

ENVI Tutorial: Vector Overlay and GIS Analysis

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Overview of This Tutorial

This tutorial introduces ENVI's vector overlay and GIS analysis capabilities using vector data from ESRI's Maps and Data CD-ROM; a simulated 4 m resolution Space Imaging/EOSAT multispectral dataset; and associated vector data of Gonzales, California, USA.

Part 1 of this tutorial demonstrates the following:

- Stand-alone vector GIS analysis, including input of shapefiles and associated DBF attribute files
- Display in vector windows
- Viewing and editing attribute data
- Point-and-click spatial query
- Math and logical query operations

Part 2 of this tutorial demonstrates the following:

- ENVI's combined image display/vector overlay and analysis capabilities
 - o Cursor tracking with attribute information
 - o Point-and-click spatial query
 - o Heads-up digitizing and vector layer editing
- Generation of new vector layers using math and logical query operations
- Raster-to-vector conversion of ENVI regions of interest (ROIs) and classification images
- ENVI's vector-to-raster conversion, using vector query results to generate ROIs for extraction of image statistics and area calculations

Sources and Files Used in this Tutorial

The data used in this tutorial are provided courtesy of the Environmental Systems Research Institute Inc. and Space Imaging/EOSAT and may not be redistributed without explicit permission from those organizations.

ESRI Data and Maps Version 1 CD-ROM

Example data used in Part 1 of this tutorial come from the ESRI Data and Maps Version 1 CD-ROM distributed with ArcView Version 3.0. ITT Visual Information Solutions strives to maintain import/export compatibility with ESRI GIS products and data formats, including ArcView shapefiles, ArcGRID files, and ArcInfo export files (.e00, non-compressed).

Space Imaging/EOSAT Carterra™ Agriculture Sampler Data

Example images and vector data used in Part 2 of this tutorial come from the Space Imaging/EOSAT Carterra Agriculture Sampler CD-ROM (Copyright © 1997, Space Imaging/EOSAT) and are used with their explicit permission. This sample dataset covers an agricultural area near Gonzales, California, USA—the north-central portion of the Palo Escrito Peak, CA USGS 7.5 minute quadrangle. The digital imagery are simulated data products designed to be similar to the space-based image data products collected and distributed by Space Imaging/EOSAT in early 1998. Space Imaging/EOSAT provides these simulated data products as examples of information extracted from their imagery products. The simulated imagery datasets were generated from digital image data collected by an airborne multispectral scanner. The airborne data were geometrically rectified, corrected for solar effects, and mosaicked at a spatial resolution simulating the Carterra data products. However, radiometric and geometric differences exist between these data and satellite-based products planned for delivery. Please see the Carterra Sampler `readme.txt` file included in the `si_eosat` subdirectory for additional information.

Required Files

ENVI Resource DVD:

- Paths: `envidata/esri_gis` (Part 1 of this tutorial)
`envidata/si_eosat` (Parts 1 and 2 of this tutorial)
`envidata/can_tm` (Part 2 of this tutorial)

Required vector GIS files for Part 1 (envidata\esri_gis)

File	Description
cities.shp (.shx, .dbf)	USA cities (points)
states.shp (.shx, .dbf)	USA states (polygons)

Optional vector GIS files for Part 1 (envidata\esri_gis)

File	Description
counties.shp (.shx, .dbf)	USA counties (polygons)
drainage.shp (.shx, .dbf)	USA states (polygons)
lakes.shp (.shx, .dbf)	USA lakes (polygons)
rivers.shp (.shx, .dbf)	USA rivers (polylines)
roads.shp (.shx, .dbf)	USA roads (polylines)

Required image files for Part 2 (envidata\si_eosat)

File	Description
0826_ms.img (.hdr)	4 m multispectral data and ENVI header

Required image files for Part 2 (envidata\can_tm)

File	Description
can_tmr.img (.hdr)	Cañon City TM data and ENVI header
can_sam.img (.hdr)	Cañon City SAM classification and ENVI header
can_pcls.img (.hdr)	Cañon City parallelepiped classification and ENVI header
can_sv.img (.hdr)	Sieved classification (threshold = 5) and ENVI header
can_clmp.img (.hdr)	Clumped (5 x 5) after sieve and ENVI header
can_tm1.roi	Cañon City TM ROI #1
can_tm2.roi	Cañon City TM ROI #2

Required vector GIS files for Part 2 (envidata\si_eosat)

File	Description
vectors.shp (.shx, .dbf)	Field outlines (polygons)

Optional vector GIS files for Part 2 (envidata\si_eosat)

File	Description
gloria.evf (.dbf)	Query results (polygons)
lanini.evf (.dbf)	Query results (polygons)
sharpe.evf (.dbf)	Query results (polylines)
si_eosat.vec	ENVI vector template for the above three vectors

Vector Overlay and GIS Concepts

Capabilities

ENVI provides extensive vector overlay and GIS analysis capabilities. These include the following:

Import support for **industry-standard GIS file formats**, including shapefiles and associated DBF attribute files, ArcInfo interchange files (.e00, uncompressed), MapInfo vector files (.mif) and attributes from associated .mid files, Microstation DGN vector files, DXF, and USGS DLG and SDTS formats. ENVI uses an internal ENVI Vector Format (EVF) to maximize performance.

Vector and image/vector display groups provide a stand-alone **vector plot window** for displaying vector data and composing vector maps. More importantly, ENVI provides **vector overlays** in display groups (Image windows, Scroll windows, and Zoom windows).

You can generate world boundary **vector layers**, including low- and high-resolution political boundaries, coastlines, and rivers, and USA state boundaries. You can display all of these in vector windows or overlay them in image display groups.

You can perform **heads-up (on-screen) digitizing** in a vector or raster display group. Heads-up digitizing provides an easy means of creating new vector layers by adding polygons, lines, or points.

Image- and vector window-based **vector editing** allows you to modify individual polygons, polylines, and points in vector layers using standard editing tools, taking full advantage of the image backdrop provided by raster images in ENVI.

ROIs, specific image contour values, classification images, and other **raster processing results can be converted to vector format** for use in GIS analysis.

Latitude/longitude and map coordinate information can be displayed and exported for image-to-map registration. Attribute information can be displayed in real-time as each vector is selected.

ENVI supports **linked vectors and attribute tables** with point-and-click query for both vector and raster displays. Click on a vector in the display group, and the corresponding vector and its associated information is highlighted in the attribute table. Click on an attribute in the table, and the display scrolls to and highlights the corresponding vector.

Scroll and pan through rows and columns of vector **attribute data**. Edit existing information or replace attributes with constant values, or with data imported from ASCII files. Add or delete attribute columns. Sort column information in either forward or reverse order. Export attribute records as ASCII text.

Query vector database attributes directly to extract information that meets specific search criteria. You can perform GIS analysis using simple mathematical functions and logical operators to produce new information and layers. Results can either be output to memory or to a file for later access.

You can set **vector layer display characteristics** and modify line types, fill types, colors, and symbols. Use attributes to control labels and symbol sizes. Add custom vector symbols.

You can **reproject** vector data from any map projection to another.

You can **convert vector data to raster ROIs** for extraction of statistics, calculation of areas, and use in ENVI's many raster analysis functions.

Generate maps using ENVI annotation in either vector or image windows. Set border widths and background colors, and configure graphics colors. Automatically generate vector layer map keys. Insert objects such as

rectangles, ellipses, lines, arrows, symbols, text, and image insets. Select and modify existing annotation objects. Save and restore annotation templates for specific map compositions.

Create shapefiles and associated DBF attribute files and indices, or DXF files, from the internal ENVI Vector Format (EVF). New vector layers generated using ENVI's robust image processing capabilities, and changes made to vector layers in ENVI are exported to industry-standard GIS formats.

Use ENVI's direct **printing** capabilities to output to printers and plotters.

Concepts

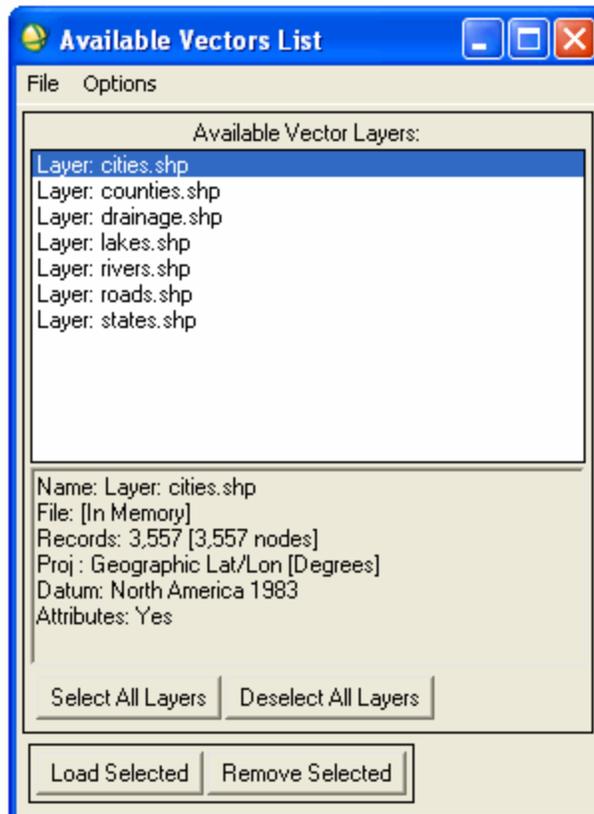
ENVI's vector overlay and GIS analysis functions generally follow the same paradigms as ENVI's raster processing routines, including the same procedures for opening files and the use of standard dialogs for output to memory or file. The following sections describe some of the basic concepts.

ENVI Vector Files (.evf)

External vector files imported into ENVI are automatically converted into EVF, with the default file extension `.evf`. The EVF format speeds processing and optimizes data storage. When you select output to memory (instead of to a file), ENVI retains the external vector format without creating an EVF file.

The Available Vectors List

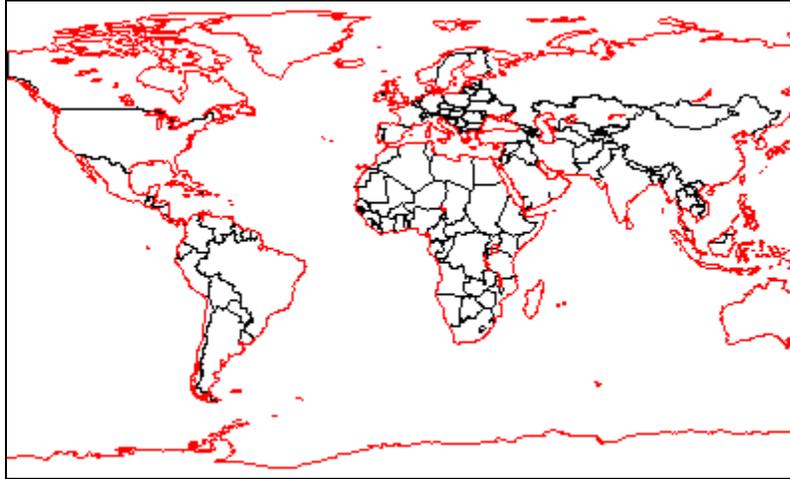
Much like the Available Bands List used to list and load image bands, the Available Vectors List provides access to all vector files open in ENVI. It appears when needed, or you can invoke it by selecting **Window** → **Available Vectors List** from the ENVI main menu bar. Vectors are loaded to either vector or image display groups when you select them from the Available Vectors List and click **Load Selected**. If you have an image display group open, you can load the vectors to that display group, or to a new vector window. In addition to listing and loading vector layers, the Available Vectors List provides utilities to open vector files, to start new vector windows, to create world boundaries and new vector layers, and to export analysis results to ROIs (through raster-to-vector conversion), shapefiles, and ancillary files.



Create World Boundaries

ENVI uses IDL map sets to generate low- and high-resolution world boundaries in EVF. Select **Options** → **Create World Boundaries** from the Available Vectors List, or **Vector** → **Create World Boundaries** from the ENVI main menu bar. You can also generate political boundaries, coastlines, rivers, and USA state boundaries.

High-resolution format is available only if the IDL high-resolution maps are installed. If these are not currently installed on your system, you can install them using the ENVI Installation CD, modifying your installation to include the high-resolution maps.

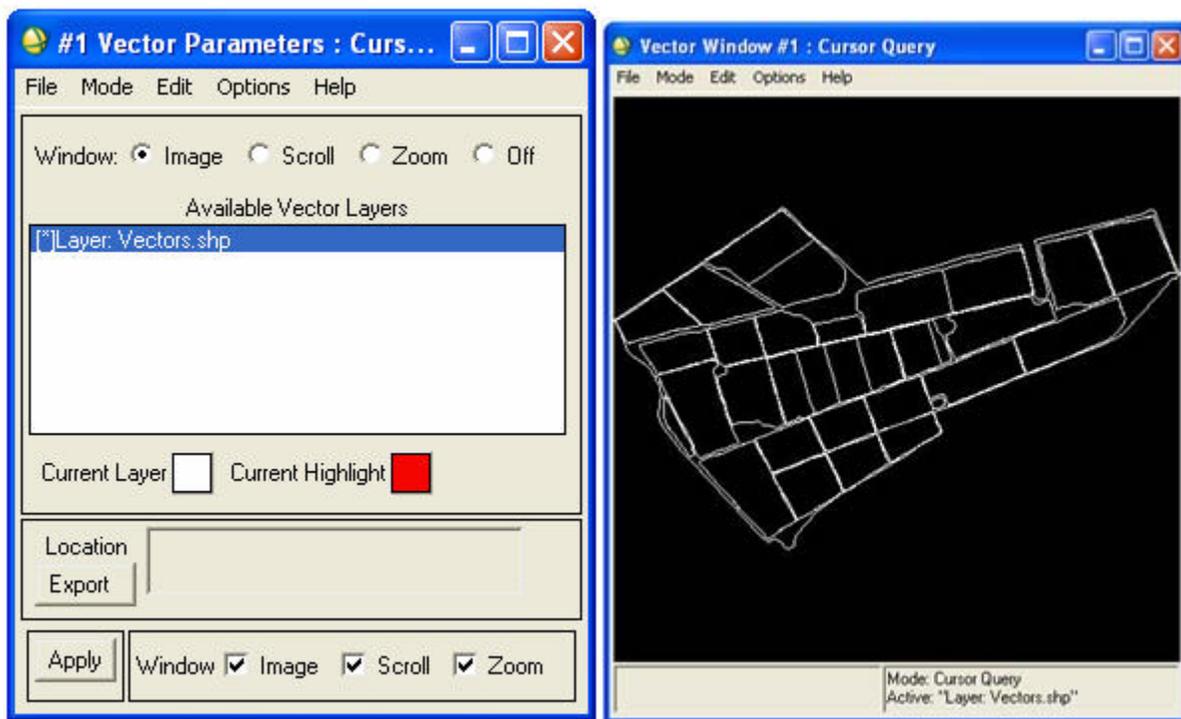


The Vector Parameters Dialog and Vector Window Menu

When vectors are overlaid on an image, the Vector Parameters dialog appears to let you control the way vectors are displayed and the functions that are available for vector processing and analysis.

When vectors are loaded into a vector window (not in an image display group), the vector window has the same menu functions available in the Vector Parameters dialog.

The Vector Parameters dialog and the vector window menu bar allow you to open vector files, import vector layers from the Available Vectors List, arrange vector layer precedence, set plot parameters, and annotate plots. They also control the mode of operation in the vector window or image display group, toggling between cursor query and heads-up digitizing and editing. The Vector Parameters dialog or the vector window menu initiate ENVI's GIS analysis functions, including real-time vector information, attribute viewing and editing, and vector query operations. Finally, the Vector Parameters dialog and the vector window menu bar provide utilities for exporting analysis results to shapefiles and ancillary attribute files, or to ROIs (through vector-to-raster conversion). You can also save the current configuration of vector overlays to a template, so you can later restore them.



ENVI Attributes

ENVI provides access to fully attributed GIS data in a shapefile DBF format. Attributes are listed in an editable table, allowing point-and-click selection and editing.

Double-clicking in a particular cell selects that cell for editing. The table also supports full column substitution using a uniform value and replacement with values from an ASCII file. Options include adding and deleting individual columns and sorting data forward and backward based on information within a column. You can save attributes to an ASCII file or to a DBF file.

Point-and-click spatial query is supported in ENVI attribute tables to help you locate key features in images or in a vector window. Select specific records by clicking the label at the left edge of the table for a specific row in the table. The corresponding vector is highlighted in a contrasting color in the image display group or vector window. You can select multiple records, including non-adjacent records, by holding down the <Ctrl> key as you click the additional row labels.

	AREA	PERIMETER	FIELD SGZ_H	FIELD SGZ_H1	RANCH	BLD
1	4136214.5	136771.67	2	34	other	0
2	1214935.5	4867.3800	3	35	gloria	7
3	1389737.8	4712.4310	4	36	lanini	11
4	1267073.5	4477.9620	5	37	lanini	10
5	1201763.5	4494.0800	6	38	gloria	8
6	1237570.6	4594.5660	7	65	gloria	10
7	1141399.6	4648.2450	8	40	gloria	6
8	1305585.9	4786.6460	9	39	gloria	9
9	753584.50	3728.9260	10	41	gloria	5
10	1197049.1	5240.3720	11	42	lanini	9
11	1322239.4	5206.0660	12	43	sharpe	6
12	664233.00	3236.1620	13	44	gloria	3
13	317763.31	2405.5420	14	45	gloria	4
14	623243.31	3128.7150	15	46	gloria	2
15	135896.97	1949.6480	16	66		0
16	609545.00	3118.4170	17	47	lanini	8
17	681300.13	3490.8470	18	48	gloria	1
18	616200.10	3177.4420	10	40	lanini	7

Part 1: Stand-Alone Vector GIS

This part of the tutorial demonstrates how to use ENVI as a simple stand-alone vector processing and analysis system for GIS data. You will use data from the *ESRI Data and Maps 1 CD-ROM*, which are provided on the ENVI Resource DVD.

Before attempting to start the program, ensure ENVI is properly installed as described in the installation guide.

Open a Shapefile

1. From the ENVI main menu bar, select **File** → **Open Vector File**. A Select Vector Filenames dialog appears.
2. Navigate to `envidata\esri_gis`. Click the **Files of type** drop-down list in the Select Vector Filenames dialog, and select **Shapefile**.
3. Select `cities.shp`. Click **Open**. The Import Vector Files Parameters dialog appears. This dialog allows you to select file or memory output, enter an output filename for the ENVI `.evf` file, and enter projection information if ENVI is unable to find the projection information automatically.
4. Click the **Memory** radio button. Accept the default values by clicking **OK**. A status window indicates the number of vector vertices being read, and the Available Vectors List appears when the data have been converted.
5. Select `cities.shp` in the Available Vectors List and click **Load Selected**. The Vector Window #1 dialog appears with USA cities plotted. The default mode (shown in the title bar or in the lower-right corner of the dialog) is Cursor Query.

Work with Vector Point Data

1. Click and drag the cursor around in Vector Window #1. Latitudes and longitudes are displayed in the lower-left corner of the dialog.
2. Zoom into the contiguous 48 states by positioning the cursor in the far northwest part of the U.S. and clicking and dragging the middle mouse button to define a box covering the desired region. Release the middle mouse button in the far southeast part of the U.S.

Multiple levels of zoom are possible. Click the middle mouse button while holding the <Shift> key to zoom into the display centered on the cursor. Right click in the Vector Window #1 dialog and select Previous Range to step backward through the previous zoom levels. Right-click and select Reset Range, or click the middle mouse button in the Vector Window #1 dialog to reset the zoom level and to set the vector display back to the original range.

3. Change the symbol used to mark the cities. From the Vector Window #1 menu bar, select **Edit** → **Edit Layer Properties**. An Edit Vector Layers dialog appears. Click the **Point Symbol** drop-down list and select **Flag**. Click **OK**. You can add your own symbols by defining them in the file `usersym.txt` in the menu directory of your ENVI installation.
4. Experiment with changing the color, symbol, and size. Click **Preview** to view your changes as you go.

Create USA State Boundaries Using IDL Map Sets

1. From the Available Vectors List menu bar, select **Options** → **Create World Boundaries**. The Create Boundaries dialog appears.
2. Select the **USA States** check box, select the **Memory** radio button, and click **OK** to create the USA States boundaries, which is loaded into the Available Vectors List.
3. In the Available Vectors List, select **USA States [full range]** and click **Load Selected**. The Load Vector dialog appears.

4. Select **Vector Window #1** as the location to load the vector. Click **OK**. The cities and the state boundaries both appear in the Vector Window #1 dialog. The state boundaries are polylines, which are not true polygons because of the way they were digitized and stored.
5. From the Vector Window #1 dialog menu bar, select **Edit** → **Edit Layer Properties**. The Edit Vector Layers dialog appears.
6. Select **USA States [full range]**. Change parameters for the state boundaries, including color, line style, and thickness. To change the color, click on the colored box until you see the color you want, or right-click on the colored box and select a color from the menu that appears. Click **OK** when you are finished.
7. Clear the state boundaries by clicking **USA States [full range]** in the Available Vectors List, then clicking **Remove Selected**.

Work with Vector Polygon Data

1. From the Vector Window #1 dialog menu bar, select **File** → **Open Vector File**. A Select Vector Filenames dialog appears.
2. Click the **Files of type** drop-down list in the Select Vector Filenames dialog, and select **Shapefile**. Select `states.shp` and click **Open**. A Import Vector Files Parameters dialog appears.
3. Select the **Memory** radio button, and accept the default values by clicking **OK**.
4. A status window reports the number of vector vertices being read, and the Available Vectors List appears when the data have been converted. The vector layer `states.shp` is loaded into the Available Vectors List.
5. In the Available Vectors List, select **states.shp** and click **Load Selected**. The Load Vector dialog appears.
6. Select **Vector Window #1** as the location to load the vector. Click **OK**. The cities and the state boundaries both appear in the Vector Window #1 dialog. The state boundaries are polylines, which are not true polygons because of the way they were digitized and stored.
7. From the Vector Window #1 dialog menu bar, select **Edit** → **Edit Layer Properties**. The Edit Vector Layers dialog appears.
8. Select **Layer:states.shp** and change the color to green. Click the **Polygon Fill** drop-down list and select **Line**. Click **OK**.

Retrieve Vector Information and Attributes

1. Right-click in the Vector Window #1 dialog and select **Select Active Layer** → **Layer: cities.shp**. From the Vector Window #1 dialog menu bar, select **Options** → **Vector Information** to open the Vector Information dialog. Click and drag over the city flags in the Vector Window #1 dialog to see the basic attribute information (from `cities.dbf`) in the Vector Information dialog.
2. Find your hometown or a nearest city by examining the AREANAME attribute in the Vector Information window. The latitude and longitude appear at the bottom of the Vector Window #1 dialog.

View Attributes and Use Point-and-Click Query

1. While `cities.shp` is still the active layer and Cursor Query is the active mode, select **Edit** → **View/Edit/Query Attributes** from the Vector Window #1 dialog menu bar. A Layer Attributes table appears. This is a fully editable table of the attributes for the selected layer.

2. Click in the left column (on the record number) to do a spatial query on a selected city. The corresponding city flag is highlighted in the Vector Window #1 dialog. If desired, zoom to the selected city by clicking and dragging a box around it with the middle mouse button. Zoom back out by clicking the middle mouse button in the Vector Window #1 dialog.
3. Verify that you have selected the correct city by clicking the city flag in the Vector Window #1 dialog and observing the attributes in the Vector Information window.
4. Edit the AREALAND value for the selected city by scrolling to the right in the Layer Attributes table until you see the AREALAND column. Double-click in the corresponding AREALAND table cell. Enter a new value and press **<Enter>** to change the value.
5. Perform a map-based query by clicking a city flag. The corresponding record is highlighted in the Layer Attributes table. In the Vector Window #1 dialog, drag the vector cursor from one city flag to another, and note how the Layer Attributes table scrolls to follow the selected cities.

Query Attributes

1. Ensure that `cities.shp` is still the active layer. From the Vector Window #1 dialog menu bar, select **Options** → **Select Active Layer** → **Layer:cities.shp**.
2. From the Vector Window #1 dialog menu bar, select **Edit** → **Query Attributes**. A Layer Attribute Query dialog appears.
3. In the **Query Layer Name** field, enter **Where State==California**. Click **Start**. A Query Expression section appears at the top of the Layer Attribute Query dialog.
4. Click the **AREANAME** drop-down list and select **ST**.
5. Click the **>** drop-down list and select **==**.
6. In the **String** field, enter **CA** (be sure to match this case).
7. Click the **Memory** radio button and click **OK**. ENVI creates a new vector layer and associated DBF file based on the results of the query. The new layer appears in the Available Vectors List and is loaded into Vector Window #1. Zoom to the selected vectors using the middle mouse button to draw a box around the state of California.
8. Right-click in the Vector Window #1 dialog and select **Select Active Layer** → **Layer:Where State==California**. Open the DBF attribute file by selecting **Edit** → **View/Edit/Query Attributes** from the Vector Window #1 dialog menu bar. The Layer Attributes table appears.
9. Perform some point-and-click query operations as described in the previous section to see the association between the selected cities, their locations in the vector window, and their attributes. You can select multiple cities from the attribute table by holding down the **<Ctrl>** key while you click on the record labels on the left side of the table.
10. Click the AREANAME column name at the top of the table to highlight the entire set of attributes. From the Layer Attributes table menu bar, select **Options** → **Sort by selected column forward** to sort the column alphabetically. Scroll down the column and click the **Sacramento** row (record 334) to highlight the location of California's capital in a different color in the Vector Window #1 dialog.

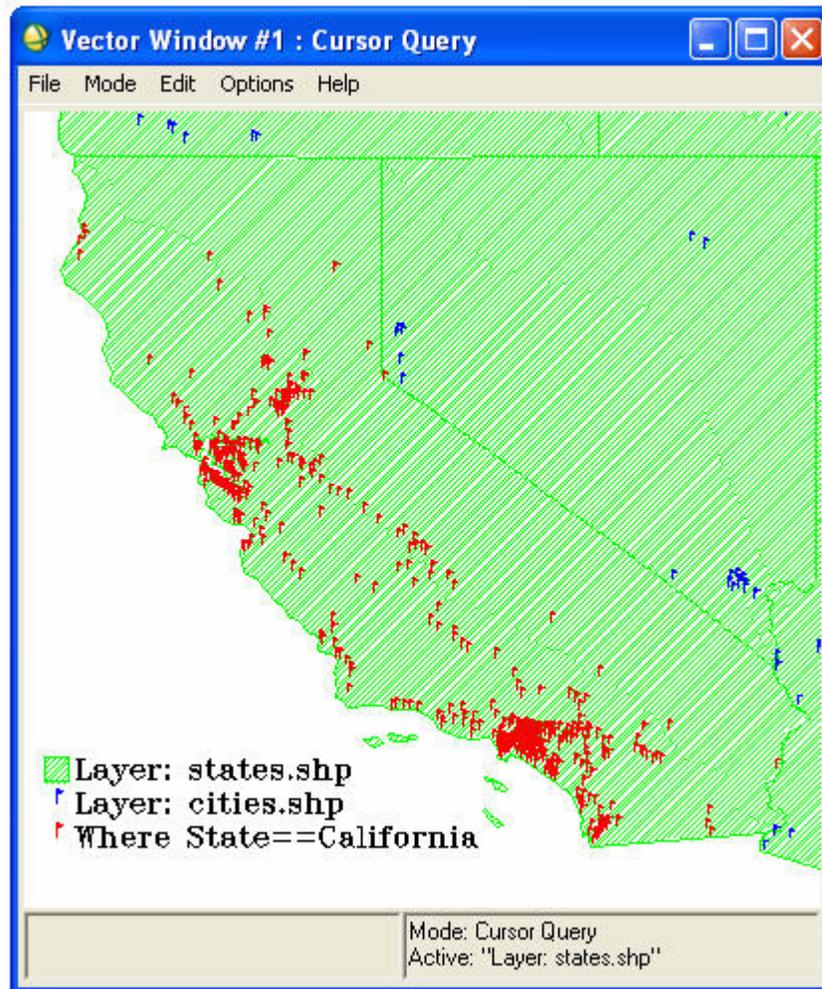
Add a Map Key in Vector Window

You can generate a vector map from the Vector Window dialog, using annotation tools. See the *Map Composition* tutorial or ENVI Help for further details. The following exercise shows you how to add a map key.

1. From the Vector Window #1 dialog menu bar, select **Options** → **Annotate Plot**. An Annotation dialog appears.

- From the Annotation dialog menu bar, select **Object** → **Map Key** to automatically create a map key for the vector layers. Click once inside the Vector Window #1 dialog to show the map key, and click and drag the red diamond handle to move it. To change the characteristics of the map key, click **Edit Map Key Items** in the Annotations dialog and change the settings in the Map Key Object Definition dialog.
- Right-click in the Vector Window #1 dialog to lock the map key in place. Annotation in the vector window behaves the same way as annotation in display groups. See the *Map Composition* tutorial or ENVI Help for further details.

The following image shows the results of the attribute queries and annotations; your results may be slightly different.



Close all Windows and Files

- In the Available Vectors List, click **Select All Layers**. Click **Remove Selected**. From the Available Vectors List menu bar, select **File** → **Cancel**.
- Close the vector window and all associate dialogs and attribute tables by selecting **File** → **Cancel** from the Vector Window #1 dialog menu bar.

Part 2: Raster and Vector Processing

This section of the tutorial demonstrates how to use vector overlays and GIS data and attributes in combination with raster images from Space Imaging/EOSAT.

Load Image Data to Combined Image/Vector Display

Open an image file to use as a backdrop for vector layers.

1. From the ENVI main menu bar, select **File** → **Open Image File**. A file selection dialog appears.
2. Navigate to `envidata\si_eosat` and select `0826_ms.img`. Click **Open**.

The Available Bands List appears with four spectral bands listed. The data simulate a 4 m Space Imaging/EOSAT multispectral dataset with spectral band coverage similar to the first four spectral bands of Landsat Thematic Mapper data. A true-color image is automatically loaded into a new display group.

Open a Vector Layer and Load to Image Display

1. From the Display group menu bar, select **Overlay** → **Vectors**. A Vector Parameters dialog appears.
2. From the Vector Parameters dialog menu bar, select **File** → **Open Vector File**. This menu option is also accessible from the ENVI main menu bar. A Select Vector Filenames dialog appears.
3. Click the **Files of type:** drop-down list and select **Shapefile**. Select `vectors.shp` and click **Open**. An Import Vector Files Parameters dialog appears.
4. Select **File** or **Memory** output, and enter an output filename for the ENVI `.evf` file if you selected File.
5. In the **Native Projection** list, select **State Plane (NAD 83)**. Click **Set Zone**. A Select State Plane Zone dialog appears.
6. Select **(404, 3351) California IV** and click **OK**.
7. Select **Memory** output and click **OK**. A status window reports the number of vector vertices being read. When the data have been converted, they are automatically loaded into the Vector Parameters dialog and displayed in white on the image. The `vectors.shp` layer should be highlighted in the Vector Parameters dialog.
8. Click the **Current Layer** colored box to select a more visible color for the vector layer or right-click on the box and select from the menu. Click **Apply** to update the vector color.

Track Attributes with the Cursor

1. In the Vector Parameters dialog, select **Options** → **Vector Information**. A Vector Information dialog appears.
2. Click and drag inside the image to view the attribute information for the vectors. Also observe the latitude and longitude listed in the Vector Parameters dialog. Select the **Scroll** or **Zoom** radio button in the Vector Parameters dialog to allow vector tracking in the corresponding window. Select the **Off** radio button to allow normal scrolling in the Scroll and Main windows and zooming in the Zoom window. Try different zoom factors in the Zoom window to assess the accuracy of the vectors.
3. Ensure that you are in Cursor Query mode by selecting **Mode** from the Vector Parameter dialog menu bar.
4. From the Vector Parameters dialog menu bar, select **Edit** → **View/Edit/Query Attributes**. A Layer Attributes table appears. Select random records by clicking the numbered columns to highlight specific polygons on the

image. You may want to change the Current Highlight color in the Vector Parameters dialog to something that is more visible in your display group.

Heads-up (On-screen) Digitizing

ENVI provides vector editing routines for adding your own vectors to an existing vector layer or for creating new vector layers. These vector editing routines are similar in function to ENVI's annotation polygons, polylines, and points. ENVI heads-up vector digitizing allows you to create new polygons, polylines, points, rectangles, and ellipses.

1. Create a new vector layer by selecting **File** → **Create New Layer** from the Vector Parameters dialog. A New Vector Layer Parameters dialog appears.
2. Enter a **Layer Name**. Click the **Memory** radio button, and click **OK**.
3. In the Vector Parameters dialog, click the new layer name to initialize a new DBF file.
4. From the Vector Parameters dialog menu bar, select **Mode** → **Add New Vectors**.
5. For this exercise, you will create a polygon vector. From the Vector Parameters dialog menu bar, select **Mode** → **Polygon**.

Since the Image radio button is selected by default in the Vector Parameters dialog, you will define the new polygon in the Image window. You can specify which display group window you want to edit your vectors in, by selecting the appropriate radio button in the Vector Parameters dialog.

You may want to change the new vector layer color from white to something more visible before drawing new polygons.

6. Draw a few polygons using field outlines on the image as guides. In the Image window, use the mouse to define the new polygon area as follows:

Click the left mouse button to draw polygon segments.

Click the middle mouse button to erase polygon segments.

Click the right mouse button to fix the polygon. Right-click again and select **Accept New Polygon** to accept the polygon.

To move the Image box in the Scroll window to a new location, you must click the **Off** radio button in the Vector Parameters dialog. When you are finished moving around the image, click the **Image** radio button to resume adding new vectors.

7. To add attributes to the new polygons, select **Edit** → **Add Attributes** from the Vector Parameters dialog menu bar. An Add Attributes Choice dialog appears.
8. Select **Define new attributes interactively**. Click **OK**. An Attribute Initialization dialog appears.
9. In the **Name** field, type **Field_ID**.
10. Click the **Type** drop-down list and select **Character**.
11. Click **Add Field**.
12. For the second attribute, type **Field_Area** in the **Name** field.
13. Click the **Type** drop-down list and select **Numeric**.
14. Click **OK** to create the attribute table. A Layer Attributes table appears.

15. Double-click in a field, enter the value, and press the **<Enter>** key. To see which rows are associated with which fields, select **Mode** → **Cursor Query** from the Vector Parameters dialog, and click the row labels in the Layer Attributes table. The corresponding polygon is highlighted in the Image window.
16. From the Layer Attributes dialog menu bar, select **File** → **Cancel**. When you are prompted to save the attribute table, click **Yes**.

Edit Vector Layers

1. In the Vector Parameters dialog, select the new vector layer and select **Mode** → **Edit Existing Vectors**.
2. In the Image window, click one of the polygons you created in the last section. The polygon is highlighted and its nodes are marked with diamonds. When the vector is selected, you can make the following changes:

Delete the entire polygon by right-clicking it and selecting **Delete Selected Vector**.

To move a node, click and drag it to a new location.

After making changes to a polygon, right-click it and select **Accept Changes**.

Exit the editing function without making any changes by clicking the middle mouse button, or right-click and select **Clear Selection**.

To add or remove nodes from a polygon, right-click to display the shortcut menu and select from the following options:

- To add a node, right-click and select **Add Node**, then drag the node to a new location.
- To remove a node, right-click it and select **Delete Node** from the shortcut menu.
- To change the number of nodes added at one time, right-click and select **Number of Nodes to Add**. Enter the number of nodes in the dialog that appears.
- To remove a range of nodes, right-click on the first node and select **Mark Node**. Right-click on the last node and select **Mark Node** again. Right-click again and select **Delete Marked Nodes**.

3. To finish this section, select **Window** → **Available Vectors List** from the ENVI main menu bar to display the Available Vectors List. Delete any new layers you have created by selecting them in the Available Vectors List and clicking **Remove Selected**. Do not remove the `vectors.shp` layer.

Query Operations

1. From the Vector Parameters dialog menu bar, select **Mode** → **Cursor Query**.
2. In the Vector Parameters dialog, highlight `vectors.shp`. Select **Edit** → **View/Edit/Query Attributes**. A Layer Attributes table appears.
3. Examine the RANCH column and note the predominance of three owners "gloria", "lanini", and "sharpe". Close the attribute table by selecting **File** → **Cancel**.
4. From the Vector Parameters dialog menu bar, select **Edit** → **Query Attributes**. A Layer Attribute Query dialog appears.
5. In the **Query Layer Name** field, type **Gloria Ranch**. Click **Start**.
6. In the Query Expression section that appears at the top of the Vector Parameters dialog, click the **AREA** drop-down list and select **RANCH**.

7. Click the > drop-down list and select ==.
8. In the **Value** field, type **gloria**. (Be sure to match the case in the attribute table).
9. Select the **Memory** radio button and click **OK**. The Gloria Ranch layer generated by the query appears in the Vector Parameters dialog.
10. In the Vector Parameters dialog, select the **Gloria Ranch** layer and select **Edit** → **Edit Layer Properties** from the menu bar to change layer parameters. An Edit Vector Layers dialog appears.
11. Click the **Polygon Fill** drop-down list and select **Line**. Click **OK**. The Gloria Ranch polygons are highlighted as a new layer.
12. To examine the attributes for this layer, select **Gloria Ranch** in the Vector Parameters dialog, and select **Edit** → **View/Edit/Query Attributes** from the menu bar. A Layer Attributes table appears. Examine the query results.
13. Close the Layer Attributes table and repeat the query for the "lanini" and "sharpe" ranches, highlighting each in a different color or pattern.
14. Try other queries on combinations of attributes by choosing one of the logical operators in the Layer Attribute Query dialog.

Convert Vectors to ROIs

ENVI provides several important links between vector analysis and raster image processing. This portion of the exercise describes how to create ROIs from vector processing results and extract ROI statistics.

1. From the Display group menu bar, select **Overlay** → **Region of Interest**. The ROI Tool dialog appears.
2. In the Vector Parameters dialog, highlight a layer name and select **File** → **Export Active Layer to ROIs**. An Export EVF Layers to ROI dialog appears.
3. Select **Convert all records of an EVF layer to one ROI**, and click **OK**.
4. Repeat Steps 2-3 for each layer you created earlier from the query operations. The layers appear in the ROI Tool dialog.
5. In the ROI Tool dialog, select the **Gloria Ranch** ROI by clicking in the far left column of its row. Click **Stats**. An ROI Statistics Results dialog appears with image statistics for the Gloria Ranch polygons and multispectral data.

Now that you have converted these vector polygons to ROIs, you can use ENVI's raster processing capabilities to analyze the image data, with respect to the ROIs. This includes masking, statistics, contrast stretching, and supervised classification.

Display Image Map Results

ENVI provides tools to generate image maps from the combined raster/vector data in a display group. These include annotation tools used for image and plot annotation, as well as QuickMap tools. The following example shows you how to add a map key to the display group. See the *Map Composition* tutorial or ENVI Help for further details on annotation.

1. From the Display group menu bar, select **Overlay** → **Annotation**. An Annotation dialog appears.
2. From the Annotation dialog menu bar, select **Object** → **Map Key**.
3. Click once inside the Image window to show the map key. Click and drag the diamond handle to move the map key.

4. Click **Edit Map Key Items** in the Annotation dialog. A Map Key Object Definition dialog appears. Change the map key characteristics as desired and click **OK**.
5. Once you have placed the map key where you want it, right-click in the Image window to lock it in place.

Close Windows and Files

1. In the Available Vectors List, click **Select All Layers**, followed by **Remove Selected**. From the Available Vectors List menu bar, select **File** → **Cancel**.
2. From the ENVI main menu bar, select **File** → **Close All Files**.

Export ROI to Vector Layer

ENVI can convert raster processing results (such as ROIs) for use in ENVI vector processing and analysis and for export to external GIS software such as ArcGIS. The following exercises illustrate the export of raster information to vector GIS.

Open and Display an Image

Open a Landsat TM image of Cañon City, Colorado, USA, to use as background for ROI definition and export to vector:

1. From the ENVI main menu bar, select **File** → **Open Image File**. A file selection dialog appears.
2. Navigate to `envidata\can_tm` and select `can_tmr.img`. Click **Open**.
3. In the Available Bands List, select **TM Band 4**, select the **Gray Scale** radio button, and click **Load Band**.

Load Predefined ROIs

1. From the Display group menu bar, select **Overlay** → **Region of Interest**. An ROI Tool dialog appears.
2. From the ROI Tool dialog menu bar, select **File** → **Restore ROIs**.
3. Navigate to `envidata\can_tm` and select `can_tm1.roi`. Click **Open**. An ENVI Message dialog reports what regions have been restored. Click **OK**. The predefined ROI is loaded into the ROI Tool dialog and plotted on the image.
4. Repeat Step 3 for the file `can_tm2.roi`.

Convert ROIs to Vectors

1. To convert these ROIs to vector polygons, select **File** → **Export ROIs to EVF** from the ROI Tool dialog menu bar. An Export Region to EVF dialog appears.
2. Select a region from the **Select ROIs to Export field**.
3. Select **All points as one record**.
4. Enter an **Output Layer Name**, click **Memory**, and click **OK** to convert the first ROI.
5. Repeat Steps 1-4 for the second ROI. The layers appear in the Available Vectors List.
6. In the Available Vectors List, click **Select All Layers**, followed by **Load Selected**. A Load Vector dialog appears.
7. Select **New Vector Window** and click **OK**. The vectors are loaded as polygons into the Vector Window #1 dialog.

8. From the Vector Window #1 dialog menu bar, select **Edit** → **Add Attributes**.
9. Add attributes as described in Steps 8-15 on page 12.

You can now use these polygons with query operations and GIS analysis with other vector data, or you can export them to shapefiles by selecting **File** → **Export Active Layer to Shapefile** from the Vector Window Parameters dialog.

Close All Windows and Files

1. In the Available Vectors List, click **Select All Layers**, followed by **Remove Selected**.
2. From the Available Vectors List menu bar, select **File** → **Cancel**.
3. From the Vector Window #1 dialog menu bar, select **File** → **Cancel**.
4. From the ENVI main menu bar, select **File** → **Close All Files**.

Export a Classification Image to Vector Polygons

You can export classes from a classification image to one or more vector layers, and you can select individual image brightness levels for export as a vector layer.

Load and Display a Classification Image

Open a parallelepiped classification image of Cañon City TM data (with three classes) to use as a background for ROI definition and export to vector:

1. From the ENVI main menu bar, select **File** → **Open Image File**. A file selection dialog appears.
2. Navigate to `envidata\can_tm` and select `can_pcls.img`. Click **Open**.
3. In the Available Bands List, click **Load Band**.

Generalize the Classification Image

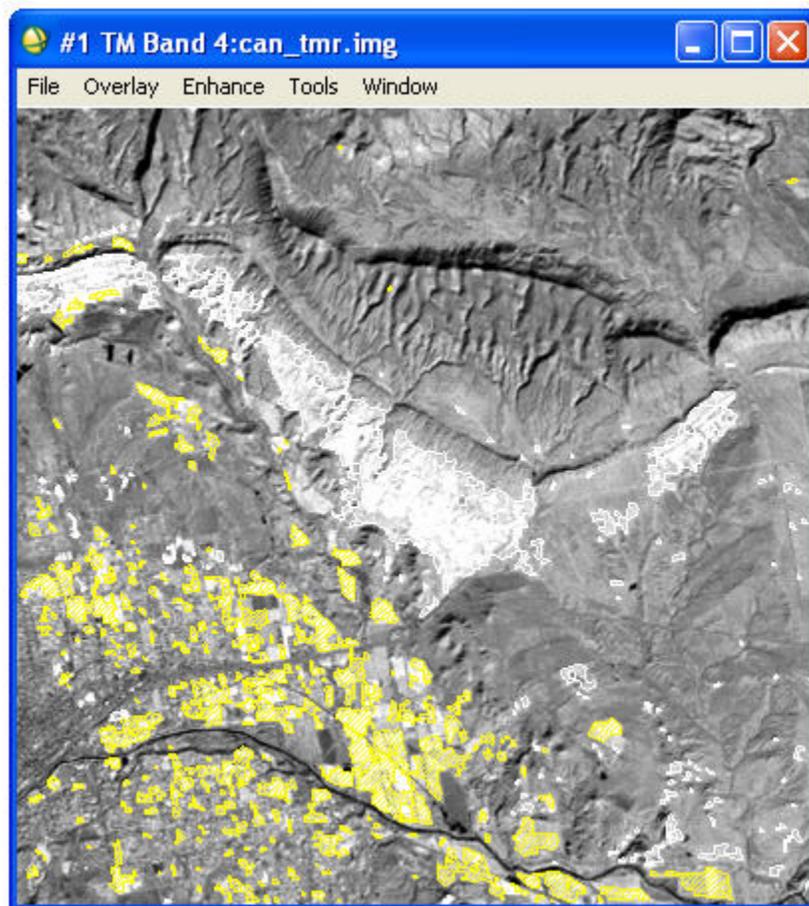
To conduct successful raster-to-vector conversions, you should typically generalize the results of raster processing. If you do not generalize, you will have vector polygons around individual pixels and small groups of pixels. To demonstrate the results of generalizing the classification image, load and display the results of a 5-pixel sieve operation, followed by a 5 x 5 clump operation as follows:

1. Open and display `can_sv.img` (the sieve results) in Display #1, replacing `can_pcls.img`.
2. Open and display `can_clmp.img` (the clump results) in Display #1, replacing `can_sv.img`.

Convert the Generalized Classification Image to Vector Polygons

1. From the ENVI main menu bar, select **Classification** → **Post Classification** → **Classification to Vector**. A Raster to Vector Input Band dialog appears.
2. Select **Clump** under `can_clmp.img` and click **OK**. A Raster to Vector Parameters dialog appears.
3. Select **Region #1**, press the **<Shift>** key, and select **Region #2** (to select both).
4. Click the Output toggle button to select **One Layer per Class**.
5. Select **Memory** and click **OK**. The new vector layers appear in the Available Vectors List.
6. In the Available Vectors List, select **Region #1**, press the **<Shift>** key, and select **Region #2** (to select both).

7. Click **Load Selected**. A Load Vectors dialog appears.
8. Select **Display #1** and click **OK**. A Vector Parameters dialog appears.
9. In the Vector Parameters dialog, select **Region #1**. Select **Edit** → **Edit Layer Properties** from the Vector Parameters menu bar. An Edit Vectors Layers dialog appears.
10. Right-click the **Color** box and select Items **1:20** → **White**. Click the **Polygon Fill** drop-down list and select **Line**. Click **OK**.
11. In the Vector Parameters dialog, select **Region #2**. Select **Edit** → **Edit Layer Properties** from the Vector Parameters menu bar. An Edit Vectors Layers dialog appears.
12. Right-click the **Color** box and select Items **1:20** → **Yellow**. Click the **Polygon Fill** drop-down list and select **Line**. Click **OK**.
13. Examine the results in Display #1. You can also overlay the vectors onto a gray scale image of `can_tmr.img` Band 3 if desired. This overlay is show in the following figure.



14. From the ENVI main menu bar, select **File** → **Exit**.