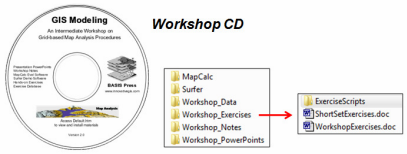
Hands on Exercises for

Grid-based Map Analysis and GIS Modeling Workshop

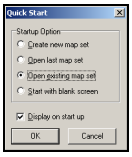
– Exercise #1 – **Map Analysis Framework** (MapCalc)
– Exercise #2 – **Example of a Simple Erosion Potential Model** (MapCalc)
– Exercise #3 – **Reclassify and Overlay Techniques** (MapCalc)
– Exercise #4 – **Measuring Distance and Connectivity** (MapCalc)
– Exercise #5 – **Characterizing Spatial Neighborhoods** (MapCalc)
– Exercise #6 – **Surface Modeling** (MapCalc and Surfer)
– Exercise #7 – **Spatial Data Mining** (MapCalc)
– Exercise #8 – **Gaining GIS Modeling Experience** (MapCalc)
– Optional Exercise – **Data Exchange Procedures** (MapCalc)

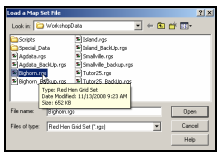


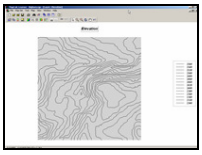
The following "**short set**" of exercises used in the workshop are designed to demonstrate basic *Map Analysis* techniques and *GIS Modeling* considerations. For a more through experience, complete the "full set" of Workshop Exercises as homework using the software contained on the Workshop CD.

(Short Exercise #1) Map Analysis Framework (Raster; grid-based data structure and analysis)

Install *MapCalc* from the *Workshop CD* using \MapCalc**mapcalc_learner.exe**.
Access *MapCalc* by Start→ Programs→ MapCalc Learner → **MapCalc Learner** and select **"Open existing map set"** then browse to the …**WorkshopData**\ folder you copied from the workshop CD and select **Bighorn.rgs** as the database.







Display Tools

Layer Contour button → mouse-over to identify Elevation values within contour polygons

Layer Mesh button

Toggle 3D View button

Rotate button

Reset View to Defaults button

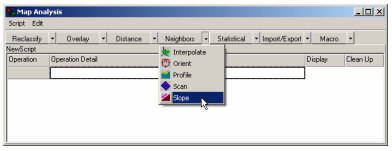
Zoom-in button → click and drag area on the map to be enlarged

Use Cells button

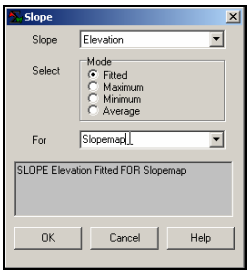
Select button → mouse-over to identify Elevation values within grid cells

Example Map Analysis (Slope operation identifying terrain steepness)

Map Analysis button, select **Neighbors→ Slope**

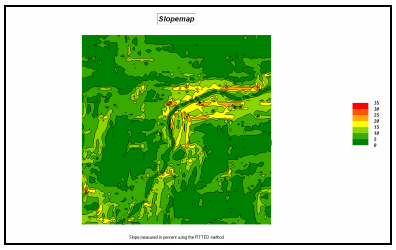


…accessing the **Slope** command



Enter **SLOPE Elevation Fitted FOR Slopemap** command, then **OK** button

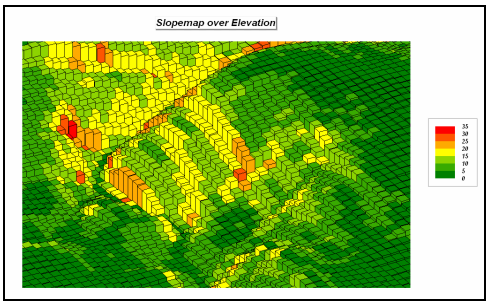
Min [>=]	Max [<]	Count	acres	% Gridded Area	Color	Lock
30	35	4	0.89	0.041		On
25	30	20	4.45	0.2		Off
20	25	162	36	1.7		Off
15	20	499	111	5.1		On
10	15	1447	322	15		Off
5	10	3692	821	38		Off
0	5	3977	884	41		On



Double-click on *Slopemap* legend and swap Red (to high values) and Green (to low values) color assignments

View, Rename and Delete Layers button → **Elevation** → **View**

And then from the **Main Menu** at the top, select **Map** → Overlay → **Slopemap**



Use Cells button **Zoom-in** button → click and drag area on the map

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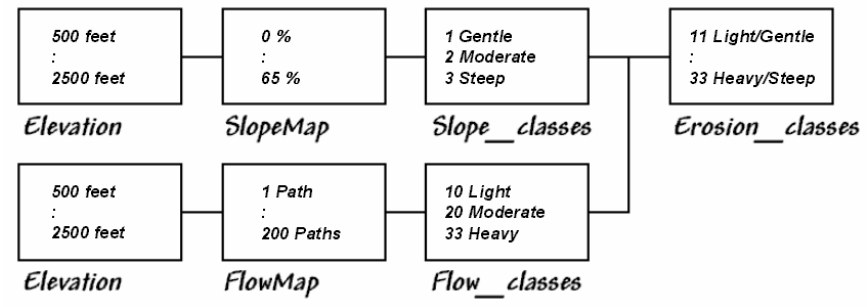
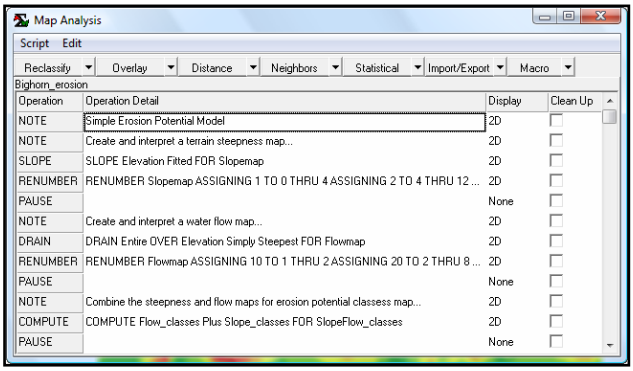
(Short Exercise #2) **Example of a Simple Physical Model** (Erosion Potential Model that Derives, Calibrates and Combines map layers)

Become familiar with the following simple model flowchart and script for estimating soil erosion potential—

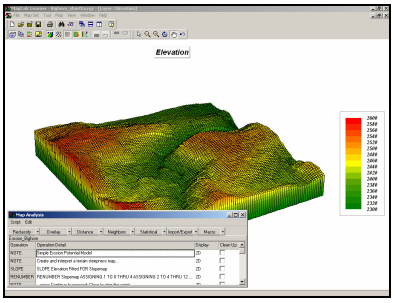


Logical processing sequence (**Flowchart**)…



Command sequence (**Script**)

Press the **Map Analysis** button to pop-up the *Map Analysis* dialog box.
Select **Script→ Open** and then browse to and select **Bighorn_Erosion.scr** file in the **…\WorkshopData\Script** folder.



Resize and position the script window to the lower-left portion of the display.

Execute the command script a line at a time by double-clicking on the line and interpreting the dialog box information. Submit a command line by pressing **OK**. The first portion of the erosion model…

NOTE	Create and interpret a terrain steepness map...
SLOPE	SLOPE Elevation Fitted FOR Slopemap
RENUMBER	RENUMBER Slopemap ASSIGNING 1 TO 0 THRU 4 ASSIGNING 2 TO 4 THRU 12 ...

…creates a map of terrain steepness **(Slopemap**) then "calibrates" the steepness into three classes (1= Gentle, 2= Moderate, 3= Steep). The next portion of the model…

NOTE	Create and interpret a water flow map...
DRAIN	DRAIN Entire OVER Elevation Simply Steepest FOR Flowmap
RENUMBER	RENUMBER Flowmap ASSIGNING 10 TO 1 THRU 2 ASSIGNING 20 TO 2 THRU 8 ...

…creates a map of water confluence (**Flowmap**) then "calibrates" water flow into three classes (10= Light, 20= Moderate, 30= Heavy). The final portion of the model…

NOTE	Combine the steepness and flow maps for erosion potential classess map...
COMPUTE	COMPUTE Flow_classes Plus Slope_classes FOR SlopeFlow_classes

…combines the steepness and flow maps into a single erosion potential map (**Erosion_classes**) to identify each map location by a two-digit code where the first number (tens digit) indicates the flow class and the second number (ones digit) indicates the steepness class. For example, 11= Light/Gentle (low erosion potential) and 33= Heavy/Steep (high erosion potential).

NOTE	Calibrate Erosion Classes for Erosion Potential ...1= high EP (reach farther) through 9= l...
RENUMBER	RENUMBER SlopeFlow_classes ASSIGNING 1 TO 33 ASSIGNING 2 TO 32 ASSIG...
NOTE	Calculate the effective distance from streams for every location in the project area
SPREAD	SPREAD Water NULLVALUE PMAP_NULL TO 300 THRU Erosion_potential Simply F...
NOTE	...end of script
RENUMBER	RENUMBER Water ASSIGNING -1 TO 1 FOR NewMap
COVER	COVER Erosion_eProx_Buffers WITH NewMap IGNORE 0 FOR EPot_display

The remaining commands create a variable-width buffer around streams (Full exercise #2).

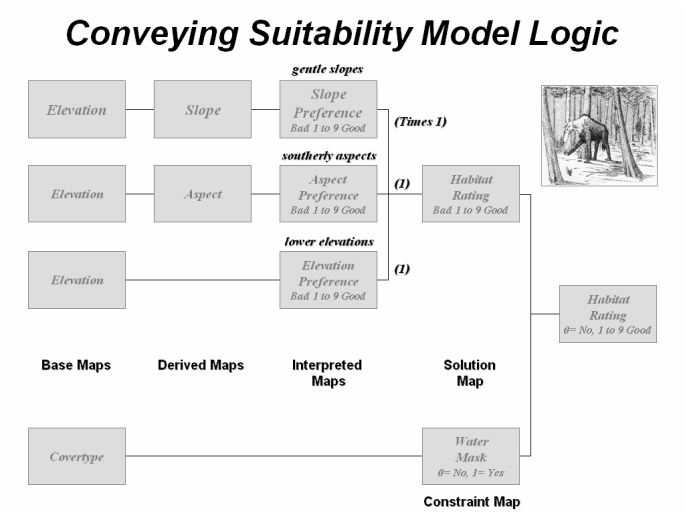
(Short Exercise #3) **Example of a Suitability Model** (Habitat Suitability Model that Derives, Calibrates and Combines map layers)

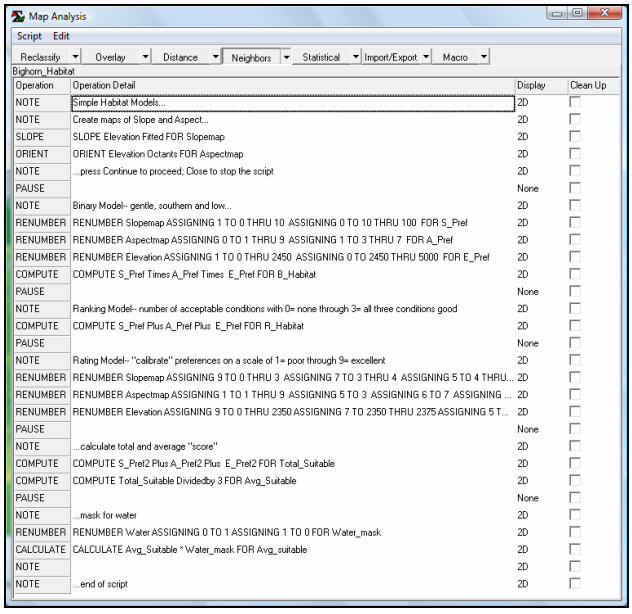
The combination of geographic factors often determine habitat quality. In this example, using the Bighorn.rgs database Hugags in this locale have shown a preference for…

- *Gentle Slopes (<10%)*
- *Southerly Aspects (E-W)*
- *Lower Elevations (<2450 feet)*

…are evaluated using computer-based map analysis techniques for Binary, Ranking and Rating suitability models.

Using the flowchart and script listing below, become familiar with the model logic ingrained in each processing step that leads to the final Hugag habitat suitability map.

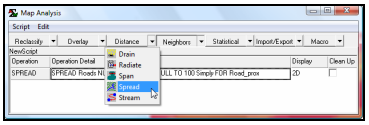




Under the guidance of the instructor, access and complete the suitability model for Hugag habitat by selecting **Map Analysis→ Script→ Open→ Bighorn_Habitat.scr** in the **…\WorkshopData\Script** folder and completing the processing a line at a time.

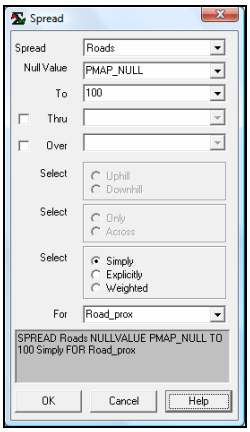
(Short Exercise #4a) **Spatial Analysis** (Simple and Effective Distance)

Within the **Bighorn.rgs** database select the **Map Analysis** button, and then select **Distance→ Spread**

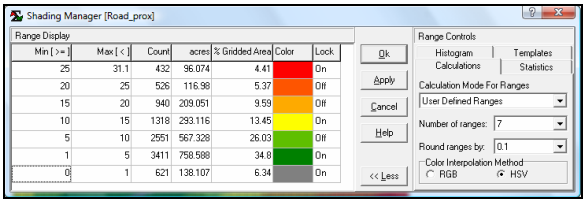


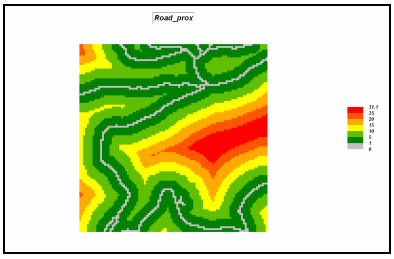
…accessing the **Spread** command

Simple Distance



SPREAD Roads NULLVALUE PMAP_NULL TO **200** Simply FOR **Road_prox**



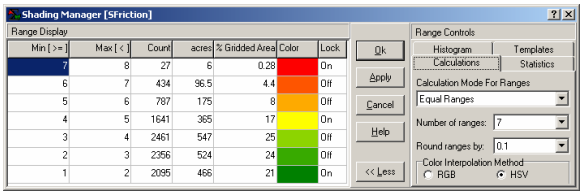


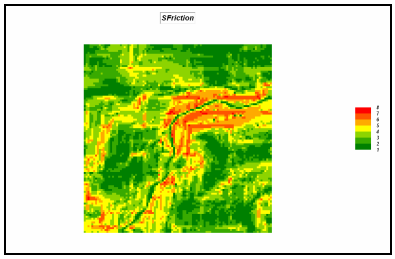
Double-click on the map legend and set the display to "**User Defined Ranges**" (Calculation Mode), "**7**" (Number of Ranges), **Color** settings as shown (Grey, Green to Red with Yellow inflection), enter the **Min[>=]** values as shown and press **OK** to create the custom display.

Effective Distance

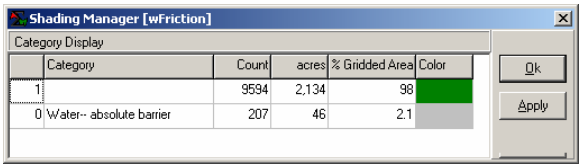
SLOPE Elevation Fitted FOR **Slopemap** *…already created*

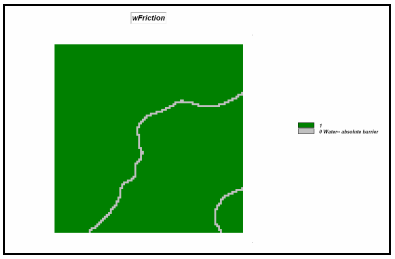
RENUMBER SlopeMap
ASSIGNING **1** TO **0** THRU **3**
ASSIGNING **2** TO **3** THRU **5**
ASSIGNING **3** TO **5** THRU **8**
ASSIGNING **4** TO **8** THRU **12**
ASSIGNING **5** TO **12** THRU **16**
ASSIGNING **6** TO **16** THRU **24**
ASSIGNING **7** TO **24** THRU **30**
ASSIGNING **8** TO **30** THRU **100**
FOR **sFriction** *…identifies increasing relative barrier to hiking movement as terrain steepness increases*



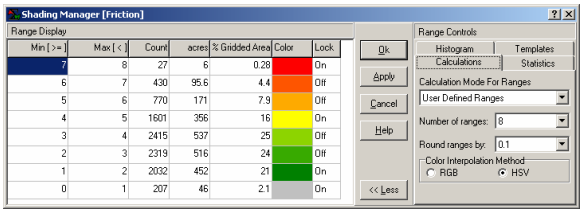


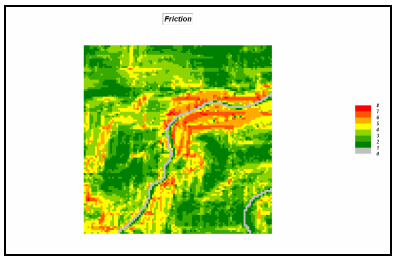
RENUMBER Water
ASSIGNING **1** TO **0**
ASSIGNING **0** TO **1**
FOR **wFriction** *…identifies water as absolute barrier to hiking movement*



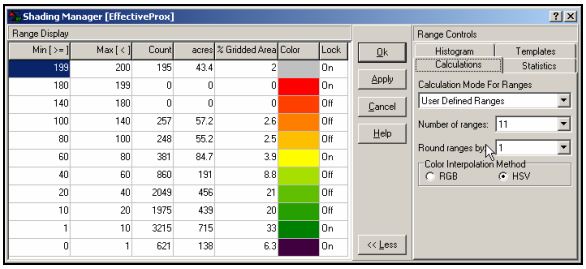


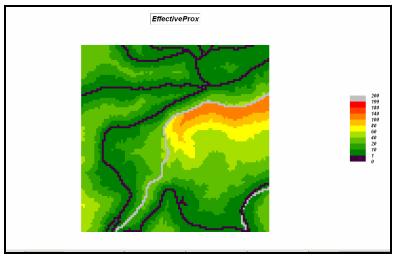
COMPUTE sFriction Times wFriction FOR **Friction** *…combines relative and absolute barriers*





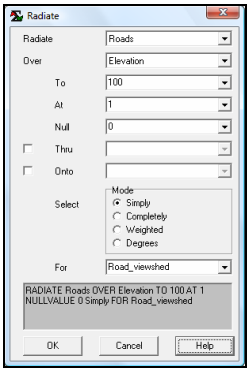
SPREAD Roads NULLVALUE PMAP_NULL TO **200** THRU **Friction Simply** FOR **Road_hikingprox** *…identifies relative proximity to the nearest road for all locations in the analysis frame.*





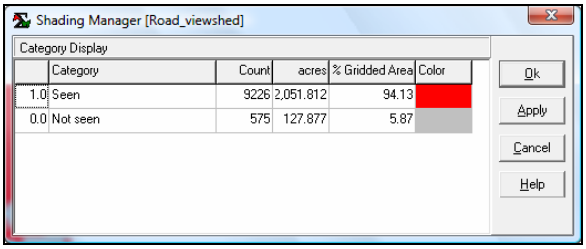
(Short Exercise #4b) Spatial Analysis (Viewshed, Visual Exposure and Weighted Visual Exposure)

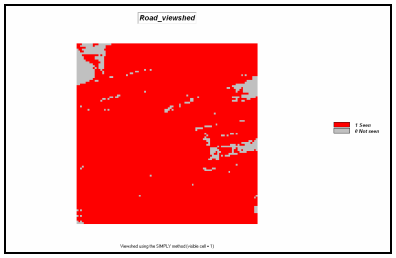
Viewshed



RADIATE Roads OVER **Elevation** TO **100** AT **1** NULLVALUE 0 **Simply** FOR **Road_viewshed**

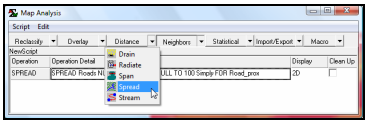
…identifies all locations that are visually connected to at least one road cell as a binary map (1=seen, 0=not seen)





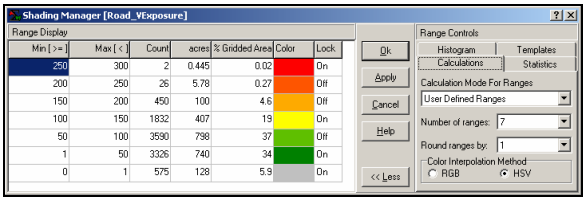
Visual Exposure

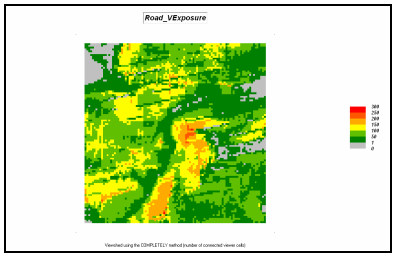
Map Analysis button, select **Distance→ Radiate**



…accessing the **Radiate** command

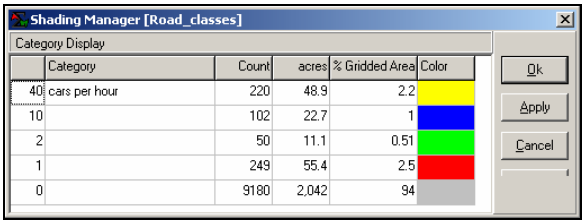
RADIATE Roads OVER **Elevation** TO **100** AT **1** NULLVALUE 0 **Completely FOR Road_VExposure** *…identifies the number of road cells visually connected to each map location (increasing values indicate areas that are increasingly more exposed)*

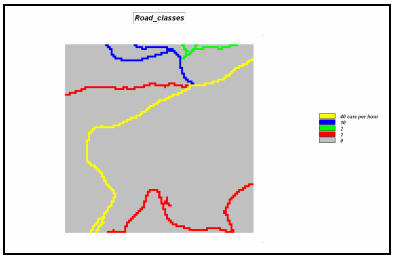




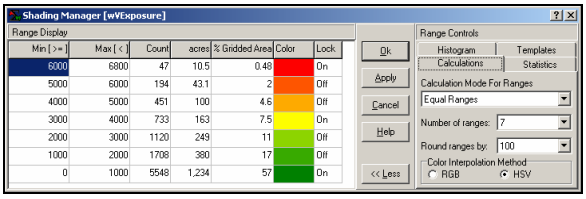
Weighted Visual Exposure

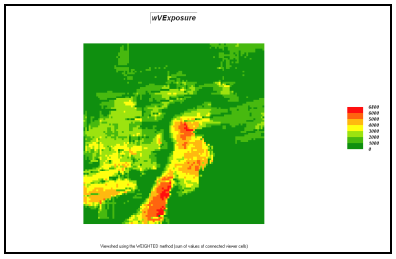
RENUMBER Road_type
ASSIGNING **1** TO **4**
ASSIGNING **2** TO **3**
ASSIGNING **10** TO **2**
ASSIGNING **40** TO **1**
FOR **Road_classes** *…calibrates the roads based on relative number of cars*





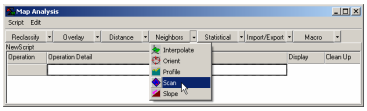
RADIATE Road_classes OVER **Elevation** TO **200** AT **1** NULLVALUE 0 **Weighted** FOR **wVExposure** *…identifies the weighted visual exposure for each map location (uses the road type as the weight)*



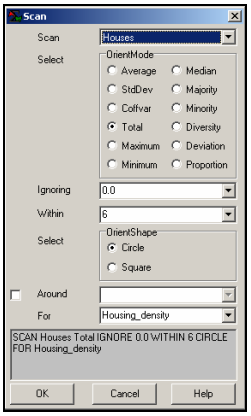


(Short Exercise #5) Spatial Analysis (Neighborhood operators)

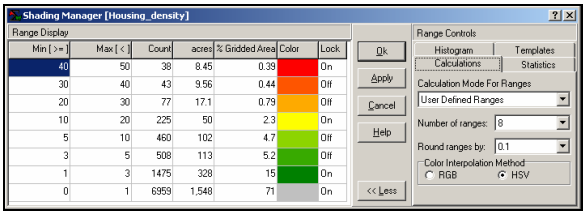
Within the **Bighorn.rgs** database select the **Map Analysis** button, and then select **Neighbors→ Scan**

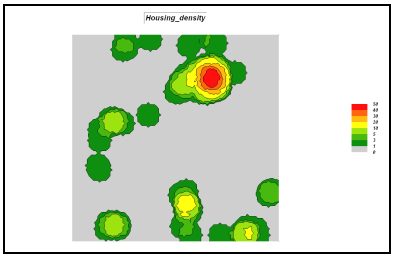


…accessing the **Scan** command

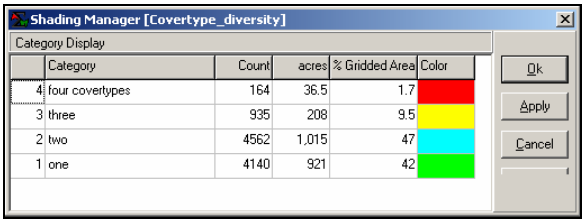


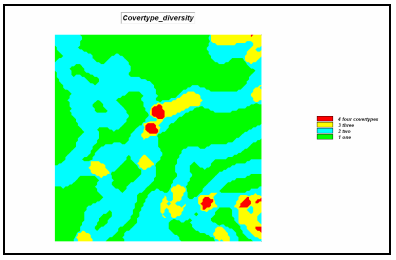
SCAN Houses Total IGNORE 0.0 WITHIN **6 CIRCLE** FOR **Housing_density** *…identifies the total number of houses within a 6-cell reach of every map location*



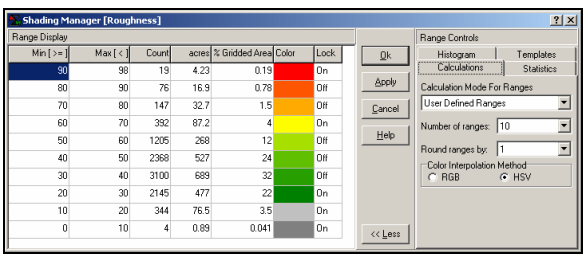


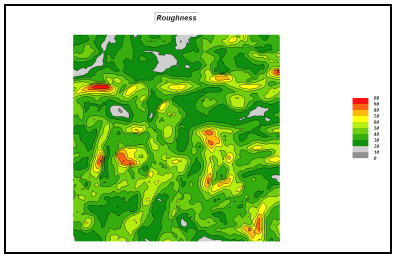
SCAN Covertype Diversity IGNORE 0.0 WITHIN **4 CIRCLE** FOR **Covertype_diversity** *…identifies the number of different cover type classes within a 4-cell reach of every map location*





SCAN SlopeMap CoffVar IGNORE 0.0 WITHIN **2 CIRCLE** FOR **Roughness** *…identifies the coefficient ([StDev / Mean] * 100) of variation as the relative amount of variation within a 4-cell reach of every map location*

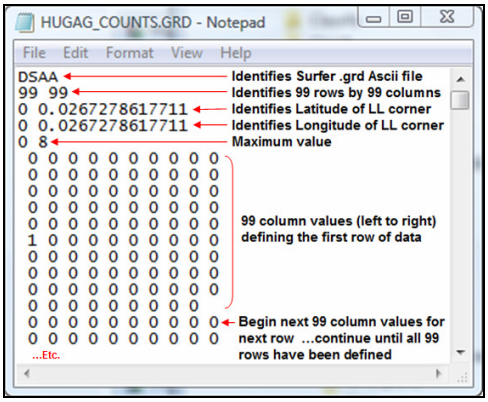


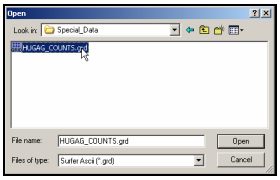


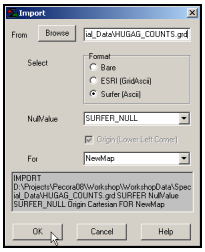
As time and interest permits for optional homework, complete the *MapCalc Tutorials* on the Workshop CD in the …\Surfer**Surfer_Tutorial*** folder.

(Short Exercise #6) Surface Modeling (Generating continuous geographic distributions from discrete point sampled data—Density Analysis and Spatial Interpolation)

Density Analysis

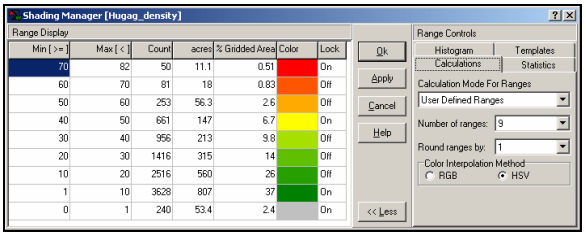


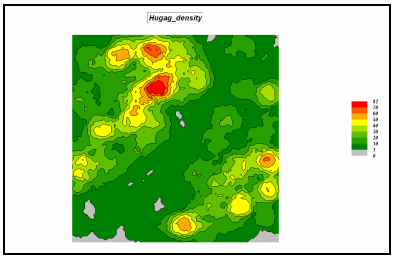




If the *Hugag_counts* map isn't in the **Bighorn.rgs** database, import it by selecting **Map Analysis→ Import/Export→ Import→** choose "**Surfer (Ascii)**" format, browse to the **Hugag_counts.grd** file in the **…\WorkshopData\Special_Data** folder you copied from the workshop CD, enter **Hugag_counts** as the new map name and click **OK**.

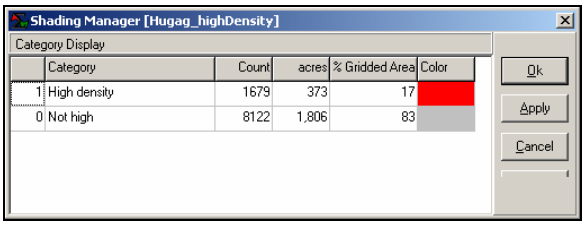
SCAN Hugag_counts TOTAL WITHIN **6** FOR **Hugag_density** *…identifies the total number of Hugag occurrences within a 6-cell reach to generate a density surface of animal activity*

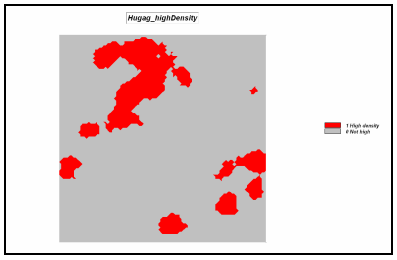




Right-click on the map and select the *Shading Manager*. Click on the *Statistics* tab and note that the average customer density is **17.5** with a standard deviation of **15.0** (rounded). Therefore the breakpoint for unusually high Hugag densities is 17.5 + 15.0= **32.5** (Mean + 1 Stdev).

RENUMBER Hugag_density
ASSIGNING **0** TO **0** THRU **32.5**
ASSIGNING **1** TO **32.5** THRU **1000**
FOR **Hugag_highDensity** *…isolates the locations of high Hugag density (assigned a value of 1 embedded in zeros)*





Spatial Interpolation

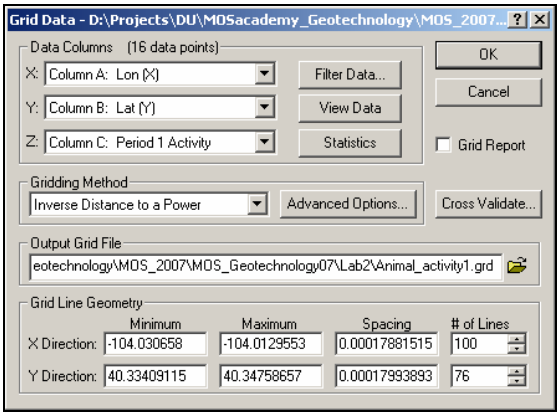
Install *Surfer* from the *Workshop CD* using \Surfer**s8demo.exe**.
Access *Surfer* by Start→ Programs→ Golden Software Surfer 8→ **Surfer 8**.

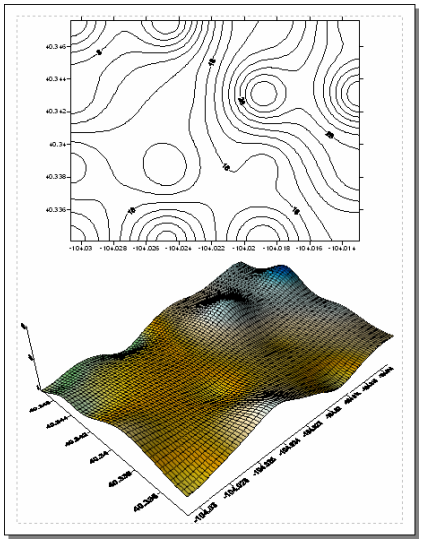
Bring the data into Surfer by…

Selecting **Grid→ Data→** and browsing to …**Program files\Golden Software\Surfer8\Samples** folder and specifying the **DEMOGRID.DAT** data file. Accept all of the defaults and press **OK** to generate the interpolated surface.

Selecting **Map→ Contour Map→ New contour map** and accepting the default DEMOGRID.GRID file specification to generate a *Contour* map of the interpolated data.

Selecting **Map→ Wireframe→ New contour map** and accepting the default DEMOGRID.GRID file specification to generate a *Wireframe* map of the interpolated data.



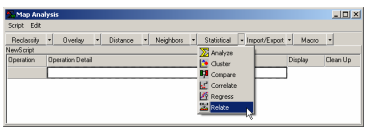


As time and interest permits for optional homework, complete the *Surfer Tutorials* in the …**Geotechnology_software\Surfer\Surfer_Tutorial**\ folder on the Workshop CD.

(Short Exercise #7) Spatial Data Mining (Similarity and Clustering)

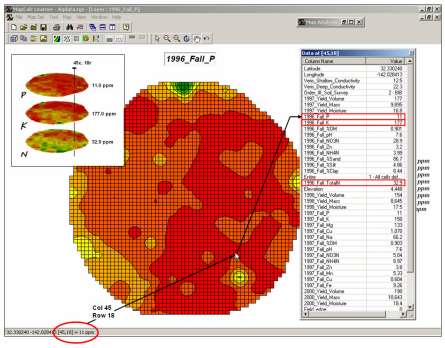
If *MapCalc* is still open, change to the Precision Farming database by File→ Open→ **AgData.rgs**. If *MapCalc* isn't open, access it by Start→ Programs→ MapCalc Learner → **MapCalc Learner** and select **Agdata.rgs** as the database.

Map Analysis button, select **Statistical→ Relate**

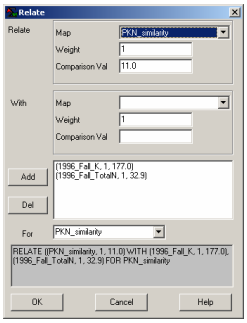


…accessing the **Relate** command

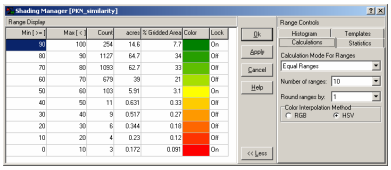
Similarity

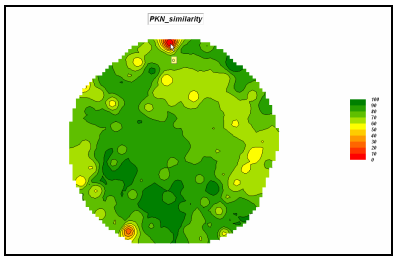


Display the **1996_Fall_P** surface and double-click at location **45c, 18r** to pop-up the "drill-down" summary of the values at that location for all maps. Note that **P= 11.0**, **K=177.0** and **N= 32.9**.

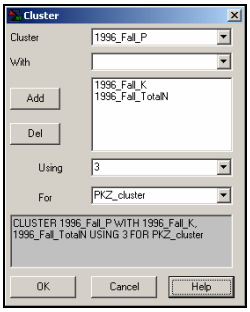


RELATE ((**1996_Fall_P**, **1**, **11.0**) WITH (**1996_Fall_K**, **1**, **177.0**), (**1996_Fall_TotalN**, **1**, **32.9**) FOR **PKN_similarity** *…identifies the relative amount of similarity of each map location to a comparison set of map values*

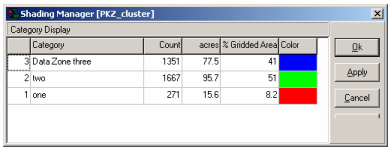


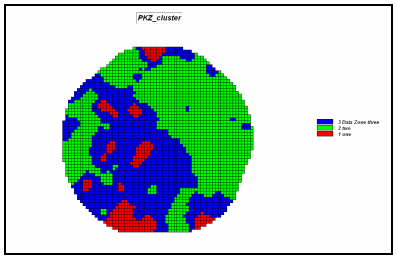


Clustering

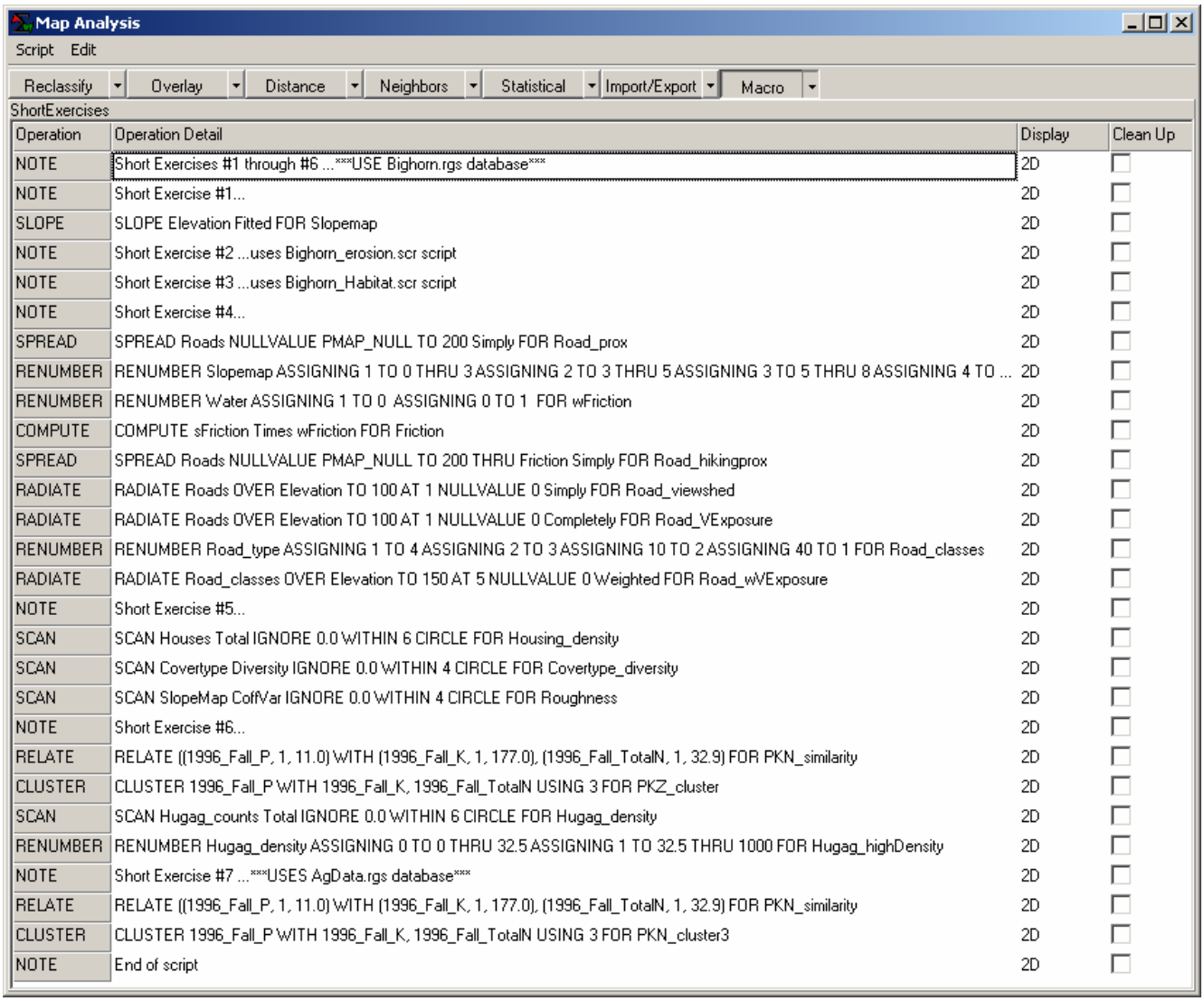


CLUSTER 1996_Fall_P WITH **1996_Fall_K**, **1996_Fall_TotalN** USING **3** FOR **PKZ_cluster** *…identifies distinctly similar data zones where the data values within a zone are as similar as possible and as different as possible among the data zones*





Script of Short Exercise Solutions (ShortExercise.scr)



Operation	Operation Detail	Display	Clean Up
NOTE	Short Exercises #1 through #6 ...***USE Bighorn.rgs database***	2D	☐
NOTE	Short Exercise #1...	2D	☐
SLOPE	SLOPE Elevation Fitted FOR Slopemap	2D	☐
NOTE	Short Exercise #2 ...uses Bighorn_erosion.scr script	2D	☐
NOTE	Short Exercise #3 ...uses Bighorn_Habitat.scr script	2D	☐
NOTE	Short Exercise #4...	2D	☐
SPREAD	SPREAD Roads NULLVALUE PMAP_NULL TO 200 Simply FOR Road_prox	2D	☐
RENUMBER	RENUMBER Slopemap ASSIGNING 1 TO 0 THRU 3 ASSIGNING 2 TO 3 THRU 5 ASSIGNING 3 TO 5 THRU 8 ASSIGNING 4 TO ...	2D	☐
RENUMBER	RENUMBER Water ASSIGNING 1 TO 0 ASSIGNING 0 TO 1 FOR wFriction	2D	☐
COMPUTE	COMPUTE sFriction Times wFriction FOR Friction	2D	☐
SPREAD	SPREAD Roads NULLVALUE PMAP_NULL TO 200 THRU Friction Simply FOR Road_hikingprox	2D	☐
RADIATE	RADIATE Roads OVER Elevation TO 100 AT 1 NULLVALUE 0 Simply FOR Road_viewshed	2D	☐
RADIATE	RADIATE Roads OVER Elevation TO 100 AT 1 NULLVALUE 0 Completely FOR Road_VExposure	2D	☐
RENUMBER	RENUMBER Road_type ASSIGNING 1 TO 4 ASSIGNING 2 TO 3 ASSIGNING 10 TO 2 ASSIGNING 40 TO 1 FOR Road_classes	2D	☐
RADIATE	RADIATE Road_classes OVER Elevation TO 150 AT 5 NULLVALUE 0 Weighted FOR Road_wVExposure	2D	☐
NOTE	Short Exercise #5...	2D	☐
SCAN	SCAN Houses Total IGNORE 0.0 WITHIN 6 CIRCLE FOR Housing_density	2D	☐
SCAN	SCAN Covertype Diversity IGNORE 0.0 WITHIN 4 CIRCLE FOR Covertype_diversity	2D	☐
SCAN	SCAN SlopeMap CoffVar IGNORE 0.0 WITHIN 4 CIRCLE FOR Roughness	2D	☐
NOTE	Short Exercise #6...	2D	☐
RELATE	RELATE ((1996_Fall_P, 1, 11.0) WITH (1996_Fall_K, 1, 177.0), (1996_Fall_TotalN, 1, 32.9) FOR PKN_similarity	2D	☐
CLUSTER	CLUSTER 1996_Fall_P WITH 1996_Fall_K, 1996_Fall_TotalN USING 3 FOR PKZ_cluster	2D	☐
SCAN	SCAN Hugag_counts Total IGNORE 0.0 WITHIN 6 CIRCLE FOR Hugag_density	2D	☐
RENUMBER	RENUMBER Hugag_density ASSIGNING 0 TO 0 THRU 32.5 ASSIGNING 1 TO 32.5 THRU 1000 FOR Hugag_highDensity	2D	☐
NOTE	Short Exercise #7 ...***USES AgData.rgs database***	2D	☐
RELATE	RELATE ((1996_Fall_P, 1, 11.0) WITH (1996_Fall_K, 1, 177.0), (1996_Fall_TotalN, 1, 32.9) FOR PKN_similarity	2D	☐
CLUSTER	CLUSTER 1996_Fall_P WITH 1996_Fall_K, 1996_Fall_TotalN USING 3 FOR PKN_cluster3	2D	☐
NOTE	End of script	2D	☐