to assign it to a class. This tool works very well with fairly uniform, well-defined feature patches.

To use the Grow and Mark Features tool, you left-click in a representative area of a feature. The image cells around that point are analyzed to determine an initial cell value range in each band. These ranges are then expanded and contiguous cells within the expanded ranges are identified on-screen as a prototype feature. You can vary the growth factor that limits the expansion by rolling the mouse wheel or pressing icon buttons on the Feature Mapping toolbar (illustrated below). The mouse wheel and the Increase/Decrease Growth Factor buttons vary the growth factor incrementally to grow or shrink the prototype. The Minimum/Maximum Growth Factor buttons set the factor immediately to its smallest or largest allowed value. When you are satisfied with the prototype, right-click to mark it with the current feature class.



STEPS

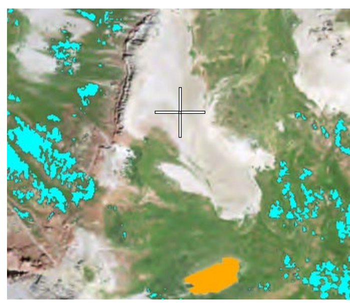
☑ press the Clear Samples and Prototypes button 

☑ press the Full icon button to zoom to full extents 

☑ place the cursor over the white patch at the top center of the image and press <1>

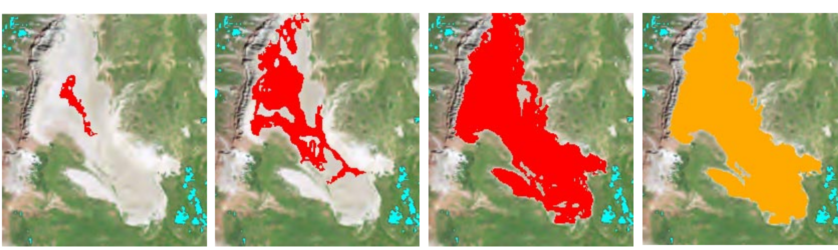
☑ turn on the Grow and Mark Features icon button 

☑ left click at the cursor position shown in the illustration below to create a small prototype feature



☑ roll the mouse wheel toward you to grow the prototype (or press the Increase Growth Factor icon button)

☑ when the prototype will not grow any larger, right-click to mark it



Prototype increasing in size as the growth factor is increased.

After marking.

Factors Affecting Prototype Growth

STEPS

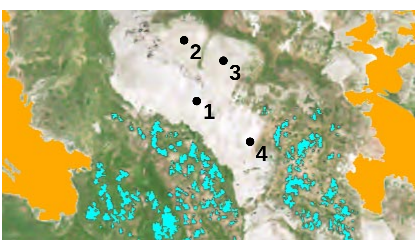
☑ pan the Feature Mapping view to the right to include the white feature patch shown below

☑ with the Grow and Mark Features tool still active, press the Maximum Growth Factor icon button 

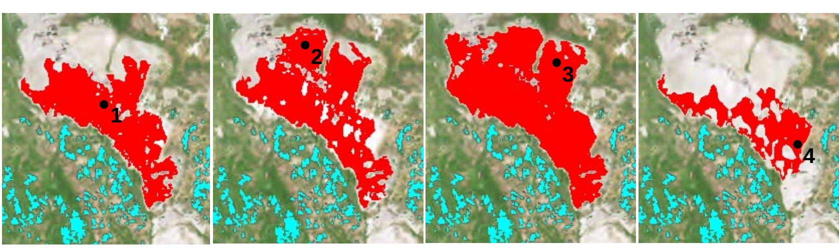
☑ left-click at the numbered locations shown in the illustration below and observe the prototypes produced (clear the prototype after each click) 

The size of the initial prototype that appears when you use the Grow and Mark Features tool depends in part on the current growth factor, which is retained by the tool. The initial and maximum prototype sizes also depend on the local cell value variability in the vicinity of the click point and how variability is distributed through the entire patch. If the starting point is a very uniform area that covers only part of the variability in the feature patch, the initial cell value ranges will be small, limiting the initial and maximum size of the expanded prototype. If you click in a location with more variability, the initial cell value ranges will be wider, potentially allowing the prototype to grow larger at the given growth factor. Thus if your prototype does not grow sufficiently to cover the entire feature patch, you can simply left-click in a more variable part of the feature, which clears the current prototype and starts a new one. (You can also use the Clear Samples and Prototypes icon button to clear the prototype before starting a new one.) In some cases moving the cursor only a few pixels can produce dramatically different results.

If there is too much variability around the click point, no prototype is generated and a warning message is shown in the status field at the bottom left of the Feature Mapping window.



Numbered sample starting locations for growing prototypes.



Prototypes produced at maximum growth factor for the numbered starting locations.

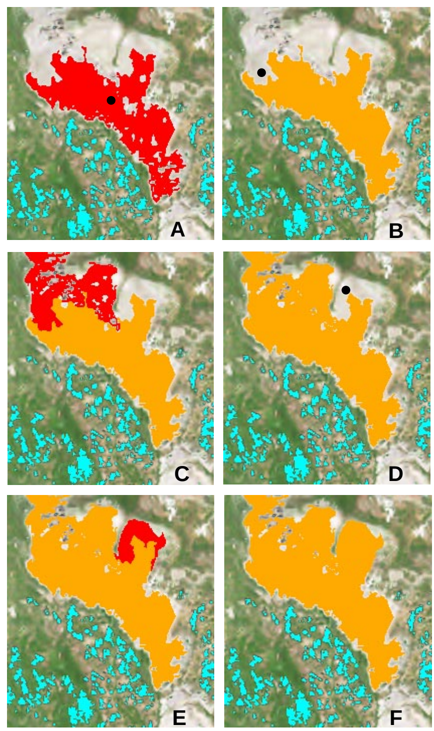
Grow Composite Features

Some larger features may have too much variability in band values for a single Grow and Mark Features prototype to cover even at the maximum growth factor. In these cases you can use the tool in a series of steps to cover the feature, as shown below in the illustrations labeled A through F. If you have the hole-filling option turned on, holes within the prototypes created by this tool are automatically filled when you mark it. But sequential marking with the Grow and Mark Features tool may leave holes along the boundaries of the individually-marked areas or around the edges of the feature. You can use the Grow and Mark Features tool or the Draw Features tool to manually fill in these gaps.

When you are working with larger images with large connected features, there is the potential for prototypes created with the Grow and Mark Features tool to grow to cover very large areas and to take considerable time to do so. The tool incorporates a time limit that lets you intervene in these situations. If the prototype feature is still growing after the specified number of seconds has passed, a Question window opens that allows you to continue, retry with a reduced growth factor, or cancel (which clears the prototype). The Options / Growth Verify Time menu lets you set the growth time limit to 1 second (the default) or 2, 5, 10, 30, or 60 seconds.

STEPS

- ☑ move the cursor back to position 1 from the previous page and left-click to grow a prototype
- ☑ right-click to mark the prototype as WhiteRock
- ☑ left-click at the point shown in illustration B below to grow another prototype and right-click to mark
- ☑ repeat with the location shown in illustration C below



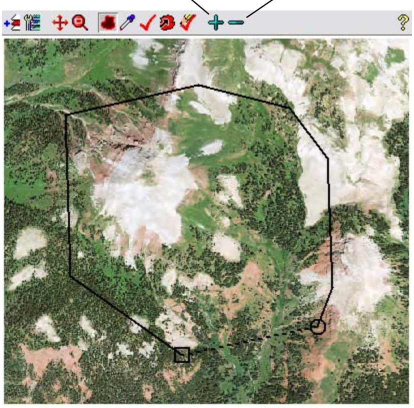
Using the Grow and Mark Features tool to sequentially mark portions of a larger feature that is too variable to cover in one pass.

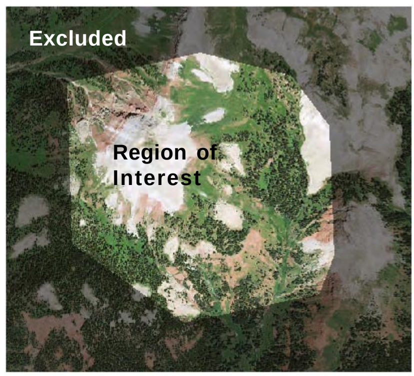
Defining a Region of Interest

STEPS

- ☑ press the Full icon button to zoom to full extents 
- ☑ press the Region of Interest icon button 
- ☑ draw a polygon in the Feature Mapping view
- ☑ right-click or press the Add to Region of Interest icon button 

You can limit the image area to be considered for your Feature Mapping activities using the Region of Interest tool. Turning on the Region of Interest icon button in the Feature Mapping toolbar activates a polygon tool with which you can outline one or more areas of the image. (The Features raster is automatically hidden when you select the Region of Interest tool so you have an unobstructed view of the reference image.) Icon buttons are provided on the tool bar to let you add the polygon to the region of interest or remove it. When you draw the first polygon and add it, the area outside the polygon is automatically set as outside the region of interest; these excluded areas are shown with a transparent gray overlay.





- ☑ choose File / Region of Interest / All to clear the Region of Interest overlay
- ☑ press the Mark Features icon button to turn the Features layer back on 
- ☑ choose File / Features / Save to save your Features raster
- ☑ choose File / Features / Open
- ☑ navigate to the WHITECAPMTNFEATURES Project File and choose the FEATURES raster

You can use the File / Region of Interest submenu to Save the region of interest as a binary mask raster in a Project File and to Open a Region of Interest mask that you have saved in a previous Feature Mapping session. Choose All from this submenu to clear the Region of Interest overlay and include the entire image in your activities.

As a shortcut to demonstrate additional Feature Mapping products, save your Features raster and open the sample Features raster provided, which maps the four feature classes over the entire area.

Generating a Report

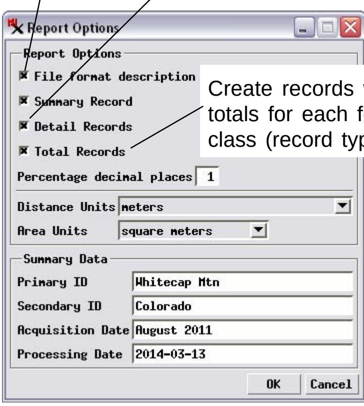
The Feature Mapping process can generate a text report that provides statistics for feature classes and individual features, including area, boundary length, number of cells, number of boundary cells, and the percentage of the area in each feature class. You can choose the distance and area units to use for the report. Excerpts of individual feature details and the feature class totals are shown below.

STEPS
- ☑ choose File / Report

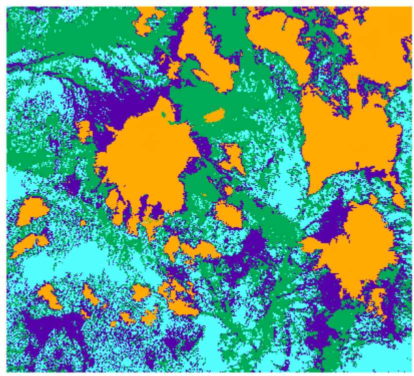
In the Report Options window:
- ☑ turn on the *File format description* checkbox
- ☑ enter Summary Data information in the provided text fields and press [OK]
- ☑ in the Select File window, name the text file and press [OK]

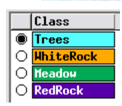
Create a description of the contents in each field in each record type in the report.

Create a record for each individual feature (record type FS).



Create records with totals for each feature class (record type FT).





- ☑ use a text editor (or choose Tools / Miscellaneous / Edit Text Files from the TNTmips menu) to view the report

Individual Feature Details

	Feature Class	Feature Number	Feature Centroid row	col	Area	Boundary Length	Number of cells	Boundary Cells
FS	Trees	83	377	0	8.00	14.00	2	7
FS	RedRock	84	419	0	20.00	24.00	5	12
FS	RedRock	85	444	0	12.00	16.00	3	8
FS	RedRock	86	301	209	119620.00	74056.00	29905	37028
FS	WhiteRock	87	490	111	55084.00	29398.00	13771	14699
FS	RedRock	88	476	0	12.00	18.00	3	9
FS	RedRock	89	492	14	716.00	606.00	179	303
FS	Meadow	90	569	210	221300.00	128494.00	55325	64247

Feature Class Totals

	Feature Class	Number of Features	Total Area	Total Boundary Length	Average Area	Average Boundary Length	Percent Area	Total Cells	Total Boundary Cells
FT	Trees	4253	849804.00	648416.00	199.81	152.46	23.6	212451	324208
FT	WhiteRock	310	843032.00	461822.00	2719.46	1489.75	23.4	210758	230911
FT	Meadow	10771	1102936.00	825560.00	102.40	76.65	30.6	275734	412780
FT	RedRock	16385	804228.00	707130.00	49.08	43.16	22.3	201057	353565

Defining Categories

STEPS 

☑ toggle off the Show / Hide checkbox for the Features layer

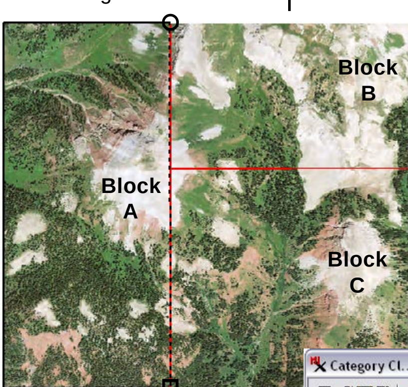
☑ press the Add Layer icon button and choose Quick-Add from the menu 

☑ navigate into the WHITECAPMTNFEATURES Project File and choose the BOUNDARIES vector

☑ choose Action / Categories

☑ in the Category Class Selection window, use the Add icon button to add categories Block A, Block B, and Block C and choose a different color for each when prompted 

☑ with Block A selected in the category list, draw a rectangular polygon around the western portion of the image, with its eastern edge following the N-S red line



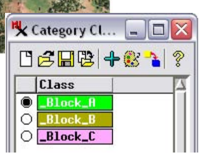
☑ right-click to assign the area to Block A

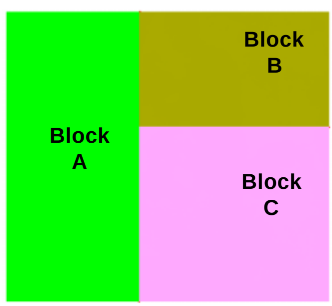
☑ repeat for Block B and Block C shown above

Categories are subdivisions of the image area that can be defined for the purpose of grouping features in the report. For example, feature listings in the report can be grouped by land ownership, county, or any other spatial subareas you choose. Here we divide the image into three hypothetical areas (Blocks A, B, and C) whose boundaries are indicated in the BOUNDARIES vector object.

Choosing Category from the Action menu activates a polygon tool (similar to the Region of Interest tool) and opens a Category Class Selection window. Use the latter window to add, name, and assign colors to the categories. When you draw a category polygon, only areas not yet categorized are affected, so you only need to be careful following boundaries with uncategorized portions of the image. It is actually a good idea to draw later categories so their boundaries overlap the previously-assigned areas to avoid leaving unintentional gaps between them. Categories are only shown in the Feature Mapping window when the Categories action is selected.

You can use the File / Categories submenu to Save the Categories overlay as a raster object in a Project File and to Open a previously-saved Categories raster. You can also save the categories as a vector object.

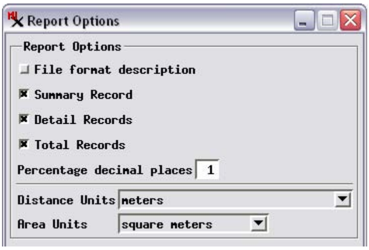




Generating a Report with Categories

If you choose the Summary Record option for the report, a summary with total area, number of cells, and area percentage is included (record type CS, shown below). If you choose Detail Records, the individual feature information is supplemented with a breakdown by category, with a record (type FB) for each category. If you choose the Total Records option, the feature class totals are also supplemented with a breakdown by category (record type CT, shown below).

STEPS
- ☑ choose File / Report
- ☑ in the Report Options window, choose the desired report options, fill in summary data fields, and press [OK]
- ☑ in the Select File window, name the text file and press [OK]



Category Area Totals

	Category	Total Area	Total Cells	Percent Area
CS	Block A	1481616.00	370404	41.2
CS	Block B	840176.00	210044	23.3
CS	Block C	1278208.00	319552	35.5

Feature Class Totals by Category

Category	Feature Class	Number of Features	Total Area	Total Boundary Length	Average Area	Average Boundary Length	Percent Area	Total Cells	Total Boundary Cells
CT Block A	Trees	2496	447004.00	356236.00	179.09	142.72	30.2	111751	178118
CT Block A	WhiteRock	79	235748.00	131138.00	2984.15	1659.97	15.9	58937	65569
CT Block A	Meadow	6130	441068.00	352600.00	71.95	57.52	29.8	110267	176300
CT Block A	RedRock	9265	357796.00	332136.00	38.62	35.85	24.1	89449	166068
CT Block B	Trees	343	58800.00	47136.00	171.43	137.42	7.0	14700	23568
CT Block B	WhiteRock	174	374024.00	201264.00	2149.56	1156.69	44.5	93506	100632
CT Block B	Meadow	727	276580.00	174894.00	380.44	240.57	32.9	69145	87447
CT Block B	RedRock	1270	130772.00	106842.00	102.97	84.13	15.6	32693	53421
CT Block C	Trees	1429	344000.00	245044.00	240.73	171.48	26.9	86000	122522
CT Block C	WhiteRock	64	233260.00	129420.00	3644.69	2022.19	18.2	58315	64710
CT Block C	Meadow	3930	385288.00	298066.00	98.04	75.84	30.1	9632	149033
CT Block C	RedRock	5876	315660.00	268152.00	53.72	45.64	24.7	78915	134076

Additional Feature Mapping Options

The main products of your interactive image classification activities in the Feature Mapping process are the Features raster object and the optional report. However, you also have the option to save the features in two other forms: as a vector object in a TNTmips Project File (File / Features / Save as Vector) and as a KML file (File / Features / Save as KML) for interactive 3D viewing in Google Earth. Feature names and feature class colors are transferred automatically to these output products.

Feature Mapping is not limited to analyzing the bands of a single image. You can work with repeat images from different dates or with rasters derived from them (such as vegetation index and Principal Components rasters). However, all rasters used must be accurately registered and must have the same row-column dimensions and cell size.

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FEATURE MAPPING

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