GEO 827 Digital Image Processing and Analysis

Exercise 9a. Training Signature Selection and Supervised Classification using the Maximum Likelihood and SAM Algorithms

This exercise builds upon your previous lab experiences. You should be familiar with the Display, Spectral Profiling and Contrast Enhancement tools in ERDAS *Imagine*. The **objectives** of this exercise are to develop/reinforce your knowledge of:

- The training site delineation (AOI) tools in ERDAS *Imagine*
- The *Signature Editor* tool in ERDAS *Imagine*
- The signature evaluation tool (*Image Alarm*) in ERDAS *Imagine*
- The classification evaluation tools in ERDAS (*Swipe* tool and *Thresholding*)

Training Signature Collection

1. **Copy** the **Data/Lab 9 folder** on DropBox to your personal folder on the server.

2. **Start** *ERDAS Imagine 2014*. **Right-mouse-button click** on the "**2D View #1**" layer in the "Contents" widow and **select Open Raster Layer** from the pop-up menu. **Navigate** to your personal folder on the server, **select** the file named "**lansing_sub.img**" and **click OK**.

3. Using the **Layer Combination** tool from the **Multispectral** tab, change the band combinations in "**2D View #1**" to display a **5,4,3 SWIR false-color image**. **Contrast stretch** this image to your liking for maximum interpretability.

    OPTIONAL - If you desire, open a second viewer and display the same image file (**lansing_sub.img**) as a **4,3,2 CIR false-color or 3,2,1 true-color composite**. If you choose this option, **GeoLink** the two viewers.

4. From the **Raster** tab on the ribbon tool bar, **click** on the **Supervised** button and **select Signature Editor** from the drop-down menu. After a few moments, the **Signature Editor Window** (**SEW**) will open. Resize the SEW, if necessary, to see all the functions and familiarize yourself with the function icons available in the window using the cursor rollover feature (*i.e.*, when you put the cursor on top of each icon, a function description line will display in the bottom-left of the SEW).
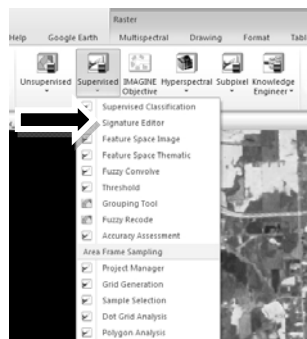
Your assignment is to create at least three signatures for each of the following eight land cover / use types (you will use these signatures to classify the image):

- **Urban, high intensity** (commercial, industrial and transportation combined)
- **Urban, low intensity** (residential)
- **Broadleaf forests** (upland and lowland, combined)
- **Green herbaceous** (crops/hay/turf grass, combined)
- **Bare mineral soils, moist and/or high organic matter content**
- **Bare mineral soils, dry and/or low organic matter content**
- **Bare organic soils**
- **Water** (rivers, lakes and ponds, combined)

5. In the "**2D View #1**" viewer, **zoom in** on a type-example of one of the land cover/use types listed above. **Click** the **Drawing tab** in the ribbon tool bar and **select** the **Polygon tool** from within the *Insert Geometry* tool group. Use the polygon drawing tool to **delineate an area of interest** (AOI) in the "**lansing_sub.img**" image in the "2D View #1" viewer (the 5,4,3 false-color composite).

    In the "2D View #1" viewer, start to **left-click** a polygon outline of the land cover/use type you zoomed in to (be careful to avoid the edge, *i.e.*, mixed pixels). To close the AOI polygon, **double left-click** without moving your cursor. Make sure you "stop short" of your "point of beginning", since the double left-click action will automatically snap a closing arc between the cursor location and the point of beginning.

    A white dotted polygon will be drawn around the area you just "digitized". If you are not satisfied with the result, you can erase the AOI by **selecting** it (the editing box will appear around the AOI polygon) using the *Select pointer tool* and then **click** on **Delete button** in the *Edit tool group* of the **Drawing** tab or just use the Delete button on your computer keyboard.
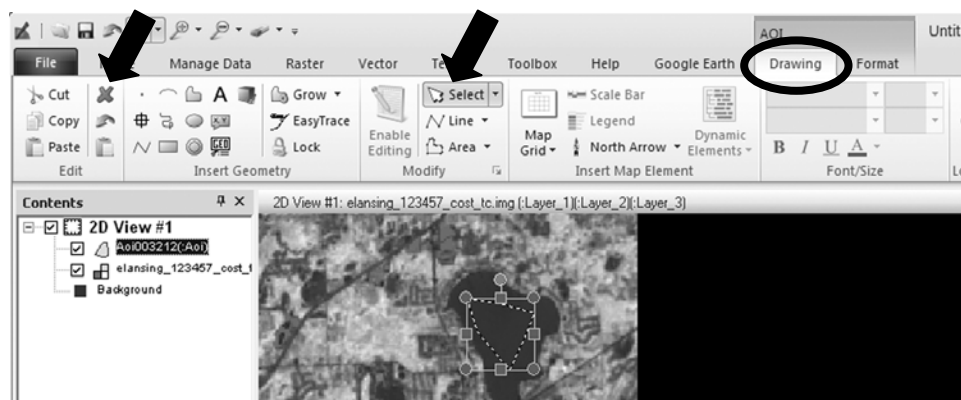
6. Once you have outlined a group of pixels that are representative of the cover type of interest, come back to the **Signature Editor** window and **click** on the "*Create New Signature(s) from AOI*" icon. A new signature called "**class1**" will be entered in the window, with information associated with the training site you just selected.
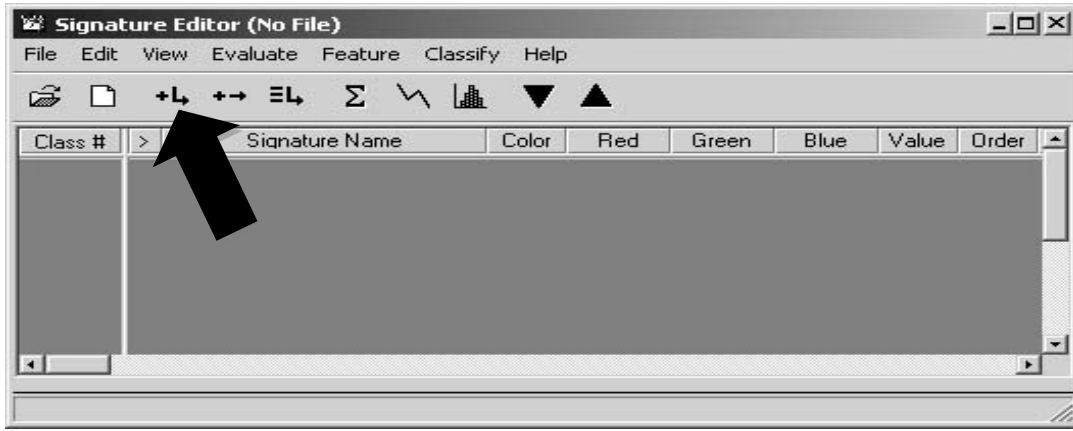
Change the name of the training site from "class1" to an appropriate land cover/use name (*e.g.*, "water1") and **change the color** of the signature class to **Yellow** (temporary color assignment to facilitate the Image Alarm function) by **left-clicking on the color box** and **selecting yellow** from the palette that appears.


✓ Rename the class

✓ Change color to Yellow for Image Alarm evaluation
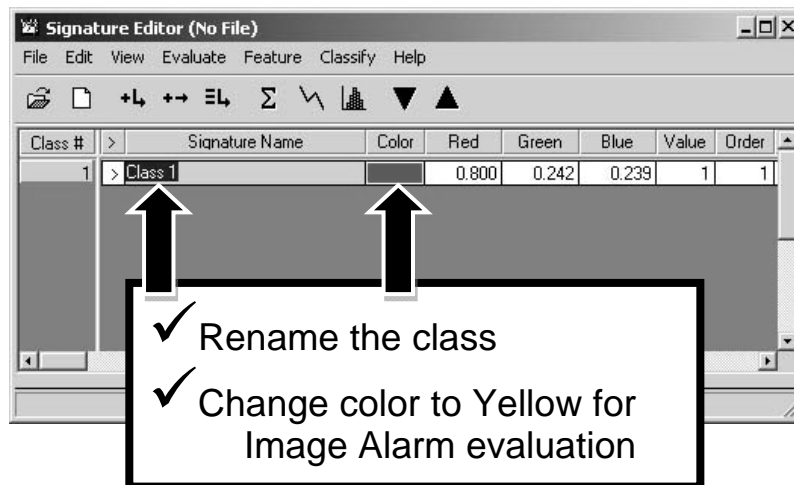
7. **Evaluate** the new training site using the *Image Alarm* function **selected** from the *Signature Editor* **tool bar** (**View → Image Alarm**). In the Signature Alarm dialog box that opens, press the "**Edit Parallelepiped Limits…**" button. At the bottom of the new window that opens, press the "**Set…**" button. We will use **standard deviation** boundaries (not "Minimum/Maximum") to establish our parallelepiped decision space in order to avoid outliers in the training data. Set the Parallelepiped Limits to "**2.00** Standard Deviations" (2 standard deviations encompasses 95.4% of the distribution of pixel values in the training set). **Press** the "**OK**" button at the bottom-left of the Set Parallelepiped Limits box. **Close** both the "**Set Parallelepiped Limits**" and "**Limits**" windows, but **LEAVE THE "SIGNATURE ALARM" WINDOW OPEN** (you will use it again and again)**.**
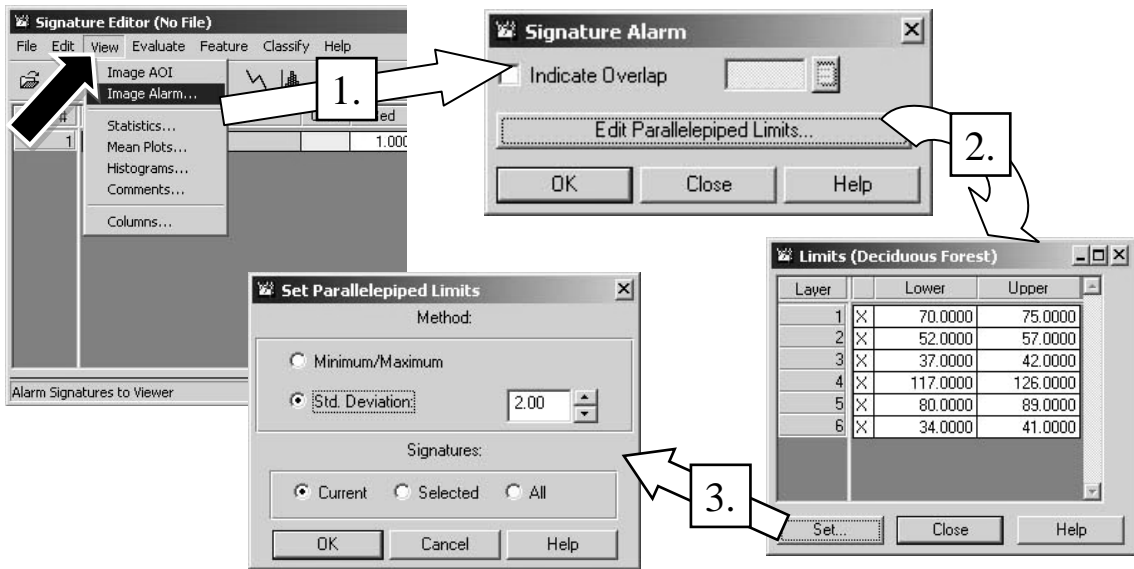
Execute the Image Alarm function by pressing "**OK**" in the *Signature Alarm* dialog box.

8. Visually check the image alarm overlay (yellow pixels) for both **Errors of Omission** (features belonging to the training class that have been left out) and **Errors of Commission** (features not belonging to the training class that have been included). Errors of Omission can be solved by selecting additional training sites. Errors of Commission must be solved by selecting a new training site that better represents the feature class of interest. *Remember, it usually takes several signatures to adequately capture the spectral variability of most land cover/use types.*

9. In order to assist you in seeing the distribution of alarm-highlighted pixels in the "**2D View #1**" display, you can use the *Swipe tool*. From the **Home** tab on the ribbon tool bar, **press** the **View** button. From the pop-up menu, **click** the **Swipe** button.
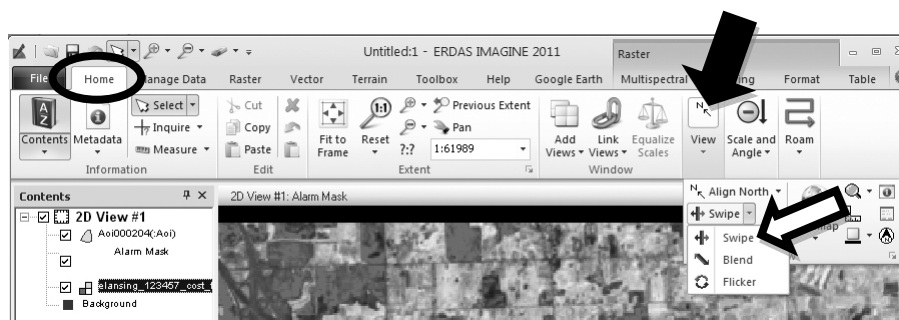
In the *Utility - Transition* window that opens, **set** the **Functional layer** (*i.e.*, the alarm mask) to **W (Working)**, and **set** the **AOI layer** and the **imagery layer** to **S (Static)**, as shown below. The default for the Swipe tool is "Left to Right" (*i.e.*, a vertical swath of image overlay that can be moved left and right to "expose" the underlying image), which opens with the left half of the viewer showing the overlay. You move the edge of the

overlay by manipulating the slider in the "Transition Extent" sub-window (right-hand arrow in graphic below).
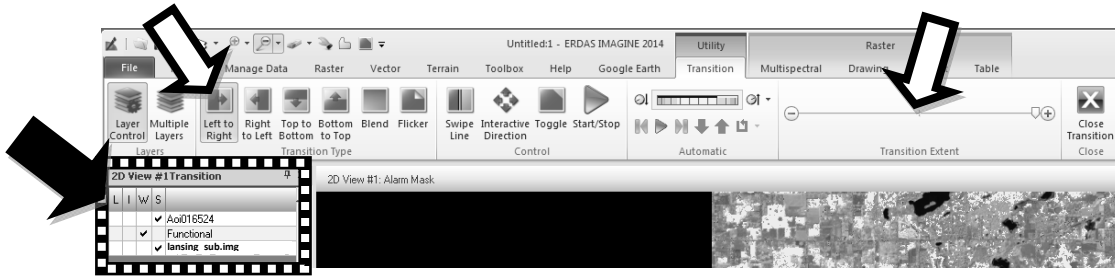

10. When you are satisfied with your training signature (whether or not you intend to have additional signatures for this land cover/use type) ***save your signature file*** by **clicking** on **File → Save As** within the "**Signature Editor**" window. **Name your file** and **save it in your personal folder on the server.**

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Each time you add or delete a signature, save the signature file.

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You should also **save the AOI file** (the training polygon outlines). From the **Table of Contents**, **right-click** on the **AOI Layer**. From the drop-down menu that opens, **click → Save Layer As. Name your AOI file and save it in your personal folder on the server.**

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Each time you add or delete an AOI from the image, save the AOI file.

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If, after evaluating the *Image Alarm* output, you decide that a particular signature is poor, **select** and **delete** it from the Signature Editor window (SEW tool bar: **Edit → Delete**). Be sure to also delete the associated AOI polygon. **Select** one or more AOIs in the "**2D View #1**"display (use the *Select* tool; use shift-left-click to select multiples) and then use the **Delete** tool from *Edit tool group* within the **Drawing** tab of the ribbon interface. **Save both the signature file and the AOI file** after any deletions.
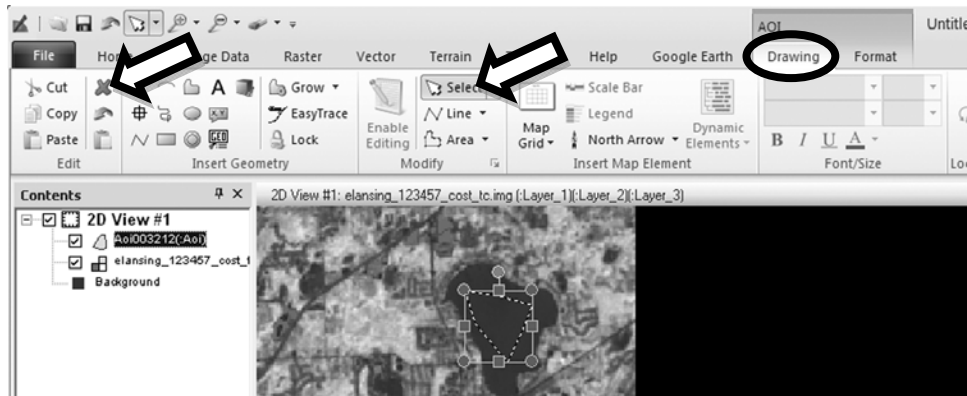
11. Now try the **region-growing approach** to training site selection. This tool is especially helpful on very narrow cover types (like rivers) or cover types with especially irregular boundaries (*e.g.*, lakes or open-grown forest stands).

Make the **2D View #1** window the **active** layer in the *Contents* window. **Click** the **Drawing tab** in the ribbon tool bar and **click** the **Grow** tool **triangle** from within the *Insert Geometry* tool group. **Select Growing Properties** from the drop-down menu.
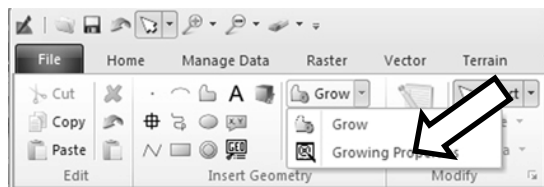
Click the "*surrounding*" (*i.e.*, the 9-pixel) Neighborhood icon. **Set** the **Area** constraint value to *10000*. Set the **Spectral Euclidian Distance** to **15**, to start. If too few pixels are "captured" within the region, **increase** this value to 20 and **click** the "Redo" button. *Keep the Region Growing Properties window open and "parked" outside of the ERDAS desktop.*
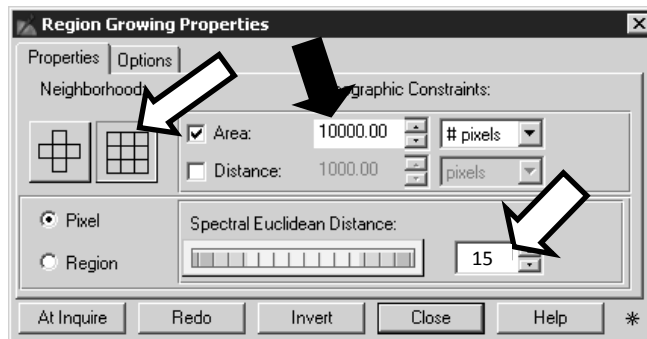
12. In the **2D View #1** window, zoom in to one of the smaller lakes in the image. Returning to the **Drawing** tab on the ribbon tool bar, **click** the **Grow** tool.

In the **2D View #1** window, note that your mouse cursor is now a cross hair. **Click** on a single representative pixel within the lake. A dotted polygon appears around the pixel group that met your search criteria. If the *Spectral Euclidean Distance* setting of 15 did not capture a large patch of pixels in the lake, **increase** the **Spectral Euclidean Distance** in the **Region Growing Properties** window to **20** or **25** and **press** the "**Redo**" button (bottom-left of the **Region Growing Properties** window) to see the impact of this adjustment. Your objective is to "capture" as many "water" pixels as possible without "growing" into any adjacent cover/use types by adjusting the Spectral Euclidean Distance. Very shallow or turbid water that is bright should be captured as its own training polygon, since this may be confused with other bright land covers.

When you are satisfied with the grown region in the lake, import this new AOI into "Signature Editor" using the **"Create New Signature from AOI"** button. Again, visually check how well the new training signature performs by running the **Image Alarm** function. Be sure to **zoom out to the full-scene view to evaluate the Alarm performance (*i.e.*, visually check for errors of omission and commission)**. After every change, s*ave your signature and AOI files.* If the image in the Viewer becomes too cluttered with AOIs, you can *temporarily* "hide" them by **un-checking** the AOI layer in the *Contents* window. To see the AOI layer again, simply **check** the AOI layer in the *Contents* window.

13. You can use **shift-click** to select multiple training signatures in the **Signature Editor** window. If you have two or more signatures representing the same class, shift-click to select them all, change all their colors to Yellow and use Image Alarm to evaluate their collective (*but still individual*) classification power. You can also shift-click to select multiple signatures and then merge them into one new signature by pressing the **Merge signatures** button, but *this is not usually recommended*. If you do experiment with signature merging, give the merged signature a unique name and test it with Image Alarm **before** deleting the individual same-class signatures.
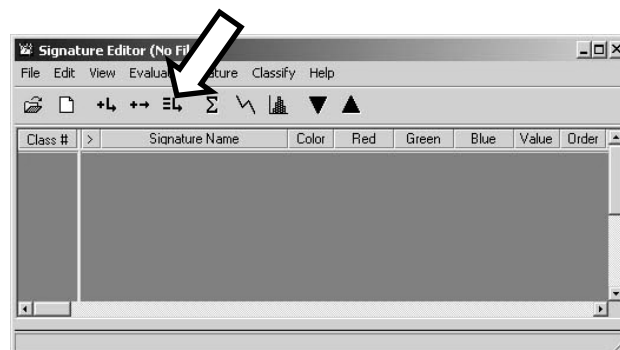
14. Continue selecting AOIs until you have a functional set of signatures for the eight required cover types.

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Be sure to save your final <u>signature file</u> and <u>AOI file</u> to your <u>personal folder</u> on the server.

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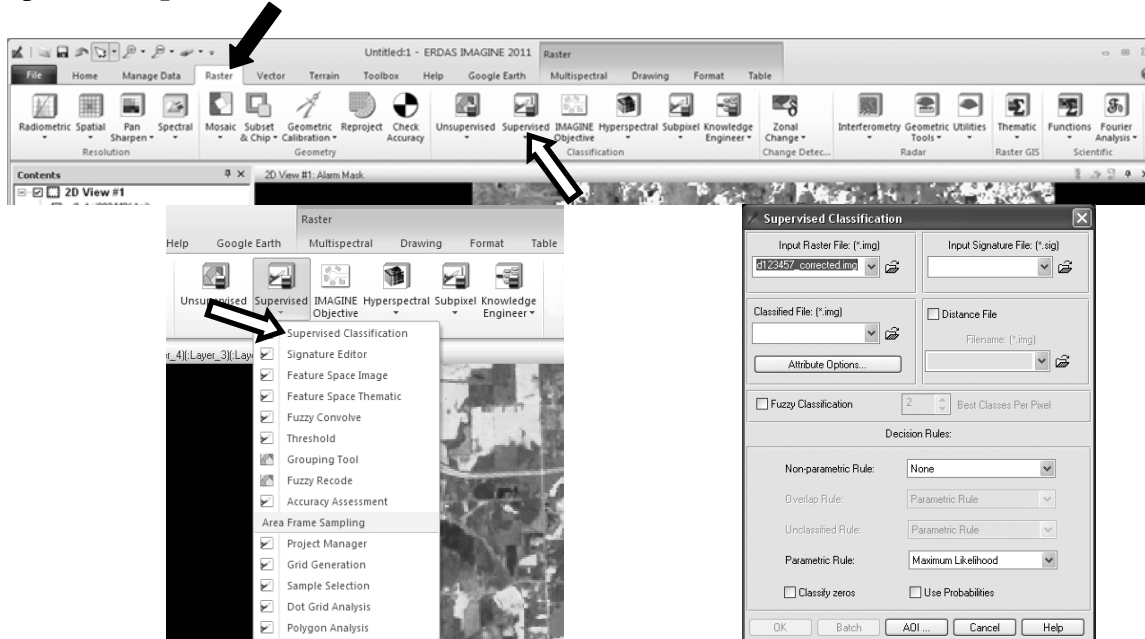# Supervised Classification – Maximum Likelihood Classifier

15. Using the signature file that you created, make sure that unique colors have been assigned to each of the eight land cover/use classes (*e.g*., if you have three signatures to represent water, all three of them should be the same blue color in the Signature Editor Window). The colors you select for the eight classes in the SEW will be the ones that the maximum likelihood classifier assigns in its output file. If you have already set your colors in the Signature Editor Window, proceed to Step B, below. If you have not set your colors in the Signature Editor Window, start with Step A, then proceed to Step B.

<u>Step A</u>. **Click** the **Raster Tab** on the ribbon tool bar and then click the **Supervised** in the *Classification Group*. Select "**Signature Editor"** from the pop-up menu. After a few moments, the **Signature Editor Window** (**SEW**) will open. **Click** on the **Open and Read a Signature File** button in the SEW tool bar, **navigate** to your signature file and **double click** to open it.
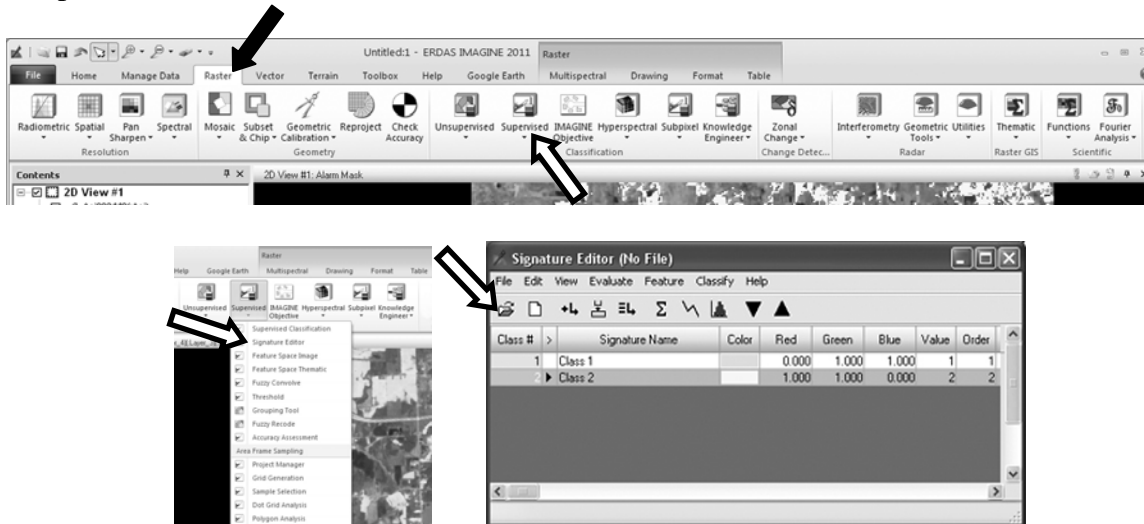
Assign unique colors to each of the eight land cover/use classes. Remember, if you have multiple signatures to represent one land cover/use class, all of them should be the same color in the SEW. The colors you select for the seven classes in the Signature Editor Window will be the ones that the maximum likelihood classifier assigns in its output file.

Step B. **Click** the **Raster Tab** on the ribbon tool bar and then click the **Supervised** in the *Classification Group*. Select "**Supervised Classification"** from the pop-up menu, which will open the **Supervised Classification** window.

- The "*Input Raster File*" should be automatically selected as (**lansing_sub.img**).
- Select your **signature file** that you created for the "*Input Signature File.*"
- Type in a unique file name for the "*Classified File*" (check to verify that this output file is being **saved into your personal folder** on the server).
- Check "ON" the **Distance File** and name it (also to be **saved in your personal folder** on the server).
- Leave the "*Non-parametric Rule*" set to **None** and the "*Parametric Rule*" set to **Maximum Likelihood**. Press **OK**.

You can monitor the progress of the classification in the Process List window that opens. When the job is done ("Progress: 100%" and "State: Done"), press **Close**.
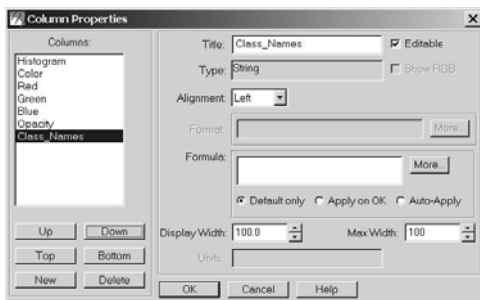
16. To **qualitatively** evaluate your supervised classification for omission and commission errors you need to visually inspect each class independently, as it is displayed on top of the original image data.

Step A. **Click** the **File** tab → **View** → **View Raster Attributes**. After a few moments, the **Raster Attribute Editor** will open. **Click** the *Open file* button, then **navigate to** and **select** (**double click**) your maximum likelihood classification output file. From the **Raster Attribute Editor** tool bar, **select Edit** → **Column Properties** to rearrange the columns in the table so that they are easier to view and work with. The *"Column Properties"* dialog opens.
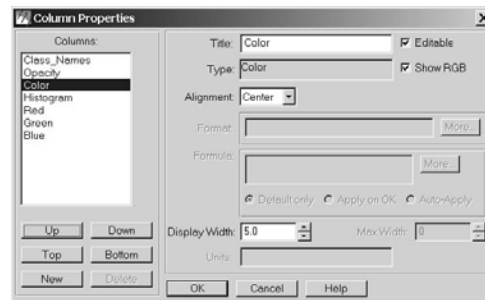
In the *"Column Properties"* **window**, within the *"Columns"* list, **select Class_Names**, then **click** the **Top** button to move it to the top. Use the **Up** button to move **Opacity** so that it is next under **Class_Names** and then move **Color** so that it is just under **Opacity**. Click **OK** in the **"Column Properties"** dialog to rearrange the columns in the Raster Attribute Editor (the Column Properties dialog closes). In the **Raster Attribute Editor,** click the **File** tab → **Save.**

Raster Attribute Editor **before** Column Editing

Column Properties **before** Column Moves

Column Properties **after** Column Moves

Raster Attribute Editor **after** Column Editing

Step B. **Click** on the **Open File icon** in the top Imagine tool bar or **right-click** in the "**2D View #1,**" then select **Open Raster Layer**. In either case, **navigate to** and **select** (**double click**) your maximum likelihood classification output file (from step 15B, above).

In the *Contents* frame, **right-click** the **classification** output file and **select** *Display Attribute Table* from the pop-up menu. The Attribute Table for your classification file automatically docks across the bottom of the ERDAS Desktop display. You can "undock" it, if you wish, by **right-click-hold**ing from its **banner** and **drag**ging it out into the viewer frame. Manually resize the Attribute Table for ease of use.

In order to effectively evaluate each land cover/use class for errors of omission and/or commission, you need to view *each class displayed individually* on top of the image. To

facilitate this type of inspection, the **opacity** for all of the classes must be **set to zero** so that they **become invisible** (*i.e.*, transparent) on top of the color composite.

In the **Attribute Table**, **right-click** on the **first row** and **click Select All** from the pop-up menu to select all of the classes. **Left-click** on the column name **Opacity** to select this column for activity, then **right-click** on the column name **Opacity** to open the Column Options pop-up menu. **Select Formula** from the *Column Options* menu, which opens the Formula window.

In the **Formula** window, **click 0** from the number pad at the right. Note that a "**0**" was placed in the **Formula** field. **Click Apply** to change all of the values in the **Opacity** column to **0** and note that the classified image "disappears" from the viewer frame. **Click** the **Close** button to dismiss the **Formula** window.
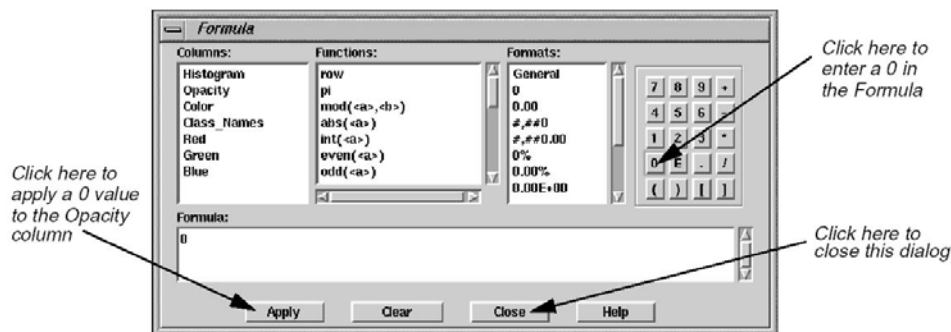
In the **Attribute Table**, **click** on the first land cover/use **Class** to make it active (you may have to "activate" more than one row in the Attribute Table, if you had more than one signature representing this class). **Click-hold on the color patch** in the **Color** column for the selected Class(es) and **change their color** to **Yellow** (temporarily) to provide better visibility in the Viewer. Now, change the **Opacity** for the selected class to **1**.

Errors of omission are shown by features in the color composite that should have been classified as members of the particular category under inspection, but are not overlain with yellow. In order to see errors of commission, we need to be able to "peak" under the yellow overlay patches to see if the image pixels seem to be correctly classified or not.

17. **Click** on the **Swipe** tool icon located within the **View group** under the **Home** tab. Follow the same procedures that you did in Step 9 on page 5.

The selected land cover/use class, displayed in Yellow, should now appear only on the left half of the scene. By manipulating the **Slider Bar** in the **"Transition Extent Sub-Window"** you can "cover" and "uncover" the color composite image with the classification image (showing only one class at the moment). **Visually check for omission and commission errors**.

Use your zoom and roam capabilities to scrutinize a number of "key" areas of "known" land cover/use. You may find it necessary to compare several different color composites with the classified image using the **Swipe** tool in order to appropriately check all of your cover/use categories. The **Swipe** process will help you assess which land cover type is "underneath" any of the classified (colored and filled) polygons.

Try to assess both **errors of commission** (*e.g.*, some actual water pixels might have been misclassified as dark needle-leaf forests) and **errors of omission** (*e.g.*, some water pixels might have been left out of the water class). There is no way to isolate either of these error types (*i.e.*, you can't ask for a display of just the omission error pixels), so just be thinking about both error types as you scrutinize you classification.

Repeat the above display and inspection procedure for all eight classes. As you finish inspecting each class, <u>don't forget to change its color back</u> to the mapping legend color you originally chose for it.

18. After your inspection, **reset** the **opacity** of all classes to "**1**" and **close** the **Attribute Table** using the "**X**" in the upper-right of the table banner. **Click YES**, in the *Verify Save on Close* window that pops up.

<u>THRESHOLD</u> (the final step of Supervised Classification).

19. **Thresholding** is a statistical method used to refine a supervised classification by determining which pixels in the new thematic raster layer **are most likely to be <u>incorrectly</u> classified** (using the **distance file** that was created during the supervised classification). These distances occur in probability space, so larger distances are associated with lower probabilities of class membership.

A distance threshold can be set for each class to "screen out" the pixels that probably do not belong to that class. For all pixels whose distance-file values are greater than the threshold value that you set, the class value in the thematic raster layer is set to **Zero** and displayed in **Black** (*i.e.*, these pixels become members of the "unclassified" group).

From the **Raster** tab on the ribbon tool bar, **click** on **Supervised** button and **select** **Threshold** from the drop-down menu. In the **Threshold** window that opens after a few moments, **click** on the **open file** icon and **select** your newly created **classified image** and the associated **distance image** file. Click **OK**.
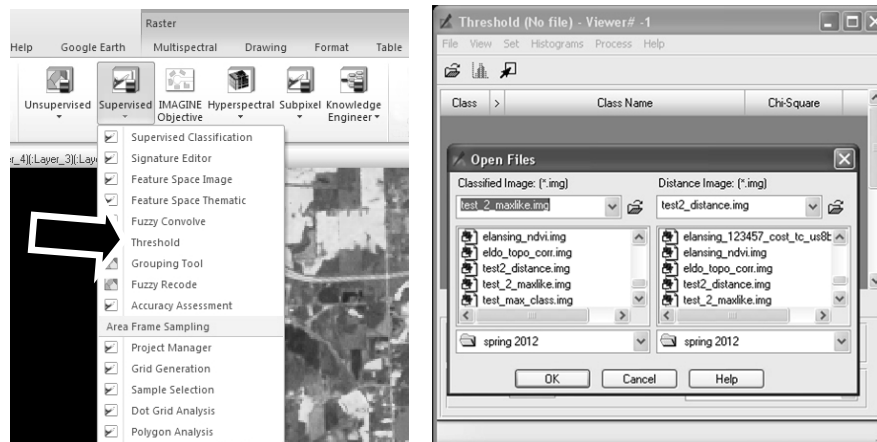
A window opens with the **Class #**, **Class Name** and **Chi-Square** values predefined, based on your classified image file. From the tool bar at the top of the **Threshold** window, **clicking** on **Histograms → Compute** will compute a histogram for every class in the image.


From the **Threshold** window tool bar, **click** on **View → Select Viewer**, then **move your mouse cursor** anywhere on the image displayed in the **2D View #1** window and **left-click** to select this viewer.

Within the **Threshold** window, **highlight** and **move the pointer >** to the class that you want to examine. **Click** on **Histograms → View…** to display the **distance histogram** for the selected class. *Note* that the *__pointer selects__* which class will have its distance histogram displayed (regardless of whether it is highlighted or not).

Interpreting the distance histogram

The brighter pixels (with the higher distance file values) are spectrally farther from the signature means for the classes to which they are assigned. **Hence, they are more likely to be misclassified.** The darker pixels are spectrally nearer to the signature means for the classes to which they are assigned, and **more likely to be classified correctly**. For supervised classifications, the darkest pixels are usually the training samples.

The histogram of the distance file usually approximates a chi-square distribution. Normally, *there are many pixels with a distance image value at or near 0, indicating that these pixels are likely to be classified correctly.* A histogram is generated for each class in the classified image file.
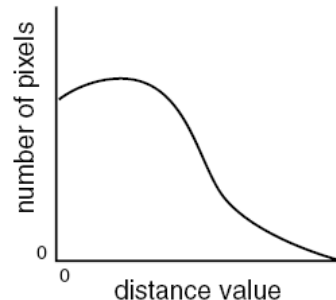
The tail of the histogram represents a relatively lower number of pixels (hopefully) with higher values in the distance image file. Since the Euclidean distance from these pixels to the class mean is large, these pixels are more likely to be incorrectly classified (*i.e.*, their assigned class membership probability is very low).

Thresholding allows you to "cut off the tail" of this distance histogram, eliminating the "low probability" pixels from each class (*i.e.*, pixels with the highest distance values).

Tips on thresholding:

A. For smooth chi-square shapes, try to find the "breakpoint" where the curve becomes more horizontal, and cut off the tail from this point.

B. Minor mode(s) in the curve probably indicate that the class picked up other features that were not represented in the signature. You will probably want to threshold these features out.

C. **If the histogram does not have a dominant peak near "0", this indicates it is not a good class.** Polymodal (multi-peaked) distributions mean that the class is "mixed" and should be re-classified using new training data.

D. If the peak of the curve is significantly shifted from "0", this indicates that the signature mean is off-center from the pixels it represents. You may need to take a new signature and reclassify.

20. In the **Threshold** window, **click** on **View → View Colors → Default**. This default setting will display the thresholded (*i.e.*, eliminated) pixels in **BLACK** in the threshold image and the remaining (good) pixels in the class in the color set in the Signature Editor.

Within the **distance histogram** for the selected class, you can **move the arrow ▲** on the **X-axis** to the position where you want to threshold the distribution of pixels (keeping the pixels left of the threshold boundary and discarding the pixels that are right of the boundary).

As you move the arrow, the **chi-square** value is updated for the current class. After each trial threshold (*i.e.*, movement of the X-axis pointer), **click** on **Process → To Viewer** in the **Threshold** window. This causes the **threshold image** to be placed in the **Viewer** window *on top* of the classified image. **NOTE** that the *highlighted* class in the Threshold window is the one that will be displayed in the view, regardless of which class the pointer **>** is set to (the pointer selects the class for the distance histogram, as noted above).

21. **Click** on the **Swipe** tool icon located within the View group under the **Home** tab. The **"Viewer Swipe Window"** opens with default settings of a Vertical "swipe edge" located 50% across the width of the scene. Since there are several layers in the *Contents* frame, you must manually **select** which one is to be the "overlay" theme. **Make** the **threshold image** (image name = "Functional") the **Working** layer and all the other layers **Static** (see figure below).

Note the **2D View #1** window: the Threshold Mask is displayed only on the left half of the scene. By manipulating the **Slider Bar** in the **"Transition Extent Sub-Window"** you can "cover" and "uncover" the color composite image with the Threshold Mask (see screen shot on next page).
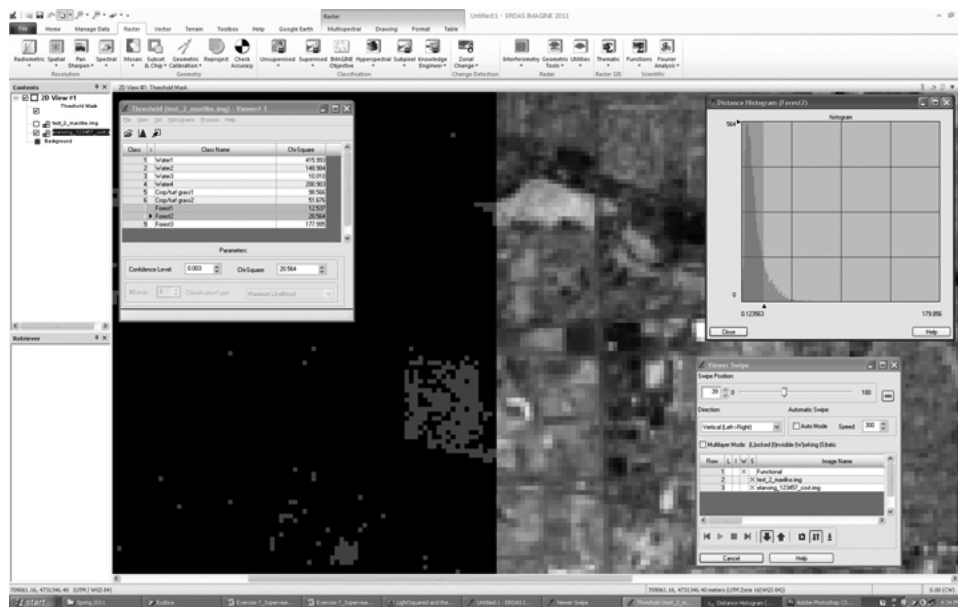
Use your best judgment about **balancing omission and commission errors** to guide you in setting an appropriate threshold for each class – in general, minimizing commission errors is the preferable. You do not have to close the distance histogram window after viewing or changing one class, just move the **pointer >** to the next class and the histogram will be updated for new class.

Repeat this process, thresholding the histogram **for each class** in the **Threshold** window. If you have multiple classes to represent one land cover/use type (*e.g.*, water1, water2 and water3), use **shift-click** to **select** all the members of one class and then **click** on **Process → To Viewer** in the **Threshold** window.

After you have established a threshold for each class, use **shift-click** to **select all** the **classes** at once in the **Threshold** window, then click on **Process → To Viewer** in the **Threshold** window. The **thresholded image,** *with all the unclassified pixels shown in black*, is placed in the **Viewer** window on top of the classified image. Once again, the Swipe tool can be used for further evaluation.

22. **Save the threshold result for the maximum likelihood classification <u>to your personal folder</u>** on the server by **clicking** on **Process → To File** in the **Threshold** window. Name the file "**ML_thresh.img**." **Close** the **Distance Histogram** and **Threshold** windows.

In real-world, production work, you can use the threshold mask (*i.e.*, the unclassified pixels) to help inform you about the need for additional training sites. If the unclassified pixels occur more or less randomly across the landscape, there is not much you can do to fix the problem. But, if they are spatially clustered in certain places in the landscape, you can use the Swipe Tool to investigate what type of land cover/use they represent and delineate additional AOIs to represent these "new" classes. We do not have the time necessary to complete such an iterative process, which may take three or four iterations before an acceptable accuracy is achieved. Nonetheless, you now have **experience with all the major steps used in the supervised classification processing chain**.

Supervised Classification – Spectral Angle Mapper

23. **Click** the **Raster Tab** on the ribbon tool bar and then click the **Supervised** in the *Classification Group*. Select "**Supervised Classification"** from the pop-up menu, which will open the **Supervised Classification** window.

   - The "*Input Raster File*" should be automatically selected as (**lansing_sub.img**).
   - Select your **signature file** that you created for the "*Input Signature File.*"
   - Type in a unique file name for the "*Classified File*" (check to verify that this output file is being **saved into your <u>personal folder</u>** on the server).
   - Check "ON" the **Distance File** and name it (also to be **saved in your <u>personal folder</u>** on the server).
   - Leave the "*Non-parametric Rule*" set to **None** and the "*Parametric Rule*" set to **Spectral Angle Mapper**. Press **OK**.

   You can monitor the progress of the classification in the Process List window that opens. When the job is done ("Progress: 100%" and "State: Done"), press **Close**.

23. To **qualitatively** evaluate your SAM classification for omission and commission errors you could visually inspect each class independently, as it is displayed on top of the original image data, by following steps 16 – 18, above. In the interest of time, you should move directly to Thresholding your SAM classification.

THRESHOLD (the final step of Supervised Classification).

24. From the **Raster** tab on the ribbon tool bar, **click** on **Supervised** button and **select Threshold** from the drop-down menu. In the **Threshold** window that opens after a few moments, **click** on the **open file** icon and **select** your **SAM classified image** and the associated **SAM distance image** file. Click **OK**.

    A window opens with the **Class #**, **Class Name** and **Chi-Square** values predefined, based on your classified image file. From the tool bar at the top of the **Threshold** window, **clicking** on **Histograms** → **Compute** will compute a histogram for every class in the image.

    A window opens with the **Class #**, **Class Name** and **Chi-Square** values predefined, based on your classified image file. From the tool bar at the top of the **Threshold** window, **clicking** on **Histograms** → **Compute** will compute a histogram for every class in the image. Note that the Threshold Window shows very small "Chi-Square" values (*e.g*., 0.001). This is because the SAM distance file is not scaled in probability space like the Maximum Likelihood distance file was. Also note that the "Parameters:" section of the Threshold Window only contains a "Distance Threshold" dialog box (no "Chi-Square" dialog box).
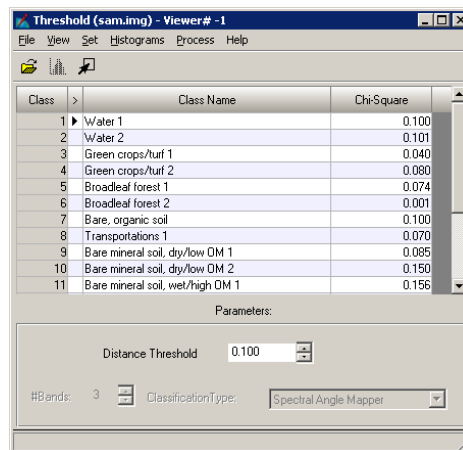
    From the **Threshold** window tool bar, **click** on **View** → **Select Viewer**, and then **move your mouse cursor** anywhere on the image displayed in the **2D View #1** window and **left-click** to select this viewer.

    Within the **Threshold** window, **highlight** <u>and</u> **move the pointer ▶** to the class that you want to examine. **Click** on **Histograms** → **View…** to display the **distance histogram** for the selected class. *Note* that the ***pointer selects*** which class will have its distance histogram displayed (<u>regardless</u> of whether it is highlighted or not).

25. Within the **Threshold** window, use the up-arrow to set the "Distance Threshold" to 0.100 and press the "Enter" key on your keyboard. Within the **distance histogram** for the selected class, you can **move the arrow ▲** on the **X-axis** to the position where you want to threshold the distribution of pixels (keeping the pixels left of the threshold boundary and discarding the

pixels that are right of the boundary), but this will NOT automatically update the "Distance Threshold" in the **Threshold** window. Hold down the left-mouse button while pointing at the arrow ▲ on the **X-axis** of the **distance histogram** to see the value at the arrow position – transcribe this value into the "Distance Threshold" dialog box in the **Threshold** window and press the "Enter" key on your keyboard. Note that this updates the "Chi-Square" value for this class in the **Threshold** window. Once a new "Chi-Square" value has been entered for a highlighted class, **click** on **Process → To Viewer** from the toolbar in the **Threshold** window. **NOTE** that the *highlighted* class in the **Threshold** window is the one that will be displayed in the view, <u>regardless</u> of which class the pointer **>** is set to (the pointer selects the class for the distance histogram, as noted above).

26. To inspect the omission – commission errors that this threshold has produced, use the swipe tool. **Click** on the **Swipe** tool icon located within the View group under the **Home** tab.

27. Repeat this process, thresholding the histogram **<u>for each SAM class</u>** in the **Threshold** window. If you have multiple classes to represent one land cover/use type (*e.g*., water1, water2 and water3), use **shift-click** to **highlight** all the members of one class and then **click** on **Process → To Viewer** in the **Threshold** window.

    After you have established a threshold for each class, use **shift-click** to **select <u>all</u>** the **classes** at once in the **Threshold** window, then **click** on **Process → To Viewer** in the **Threshold** window. The **thresholded image,** *with all the unclassified pixels shown in black*, is placed in the **Viewer** window on top of the classified image. Once again, the Swipe tool can be used for further evaluation.

    Save the threshold result for the SAM classification <u>to your personal folder</u> on the server by **clicking** on **Process → To File** in the **Threshold** window. Name the file "**SAM_thresh.img**."

28. **Close** the **Distance Histogram** and **Threshold** windows. **Exit** the ERDAS Imagine program.