**U.S. Fish & Wildlife Service**

## Spatial Inventory and Monitoring on National Wildlife Refuges


**Southwest Region**
**National Wildlife Refuge System**
**NWR Remote Sensing Lab, Division of Planning**

**TECHNICAL MANUAL**

# Vegetation/Habitat Mapping: *Object Based Image Classification Using SPRING Software*

***Draft 02/24/2006***

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# 1.0 Introduction

## 1.1 Purpose

Spatial inventory and monitoring of vegetation, land cover and wildlife habitat on National Wildlife Refuges (NWR) plays an important roll in the management of our natural resources. Within the Southwest Region (R2) the NWR Remote Sensing Lab has been tasked with developing spatial habitat inventory and monitoring methods and producing these data for all NWRs throughout the region.

In addition to using eCognition, the NWR Remote Sensing Lab has begun recent research into utilizing SPRING software to complete the image segmentation and supervised classification steps in inventory and monitoring project processes.

Spring is an object oriented data model image/classification software similar to eCognition. The software takes advantage of innovative algorithms for spatial indexing, image segmentation, region-based classification by neural networks and TIN generation. Segmentation tests between SPRING and eCognition have shown no notable differences between the ability of the software packages to derive image objects within vegetation communities. SPRING reaches beyond eCognition in terms of classification algorithms, allowing users to apply far more than an object based nearest neighbor.

Because the software was developed by the Brazilian government, the help document and user guide is in Portuguese. This has made the learning curve a little bit steeper, but recently a tutorial was translated to English and ships with Version 4.2 of SPRING. This undoubtedly will help users new to SPRING to fully utilize the software. The **software is FREE** and can be downloaded at: http://www.dpi.inpe.br/spring/english/index.html . Before downloading, registration is required.

The Lab plans to continue the application and testing of this software. If successful it could **greatly reduce the image processing steps required to generate vegetation/habitat inventories, further reducing the dependency on ERDAS Imagine and end use of eCognition.**

The following is directly from the SPRING website:


### What is SPRING?

**SPRING** is a state-of-the-art GIS and remote sensing image processing system with an object-oriented data model which provides for the integration of raster and vector data representations in a single environment. SPRING is a product of Brazil's National Institute for Space Research (INPE/DPI (Image Processing Division ) with assistance from:

- EMBRAPA/CNPTIA - Brazil's Agricultural Research Agency.
- IBM Brasil
- TECGRAF - Computer Graphics Technology Group.
- PETROBRÁS / CENPES

The SPRING project has received substantial support from CNPq (National Research and Development Agency) through its programs RHAE and PROTEM/CC (GEOTEC project).

### SPRING main features

- An integrated GIS for environmental, socioeconomic and urban planning applications.
- A multi-platform system, including support for Windows95/98/NT, Linux and Solaris.
- A widely accessible freeware for the GIS community with a quick learning curve.
- To be a mechanism of diffusion of the knowledge developed for the INPE and its partners with the introduction of new algorithms and methodologies.

### Scientific Citation of SPRING

For citation of SPRING in scientific reports, please use a reference to the paper: "SPRING: Integrating remote sensing and GIS by object-oriented data modelling" Camara G, Souza RCM, Freitas UM, Garrido J Computers & Graphics, 20: (3) 395-403, May-Jun 1996.

## 1.2 Overview

This document provides a demonstration in the use of SPRING. The methods described in this document may be applied to vegetation/landcover/habitat mapping, historical land use and change detection analysis. The steps outlined below have been applied by NWR Remote Sensing Lab for the delineation of image objects optimized to vegetative classes at the physiognomic level (NVCS Class level).

SPRING Demo
Salt Plains NWR imagery subset

**Goal:** To use SPRING to classify an image for final output as a shapefile for use in a GIS.

## 2.1 Download and Install SPRING

1. Download SPRING Version 4.2 from: http://www.dpi.inpe.br/spring/english/index.html. You will need to register.
2. Install SPRING Version 4.2

## 2.2 Acquire and Install ERDAS ViewFinder

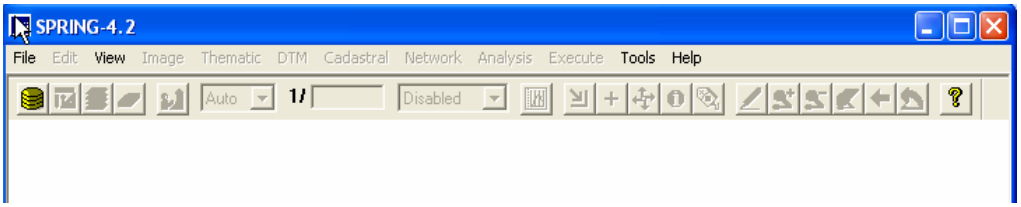
1. Acquire ERDAS ViewFinder. It was free at one time.
2. Install ERDAS ViewFinder.

## 2.3 Reproject and Resample Imagery with ERDAS ViewFinder

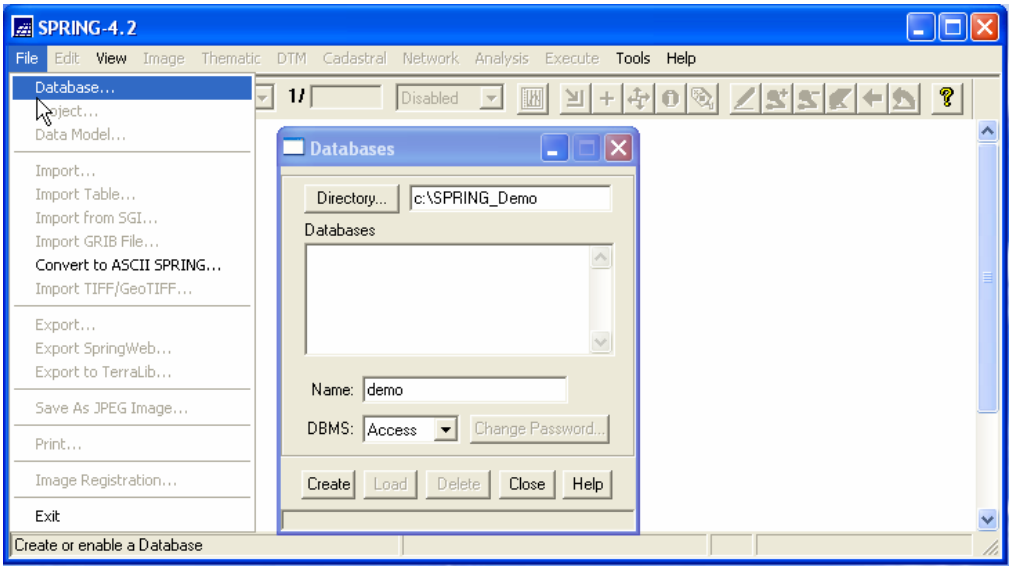
1. Load project imagery into ERDAS ViewFinder.
2. Select **File | Save As…**. Click on **Output file options** tab, click in checkbox for **Change Output Pixel Size**, increase **Width:** to 3 and **Height:** to 3.
3. Under **File** tab, navigate to appropriate directory (e.g. C:/SPRING_Demo_imagery), type in **File name:** (e.g. sps3x), change **Files of type:** to TIFF.
4. Click on **Change Output Projection** checkbox. In **Category:** box, select UTM WGS 84 North. In **Projection:** box, select UTM Zone 14 (Range 102W – 96W). Leave **Resample Method:** set to Nearest Neighbor.
5. Go back to **File** tab, make sure **File name:**, **Files of type:**, and **Look in:** (directory) are set correctly and click on **OK**. A blue progress bar should appear at bottom of window and a when processing is complete, a new window will open with the newly created file.
6. Close all ERDAS ViewFinder windows.

## 2.4 Create Database, Project, Category, and Import Image

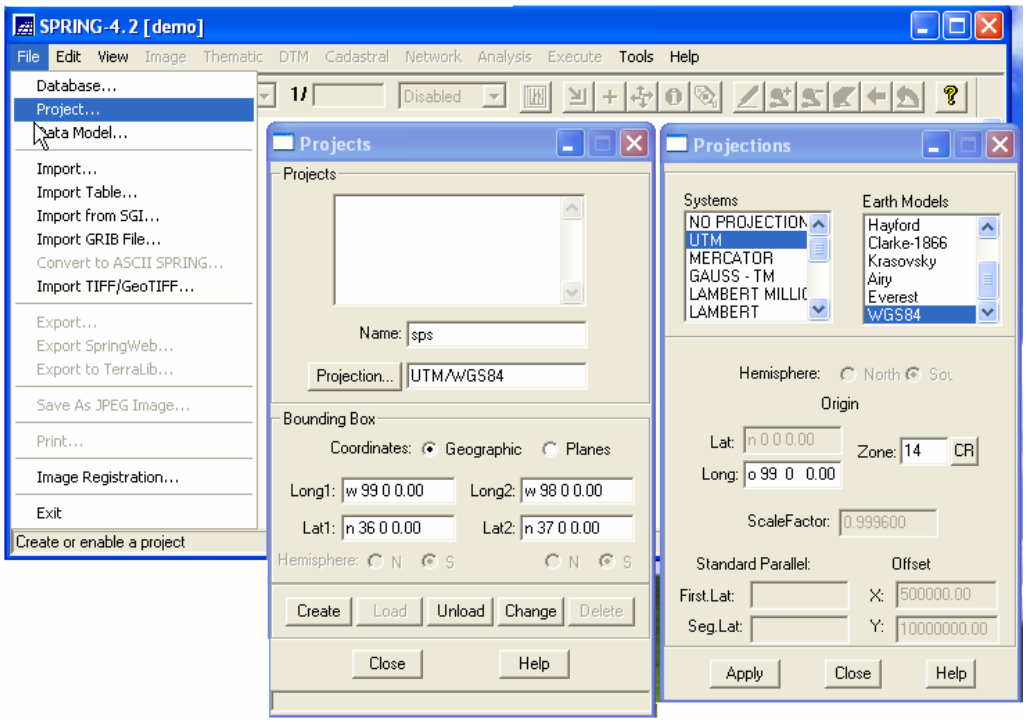
1. Using Windows tools, create a directory where the SPRING database will reside (e.g. C:\SPRING_Demo)
2. Start SPRING



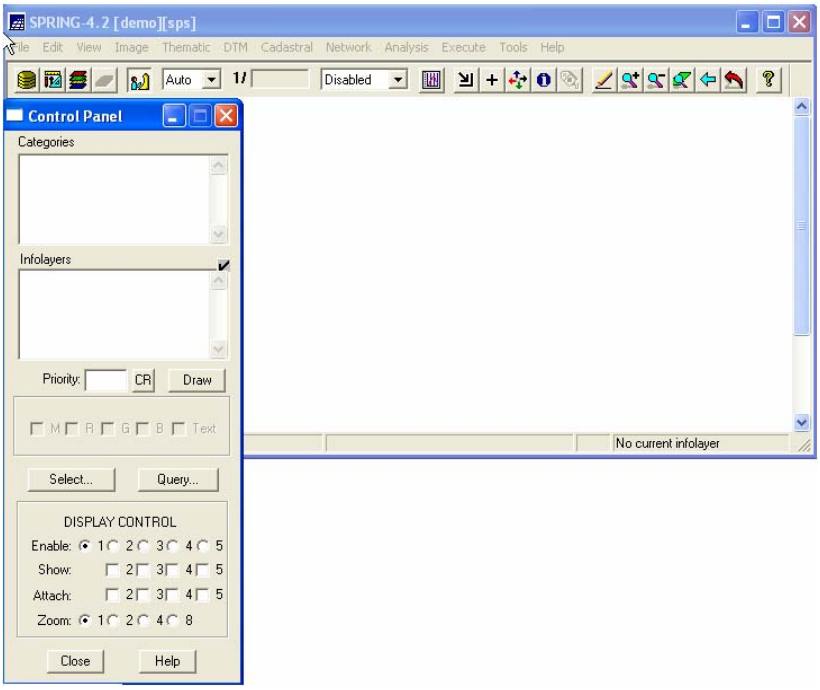

3. Create the SPRING database by selecting **File | Database** then click on the **Directory** button and navigate to the directory where the SPRING database will reside. In the **Name:** box type demo, pick a preferred database type in the **DBMS:** box pulldown such as Access (any of the provided databases can be used), then click on **Create**. After the database is created, click on **Load**. If a database already exists, select it and click on **Load**. You will be asked if you want to define a password for the database. Click on No unless you want one.



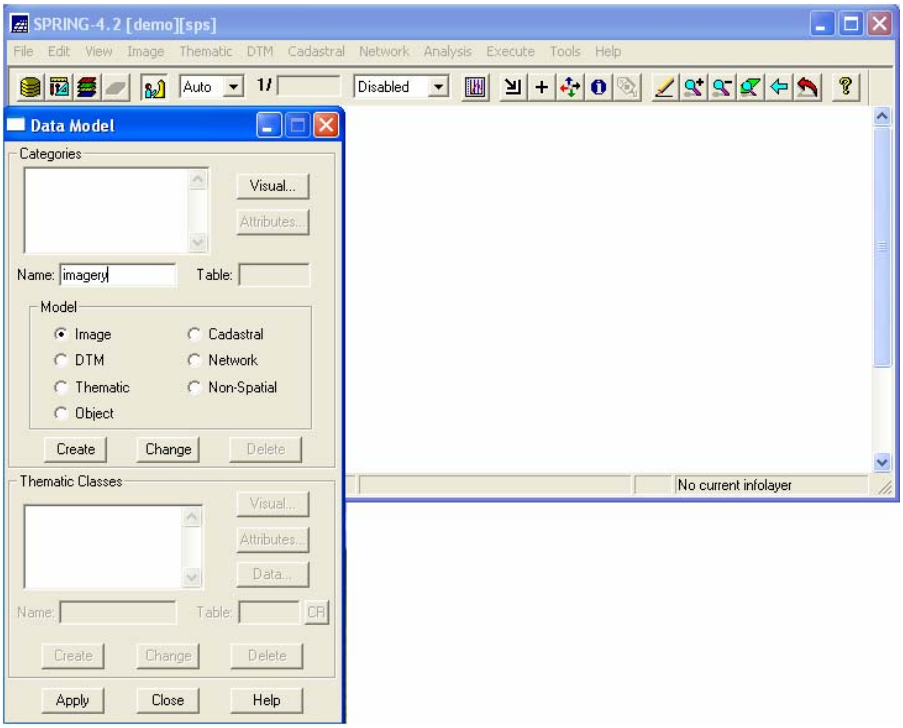

4. Create a Project by selecting **File | Project**. A **Projects** popup will appear. Type sps in the **Name**: box. Click on the **Projection** button. A **Projections** popup will appear. In the **Systems** box, highlight UTM. In the Earth Models box, highlight WGS84. Under the **Origin** section, type 14 in the **Zone:** box and w 99 0.0.00 in the **Long:** (longitude) box. In the Projections popup, click on **Apply** and **Close**. Note: Under the **Origin** section, the value in the **Long:** box (w 99 0 0.00) is equal to the Central Meridian which can be found using ArcCatalog.



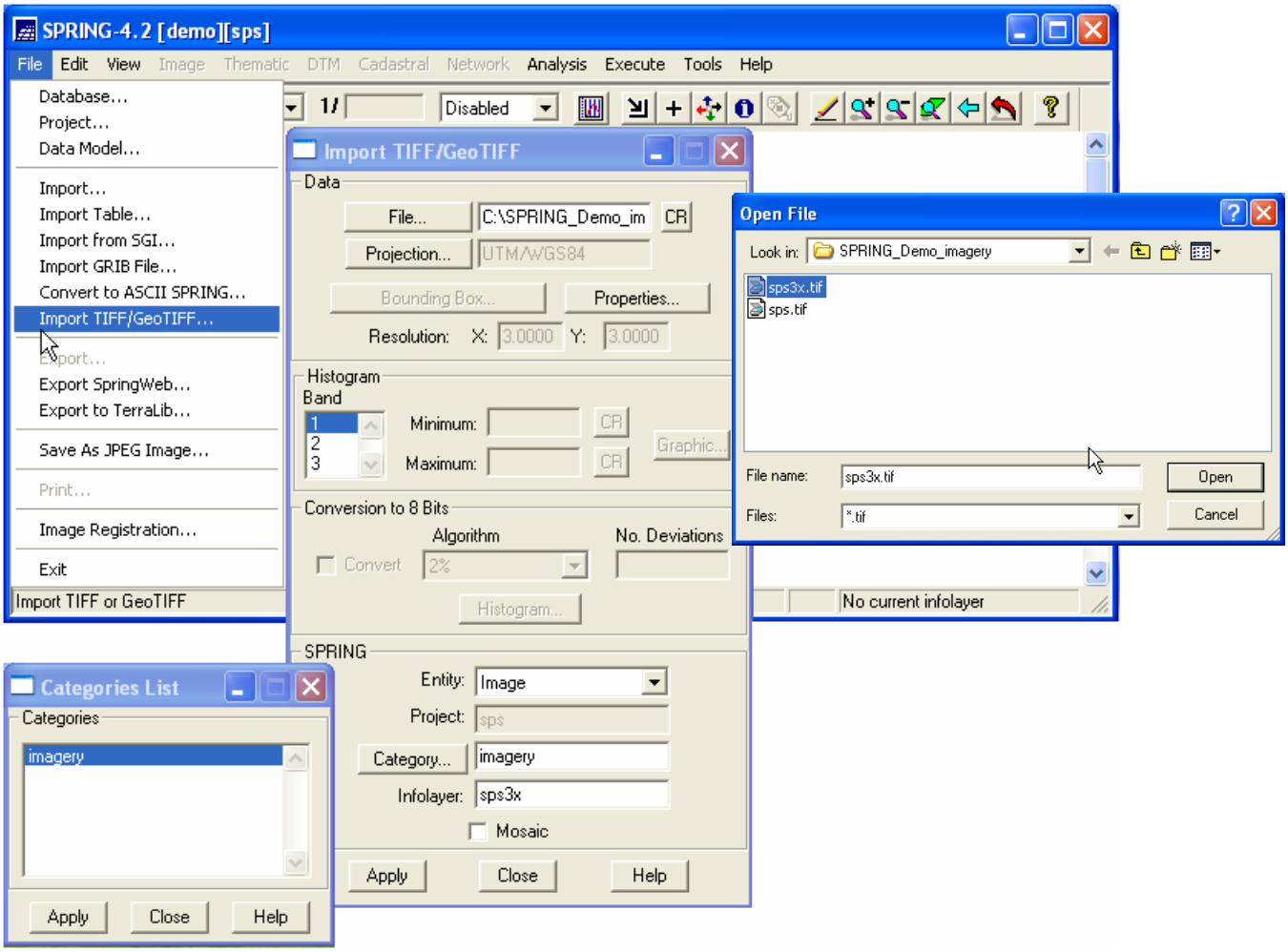

**5.** In the **Projects** popup, under the **Bounding Box** section, set the **Coordinates:** checkbox to Geographic, then enter **Long1:** w 99 0 0.00, **Long2:** w 98 0 0.00, **Lat1:** n 36 0 0.00, and **Lat2:** n 37 0 0.00. Click on **Create**. In the Projects box of the Projects popup sps will appear and will be highlighted. Click on **Load**. The **Control Panel** popup should appear. Minimize the **Control Panel** popup.



6. Create a place for images to reside in SPRING by selecting **File | Data Model**. Select the **Image** checkbox. In the **Name:** box type imagery then click on **Create**, **Apply**, and **Close**. It will appear as though nothing has happened but a place for images has been created and will appear in the **Control Panel** as soon as the first image is imported.



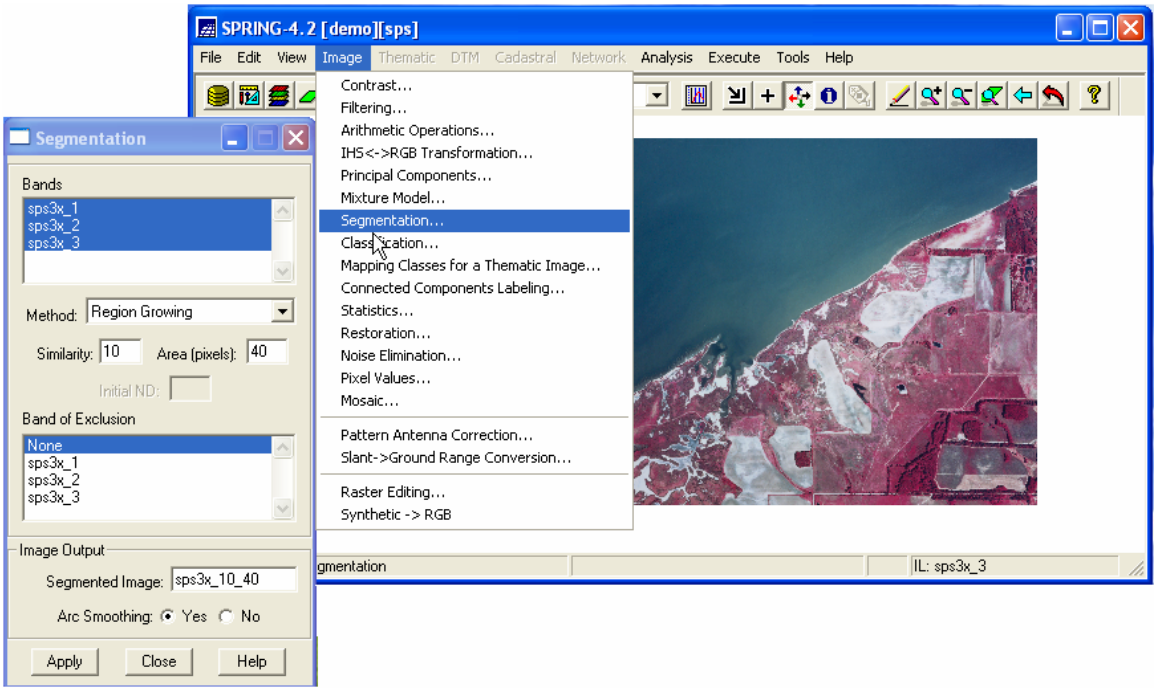

7. Import the image by selecting **File | Import TIFF/GeoTIFF…**. The **Import TIFF/GeoTIFF** popup should appear. Click on the **File…** button and navigate to sps3x.tif. In the bottom section of the **Import TIFF/GeoTIFF** popup, leave Image selected in the **Entity:** box. Click on the **Category:** button and with imagery highlighted, click on **Apply**. In the **Infolayer:** box type sps3x then click on **Apply**. The image should import 3 bands for this demo. To the root name of the image, an _1 will be applied to band 1, an _2 to band 2, and an _3 to band 4. Images with more than 3 bands also can be processed. When processing is complete, clickon **Close**.



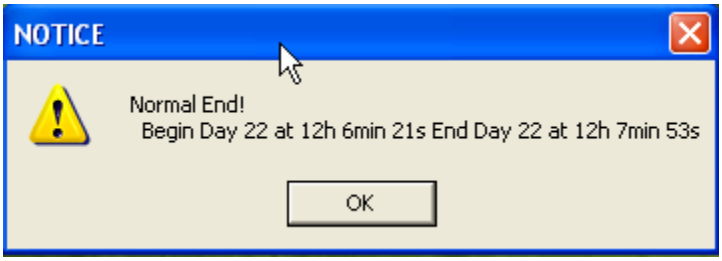

8. Open the **Control Panel** and turn each of the bands on: sps3x_1 as **R**(ed), sps3x_2 as **G**(reen), and sps3x_3 as **B**(lue) then click on **Draw**. The image should appear in the main display. To zoom in, click on the **Zoom Cursor**  , click on opposite corners of the image, then click on the zoom in button  . To pan, use the **Roaming Cursor**  .

## 2.5 Create Segmentation

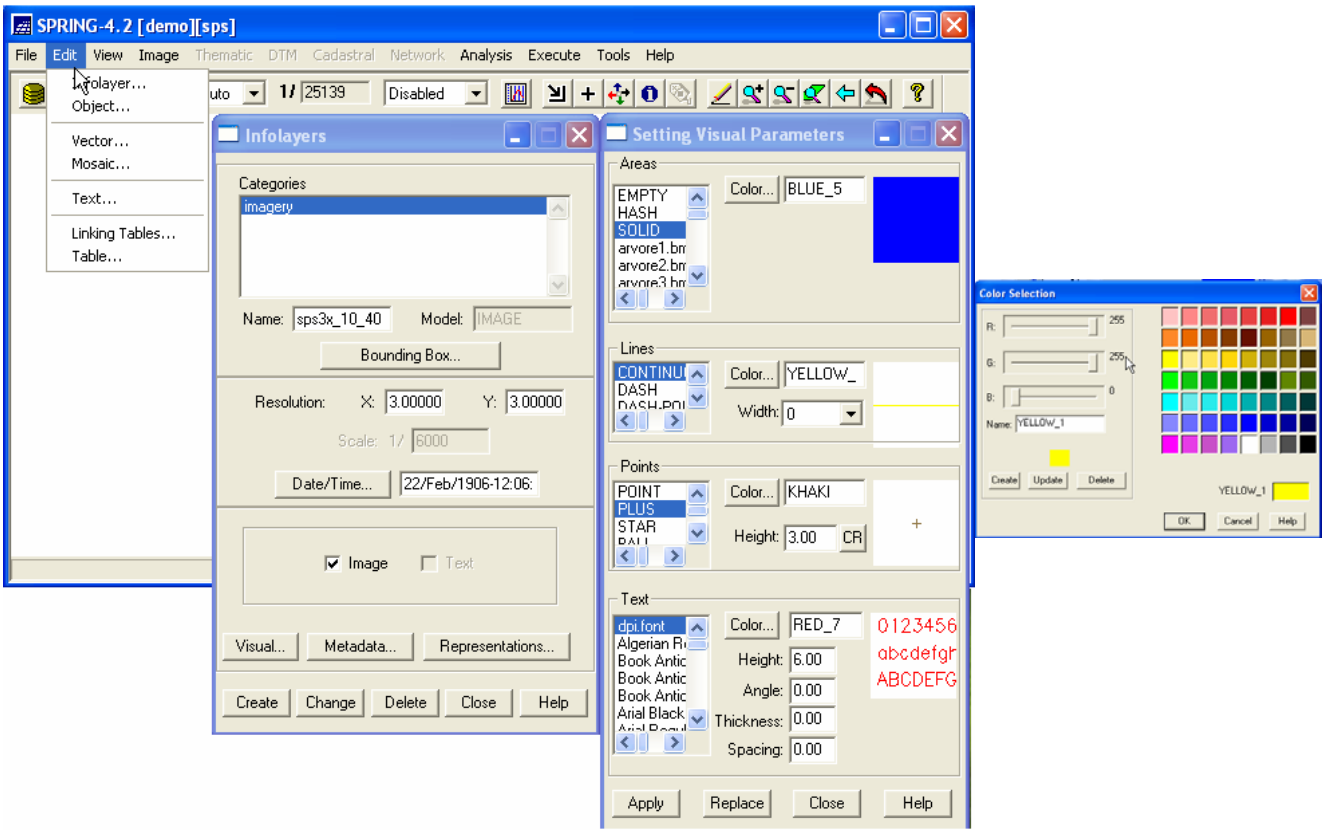
To create a segmentation, select **Image | Segmentation**. In the **Bands** box highlight all 3 bands. In the **Method:** box select Region Growing. Set the **Similarity:** box to 10 and the **Area(pixels):** box to 40. In the **Segmented image:** box type in a name such as sps3x_10_40. Set the **Arc Smoothing:** to Yes and then click on **Apply**. The segmentation should begin. On large, high resolution images you should let this run overnight. Use names that help you remember how the images were created.




When the segmentation is complete, the following notice will appear:




Click on **OK** to close the notice. If you want to inspect the segmentation, highlight the segmentation infolayer in the **Control Panel**, click on the **Labeled** checkbox, and click on **Draw**. Use the SPRING Roaming Cursor (pan) and zoom tools to inspect the segmentation. If you want to change the color of the segmentation lines, select **Edit | Infolayer…**. The **Infolayers** popup should appear. In the lower section of the **Infolayers** popup, select the **Image** checkbox. Click the Visual… button. The **Setting Visual Parameters** popup should appear. In the **Setting Visual Parameters** popup, in the Lines section, click on the Color… button. The Color Selection popup should appear. Select yellow then click on **OK**. In the **Setting Visual Parameters** popup, click **Apply** then **Close**. In the **Infolayers** popup, click on **Change** then **Close**. When you turn the lines on again, they should now be yellow.


SPRING-4.2 [demo][sps]
File Edit View Image Thematic DTM Cadastral Network Analysis Execute Tools Help
Infolayer...
Object...
Vector...
Mosaic...
Text...
Linking Tables...
Table...
Infolayers
Categories
imagery
Name: sps3x_10_40
Model: IMAGE
Bounding Box...
Resolution: X: 3.00000 Y: 3.00000
Scale: 1/ 6000
Date/Time... 22/Feb/1906-12:06:
Image Text
Visual... Metadata... Representations...
Create Change Delete Close Help
Setting Visual Parameters
Areas
EMPTY
HASH
SOLID
Color... BLUE_5
Lines
CONTINU
DASH
Color... YELLOW_
Width: 0
Points
POINT
PLUS
STAR
Color... KHAKI
Height: 3.00 CR
Text
dpi.font
Color... RED_7
Height: 6.00
Angle: 0.00
Thickness: 0.00
Spacing: 0.00
0123456
abcdefgh
ABCDEFG
Apply Replace Close Help
Color Selection
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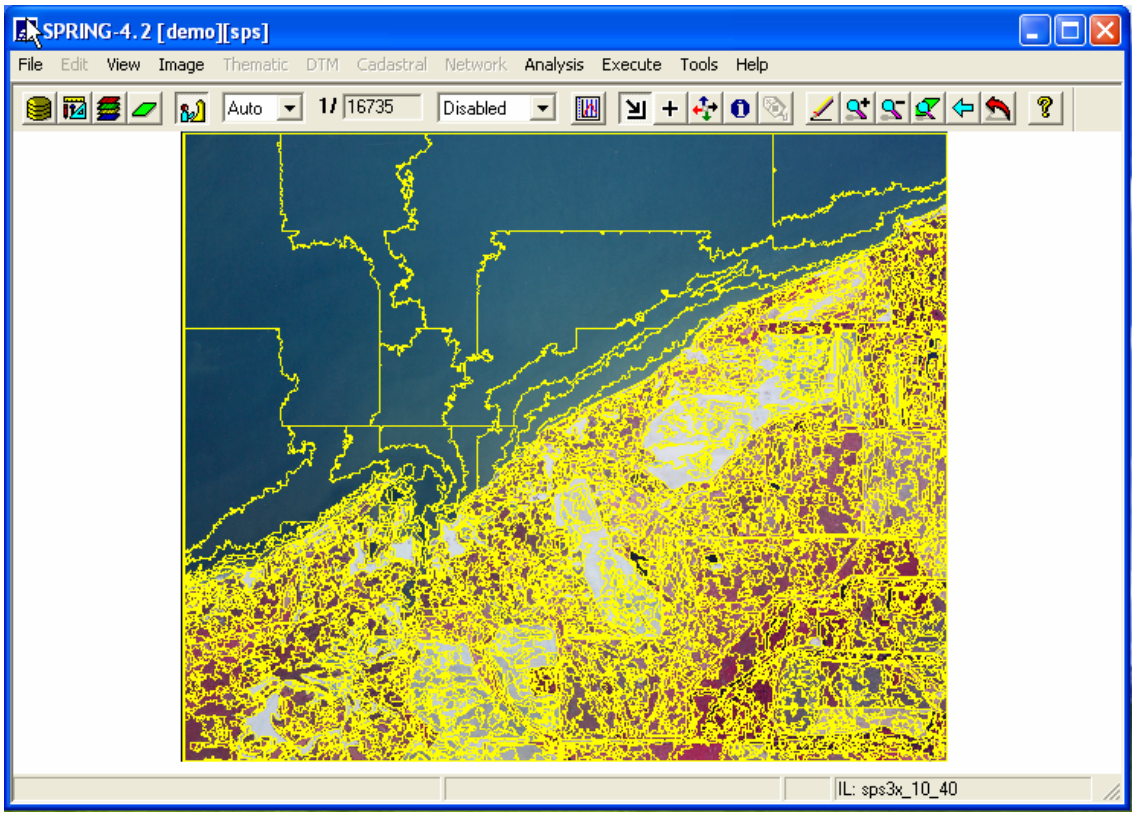
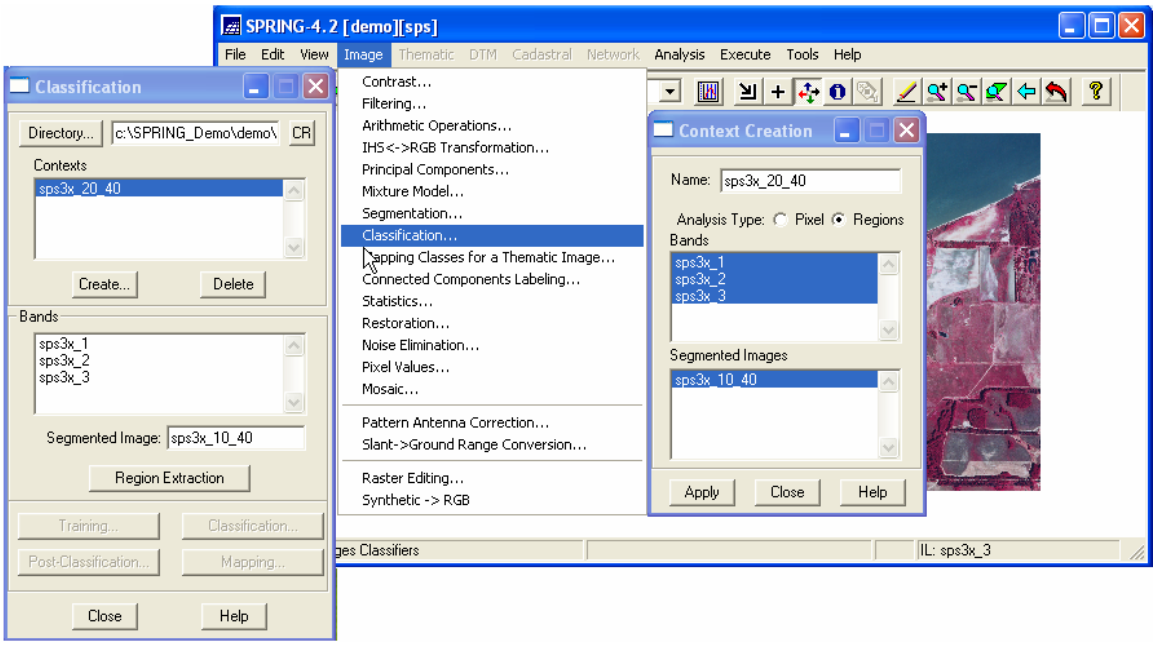
G: 255
B: 0
Name: YELLOW_1
Create Update Delete
YELLOW_1
OK Cancel Help

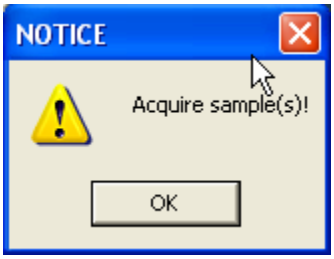

SPRING-4.2 [demo][sps]
File Edit View Image Thematic DTM Cadastral Network Analysis Execute Tools Help
Auto 1/ 16735 Disabled
IL: sps3x_10_40

## 2.6 Create Classes for Classification Training Samples Collection

1. In the **Control Panel**, highlight one of the image bands that was used in the segmentation.
2. Select **Image | Classification.** Under the **Context** box, click on the **Create** button. The **Context Creation** popup should appear. In the **Name:** box, type a name such as sps3x_10_40_class. For the **Analysis Type:** select the **Regions** checkbox. Highlight all three bands in the **Bands** box, select appropriate segmentation in **Segmented Images** box such as sps3x_10_40 and click on **Apply**.
3. Before you can begin collection training samples, you need to click on **Region Extraction** in the **Classification** popup. On a large image, this will take a few minutes.

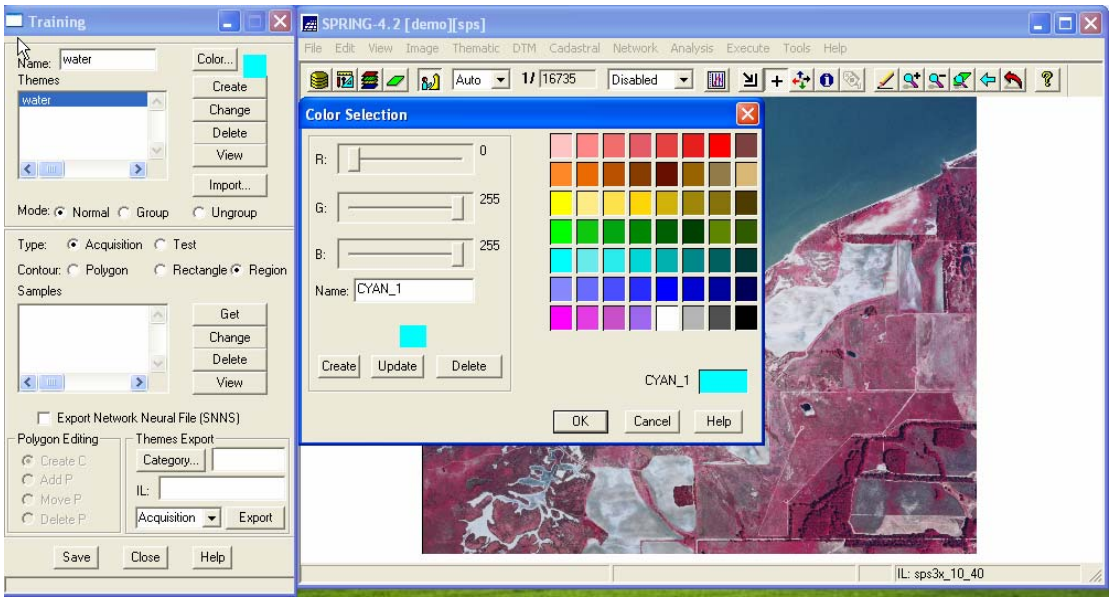


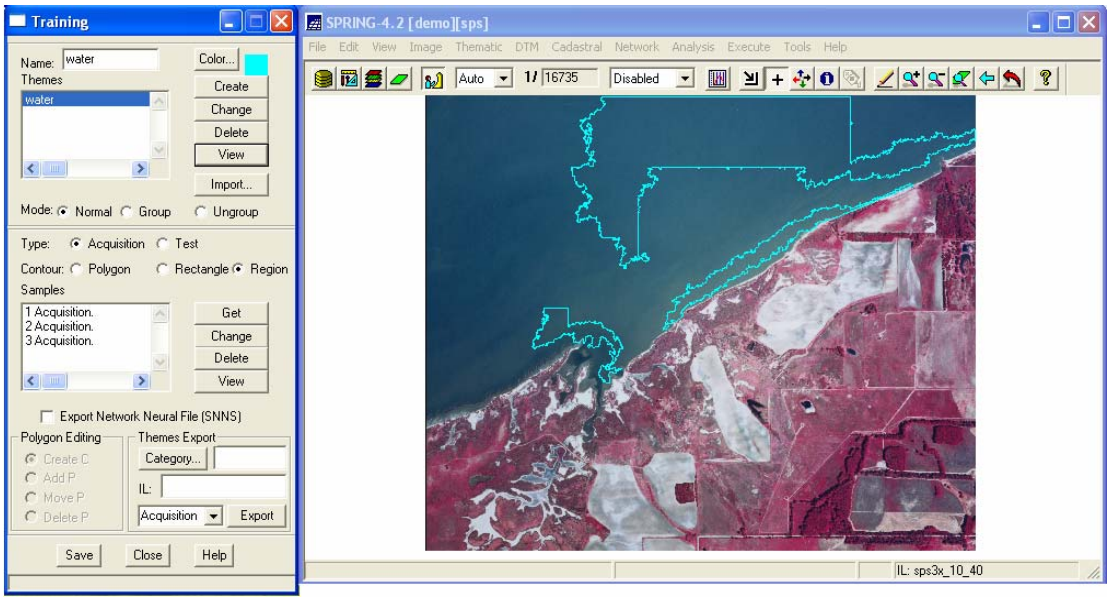

4. When **Region Extraction** is complete, click on the **Training** button. A small window should pop up telling you to "Acquire sample(s)!". Click on OK.




5. At this point you may want to minimize the **Control Panel** and **Classification** popups and reposition/resize the main display window and move your **Training** popup to the side.

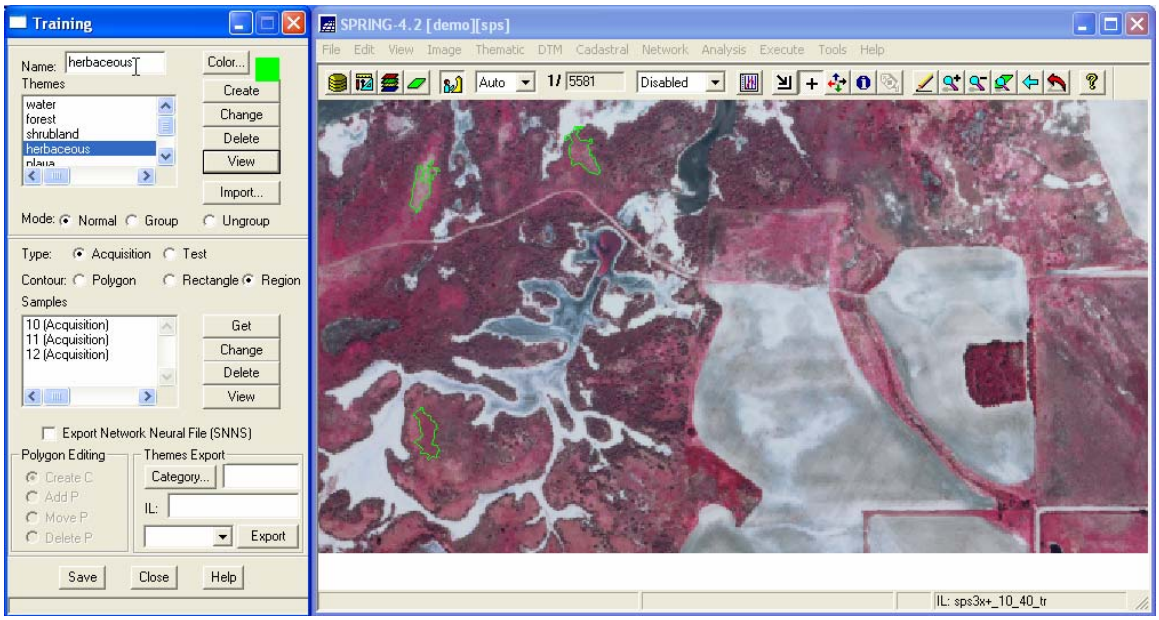
6. In the **Training** popup, enter a theme (physiognomic or vegetation class) name into the **Name:** box such as water, click on the **Color** button, select Blue, **OK**, and **Create**. The name water should appear in the **Themes** box. Make sure the **Type:** Acquisition and **Contour:** Region checkboxes are selected. Then using the **Cross Cursor** +, select a sample, then click on **Get**, **Save**, and the top **View** button. Repeat for each water sample.



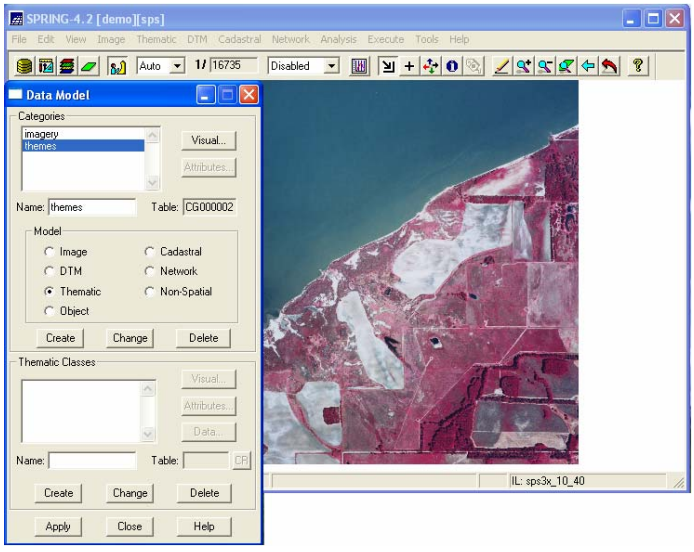




7. Repeat this training sample collection process for forest, shrubland, herbaceous, playa, and ag. As you collect samples, try to capture as much of the variation in signatures for each class from

all over the imagery.

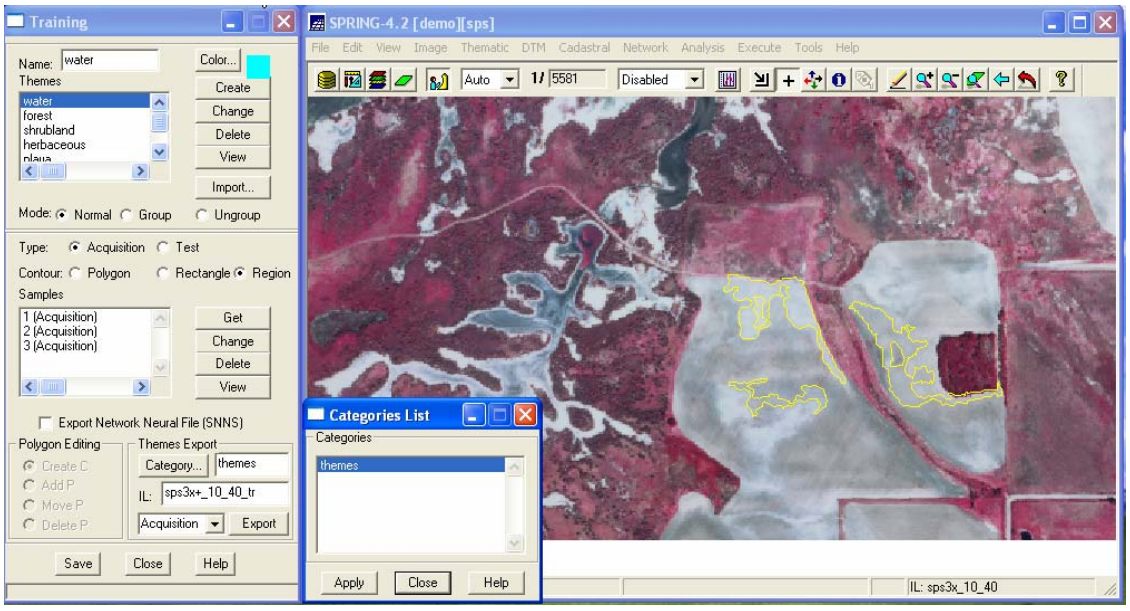


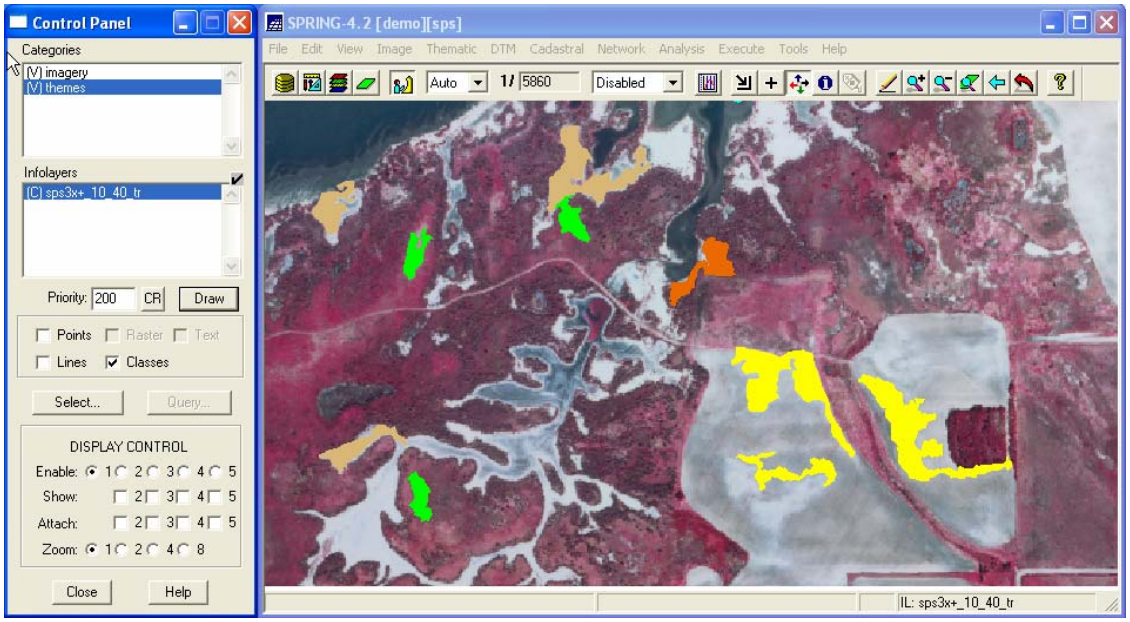

**8.** At some point you may want to save an image of your samples. To do this you will need to create a **Category** to hold thematic data. Select **File | Data Model**. In the **Name:** box type themes, select the **Thematic** checkbox, click on **Create**, then **Apply**. It will appear that nothing has happened but the newly created **Category** will appear in the **Control Panel** as soon as you put something in it.




**9.** Returning to the **Training** popup, near the bottom of the popup, under **Themes Export**, click on **Category…**. A **Categories List** popup should appear. Select the themes category you just

created and click on **Apply**. Back in the **Training** popup, in the **IL:** box type sps3x_10_40_tr, making sure Acquisition appears in the window just below **IL:**, then click on the **Export** button. Maximize the **Control Panel** popup, highlight the themes **Category**, in the **Infolayers** window highlight the IL you just exported, click in the **Classes** checkbox, then click on **Draw**. All of your samples should appear.



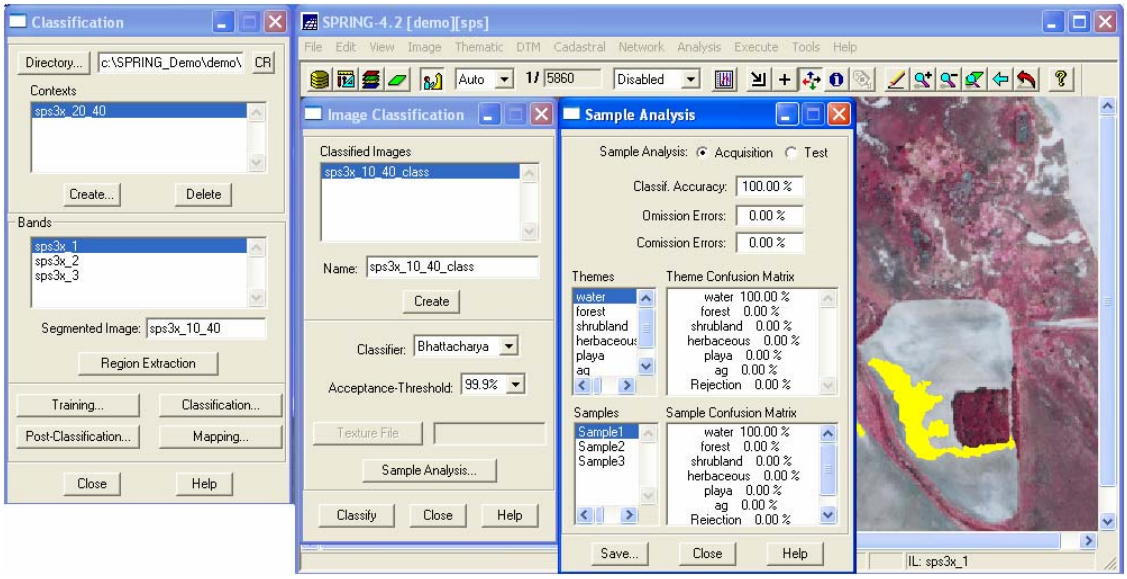




**10.** As you select, Get, Save, and View your samples, you may want to occasionally export them, overwriting your themes Category. If something should go wrong, you can import the training

samples by clicking on the **Import** button in the upper section of the **Training** popup, selecting the appropriate IL, then **Apply**.

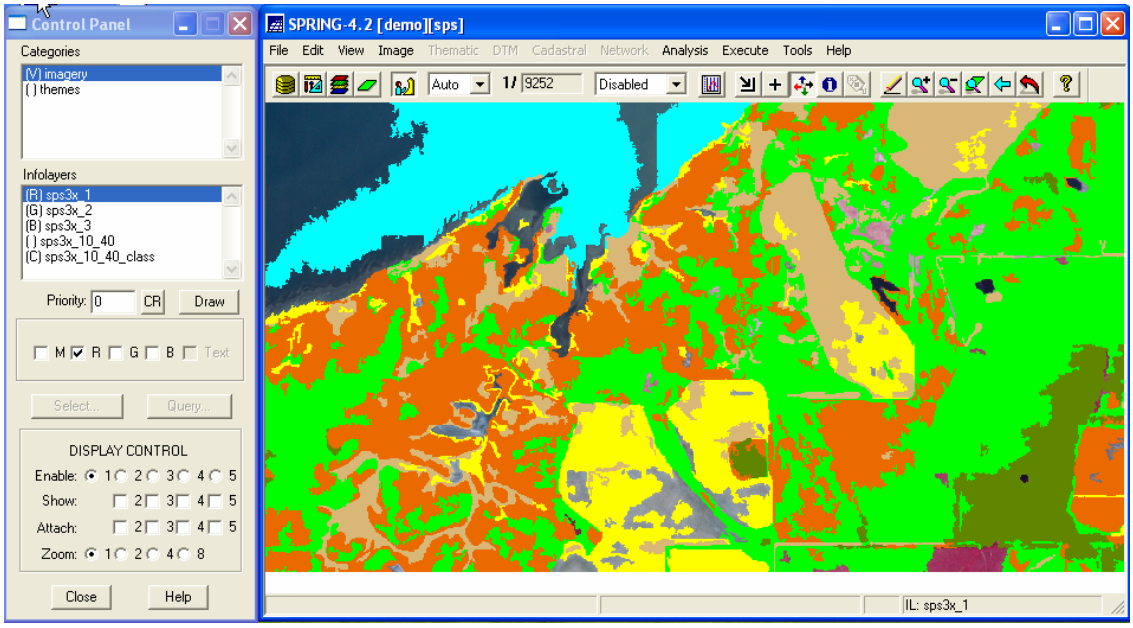
## 2.7 Run Training Sample Analysis, Classification, and Output Map

1. To make sure that your samples do not overlap, maximize the **Classification** popup, click on **Classification**, in the **Name:** box type sps3x_10_40_class, click on **Create**, in the **Classifier:** select Bhattacharya, **Acceptance-Threshold:** 99.9%, then click on the **Sample Analysis** button. A **Sample Analysis** popup should appear and will provide you with an accuracy assessment. If there are any questionable samples, you can easily find them by noting the theme, the sample number, returning to the **Training** popup, selecting the appropriate **Theme** and searching through the sample numbers. Highlight the suspect sample, click on **View** in the **Samples** section and locate, zoom to, and inspect the suspect sample. You can delete it and select, **Get**, **Save**, and **View** more samples.



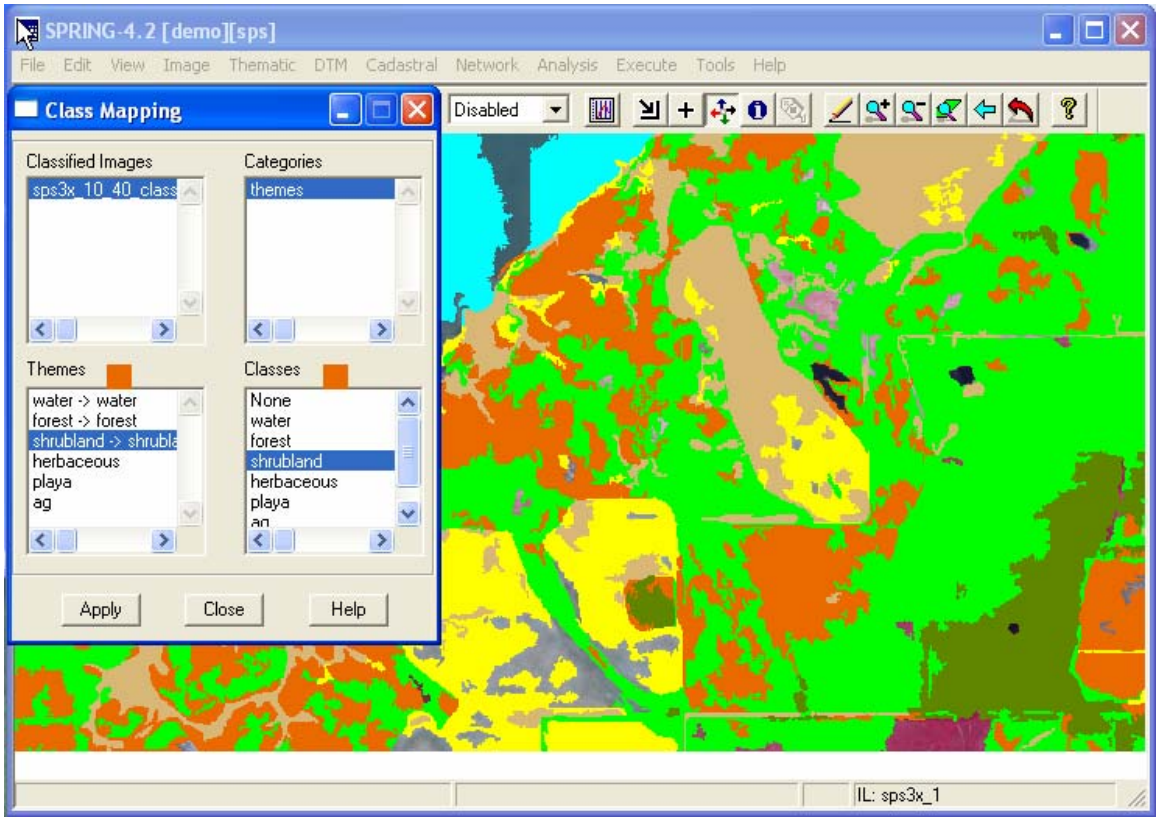

2. When you have gathered a few samples and tested for accuracy, run a classification. Maximize the **Image Classification** popup, highlight the classified image name you have been using to run the **Sample Analysis** or create a new one, under the **Sample Analysis** button, which you have been using, click on **Classify**. The classification should begin to run and will take up to a few hours on a large image. Once the classification has completed, a **Notice** will popup telling you exactly how long the classification took. This may prove handy in predicting how long various images will take to process for planning and scheduling purposes. Click on **OK** to close the Notice popup. Minimize the **Classification** popup. Minimize the **Training** popup. Minimize any other popups that may be in the way. Maximize the **Control Panel** popup. In the imagery

Category, highlight the classification you just created (i.e., sps3_10_40_class), click in the **Classified** checkbox, then **Draw**.




You can turn on and off other infolayers as you require. After inspecting the classification, you may notice some areas that were not classified and so you may want to collect more samples and rerun the **Sample Analysis** and then another **Classification**.

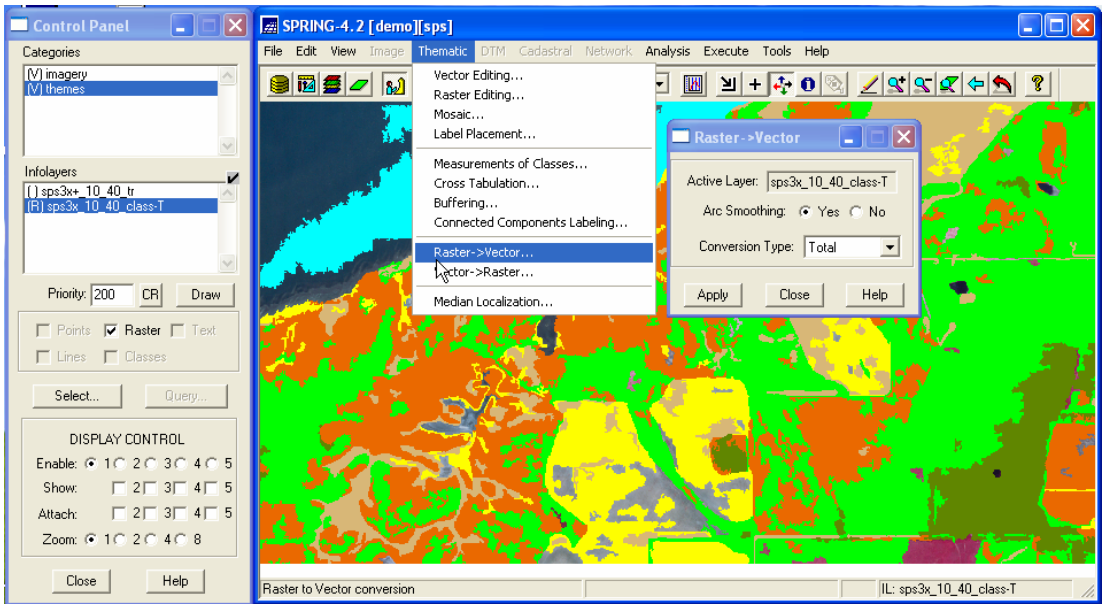
**3.** When you are satisfied with you classification, maximize the **Classification** popup, and click on the **Mapping** button. The **Class Mapping** popup should appear. In the upper left window of the popup, highlight the classified image in the **Classified Images** box . In the upper right window, in the **Categories** box, highlight the **Thematic Category** where you want the final map to reside. In the lower left window of the popup, highlight a theme (class) in the **Themes** box. In the lower right window, in the **Classes** box, select the matching **Class**. In the lower left select the next Theme and match it to the corresponding Class in the lower right window. Continue until all Themes and Classes have been matched. Click on Apply, then Close. You can minimize or close the Classification popup.



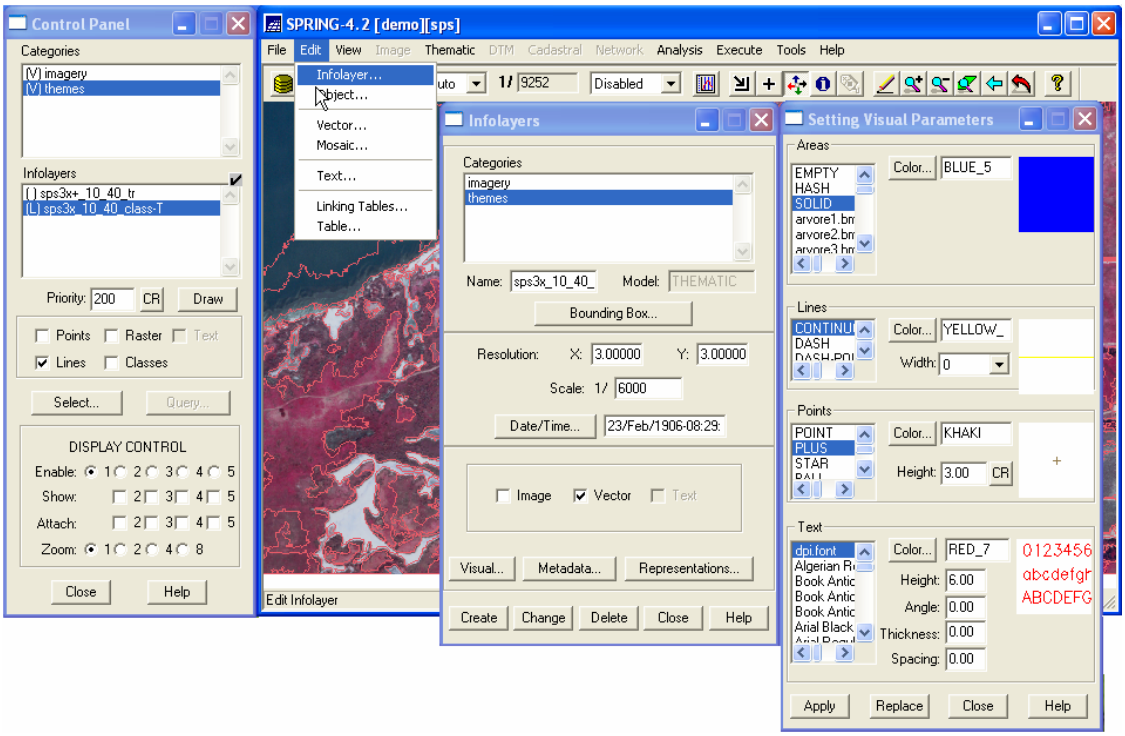

## 2.8 Create Vector

1. With the goal of exporting the Infolayer from SPRING to a shapefile, you must now create a vector component in the thematic **Infolayer**. To do this, open or maximize the **Control Panel**, select the **Thematic Category** that you just sent the map to and highlight the **Infolayer** just created. SPRING automatically attaches –T as a suffix to the thematic **Infolayer**. In this case, sps3x_10_40_class-T.

2. Select **Thematic | Raster->Vector…**. The highlighted thematic **Infolayer** by default will appear in the **Active Layer:** window. Set **Arc Smoothing:** to Yes and **Conversion Type:** to Total then **Apply**.

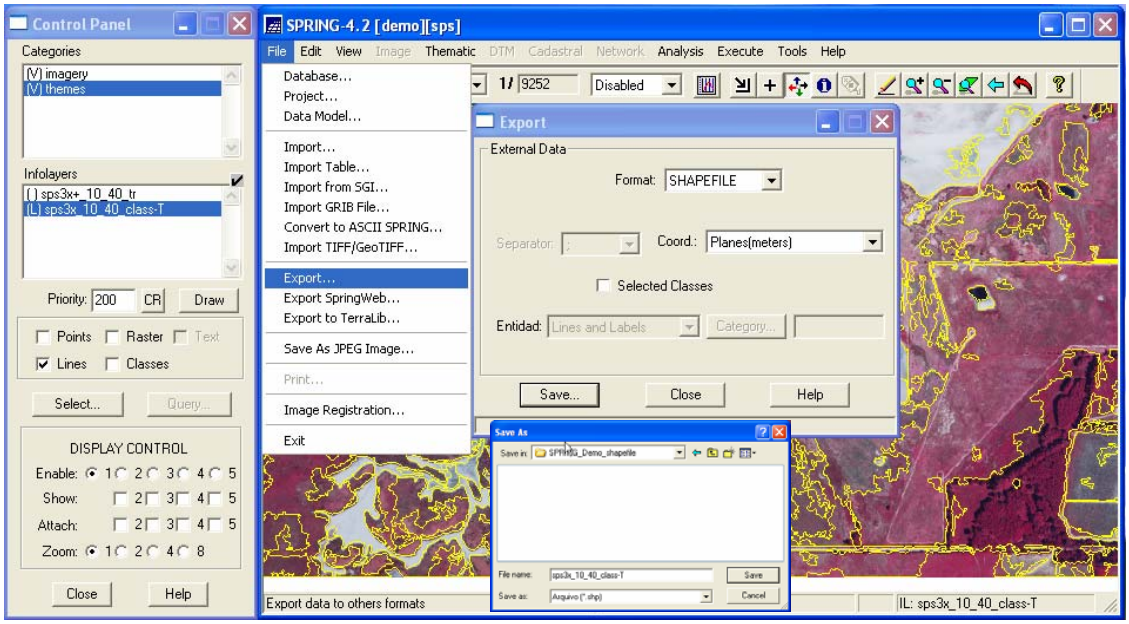



You should see a series of blue progress bars flash across the bottom of the main viewer. Close the **Raster->Vector** popup when processing is complete. You will notice that in the **Control Panel** the **Points**, **Lines**, and **Classes** checkboxes and associated text are no longer grayed out. Uncheck the **Raster** checkbox and check on the **Lines** checkbox. Go to **Category** imagery and turn the image bands back on and **Draw**. If you want to see the lines better, go back and highlight the thematic **Infolayer**, then **Edit | Infolayer…**, click on the **Vector** checkbox, click the **Visual** button. The **Setting Visual Parameters** popup should appear. In the **Lines** area of the popup, click on the **Color…** button, select yellow, **OK**, **Apply**, and **Close**. In the **Infolayers** popup, click on **Change**, **Close**, and then **Draw**. The lines should now be yellow and much easier to see. This procedure for changing line color of the **Vector** output is the same procedure used previously to change the color of the **Segmentation** lines.




## 2.9 Export Thematic Map

1. With the thematic **Infolayer** highlighted, select **File | Export**. In the **External Data** popup, select SHAPEFILE in the **Format:** box, then click on **Save…**, navigate to the directory where you want to save the shapefile. Use the default name or enter a new file name in the **File name:** box such as sps3x_10_40_class-T (.shp will be added by SPRING), then click on **Save** and then **Close**.



**2.** Minimize or exit SPRING.

## 2.10 Add Projection, Reproject, Load into GIS

SPRING does not add the projection to the shapefile so you will need to add it using **ArcCatalog**. Remember it is UTM Zone 14, WGS84, in this case. You may need to then reproject to UTM Zone 14, GRS80. Then use the shapefile as is or convert it to a personal geodatabase and load it into and work with it in your favorite GIS.