

Lecture given at the

**WCS Workshop on Land Change Modeling for REDD**

October 25– 29, 2010

Wildlife Conservation Society - Bronx Zoo  
Bronx, New York, USA

Hosted by

Clark Labs and the Wildlife Conservation Society



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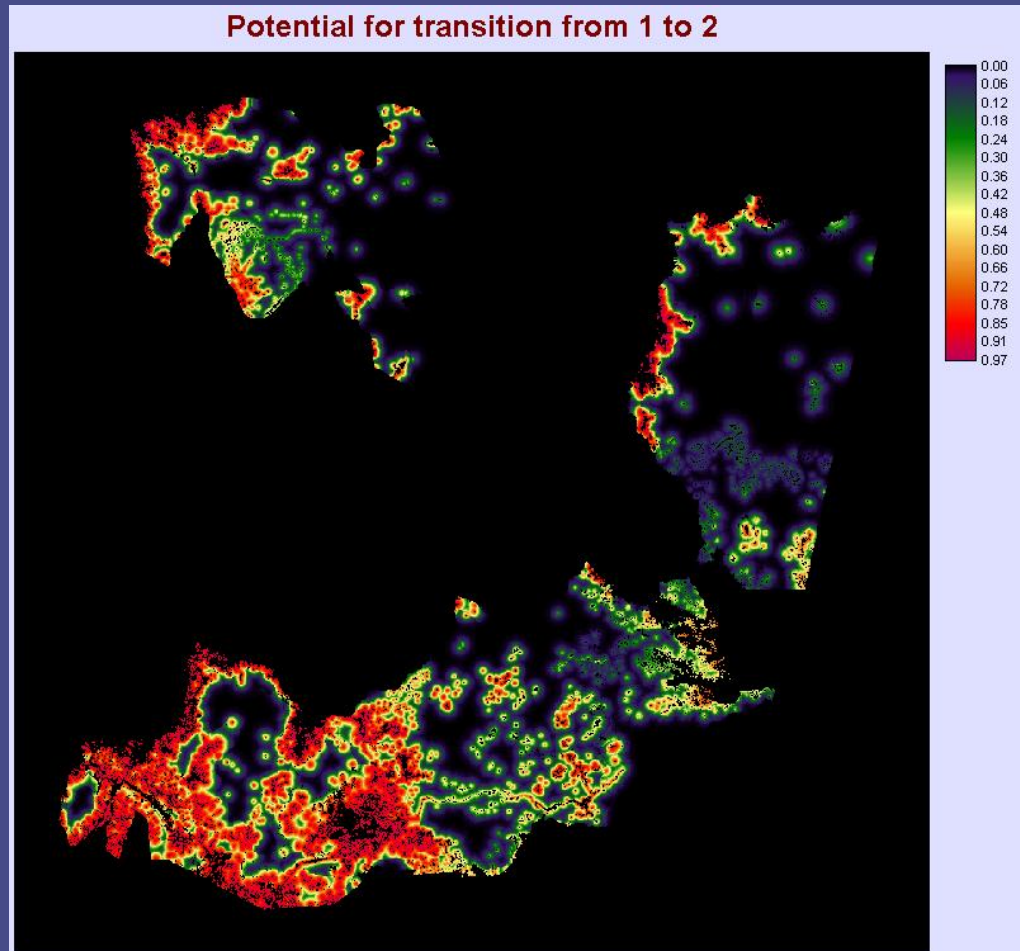
# Taiga



idrisi

# Transition Potential - MLP

## Multi-Layer Perceptron



# Weights

```

Help - [J:\Aintas\WCS\WCS_workshop_data\results\60m_lcm_98_08_Train_Fores_to_Non_F.bpr]
File Display GIS Analysis Modeling Image Processing Reformat Data Entry Window List Help

1 1 6 3 2 0 3483 3427 5.76055750000000E+0005 7.85035750000000E+0005 1.30517424725980E+0006 1.51079424725980E+0006
uta=48n
m
unspecified
1 0000000000000000E+0000
1 66245257327274E+0000 -6.48929122429286E+0000 7.75683912412537E+0000 -4.29923776146285E+0000 1.09548878831332E+0001 -4.62521699124489E+0000 8.35565248271450E-0002
-2.02621643785582E+0001 -1.79149266446407E+0000 -8.28166572096600E+0000 5.6609459372865E+0000 -5.55160764435700E+0000 4.09914508769791E+0000 6.37097109574825E-0002
-1.89979974798146E+0000 -5.19267427171484E+0000 9.30103087230070E+0000 4.90660366128623E+0000 3.84429451174879E+0000 1.56010573517401E+0000 -2.02832797891460E-0001
9.00294225026890E+0000 9.69382410908414E+0000 -1.11130157158827E+0001 1.21758311172016E-0001
-9.04746716506729E+0000 -9.73753398443358E+0000 1.11372464724797E+0001 -1.06624528183601E-0001
9922 9923 6 2 3 5.00000000000000E-0004 5.00000000000000E-0001 1.00000000000000E+0000

No. of training sample :5000 X 2 = 9922
No. of testing sample :5000 X 2 = 9923
No. of input layer node :6
No. of output layer node:2
No. of hidden layer :1
No. of hidden layer 1 node :3
Learning rate : 0.00
Momentum factor : 0.50
Sigmoid fuction constant a : 1.00000000000000E+0000
Acceptable RMS : 0.0100

Terminate epoch :10000
Training RMS : 0.3572
Testing RMS : 0.3606
Accuracy rate :81.97%

Band image 1 : J:\Aintas\WCS\WCS_workshop_data\input_raster\60m_distance_nonforest1998.rst
Band image 2 : J:\Aintas\WCS\WCS_workshop_data\input_raster\60m_el_sci_l_98_08.rst
Band image 3 : J:\Aintas\WCS\WCS_workshop_data\input_raster\60m_distance_villages.rst
Band image 4 : J:\Aintas\WCS\WCS_workshop_data\input_raster\60m_distance_roads1998.rst
Band image 5 : J:\Aintas\WCS\WCS_workshop_data\input_raster\60m_elevation.rst
Band image 6 : J:\Aintas\WCS\WCS_workshop_data\input_raster\60m_slope.rst

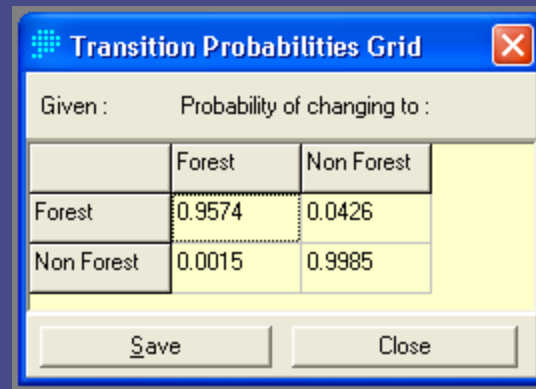
Training Sites File : J:\Aintas\WCS\WCS_workshop_data\results\60m_lcm_98_08_Train_Fores_to_Non_F.rst

cursor position: 1,1

Logisticreg : Pass 5 of 6, 88%
  
```

# Transition Probabilities

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A screenshot of a software dialog box titled "Transition Probabilities Grid". The dialog box has a blue header bar with a grid icon on the left and a red close button on the right. Below the header, there are two labels: "Given :" and "Probability of changing to :". The main area contains a 2x2 table with "Forest" and "Non Forest" as both rows and columns. The table cells contain the following values: Forest to Forest is 0.9574, Forest to Non Forest is 0.0426, Non Forest to Forest is 0.0015, and Non Forest to Non Forest is 0.9985. At the bottom of the dialog box, there are two buttons: "Save" and "Close".

Given :	Forest	Non Forest
Forest	0.9574	0.0426
Non Forest	0.0015	0.9985

Buttons: Save, Close

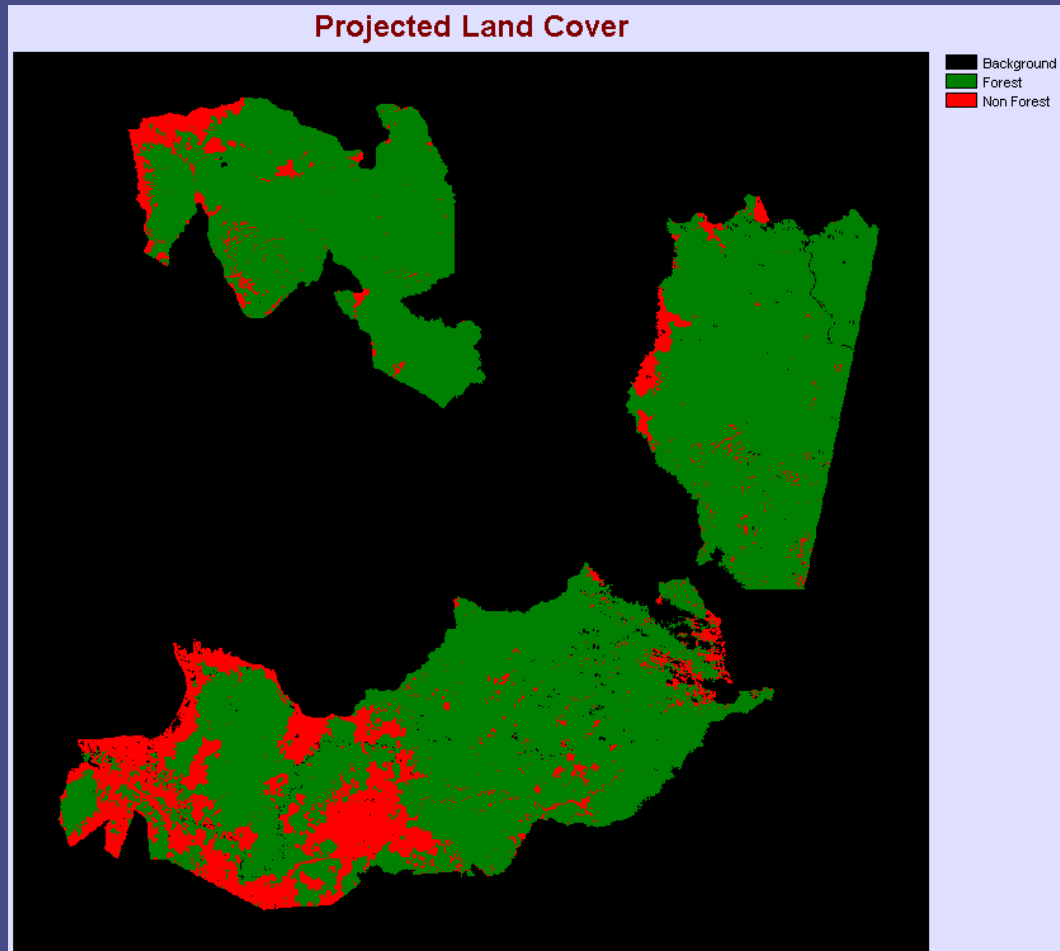
# Quantity of change

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Probability of change	Value	Unit
Forest2002-NonForest2008	301,391	cells
Forest2002	3,299,668	cells
Transition potential to validate 2002 and 2008		
Persistence of Forest	0.9087	
Change to NonForest	0.0913	

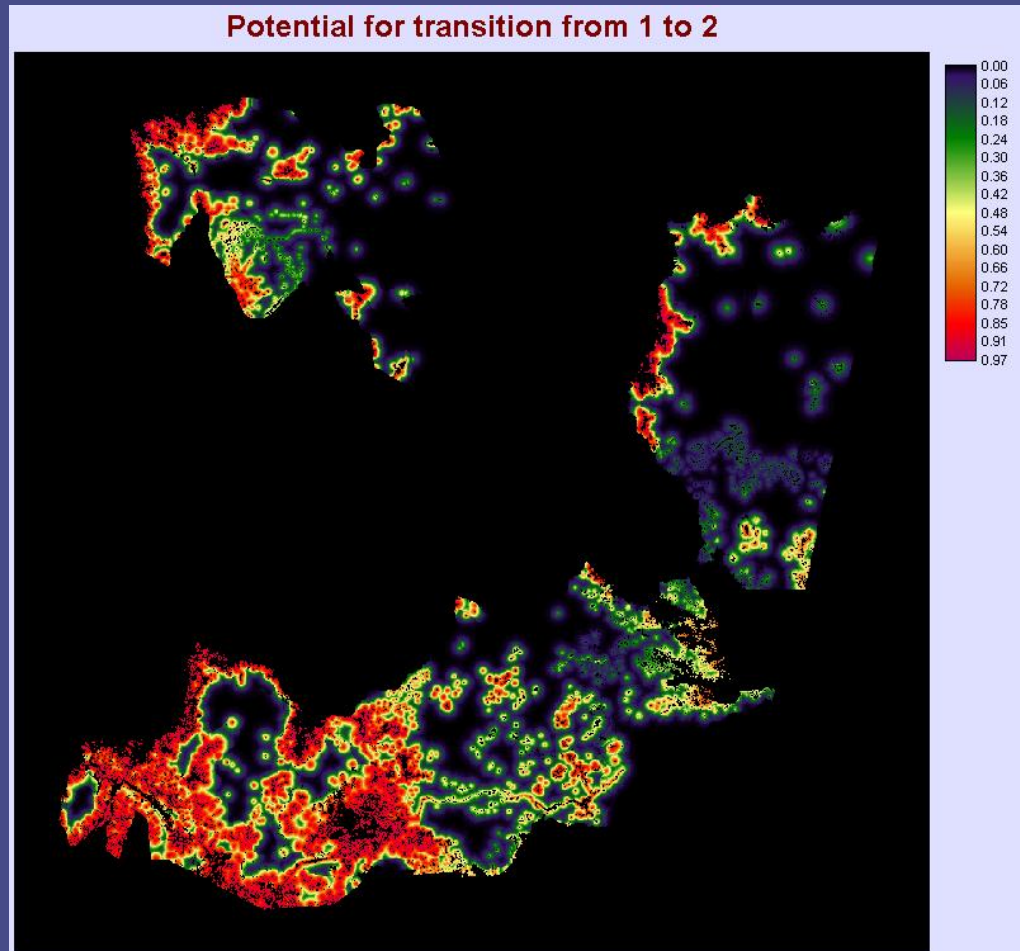
# Prediction - Hard

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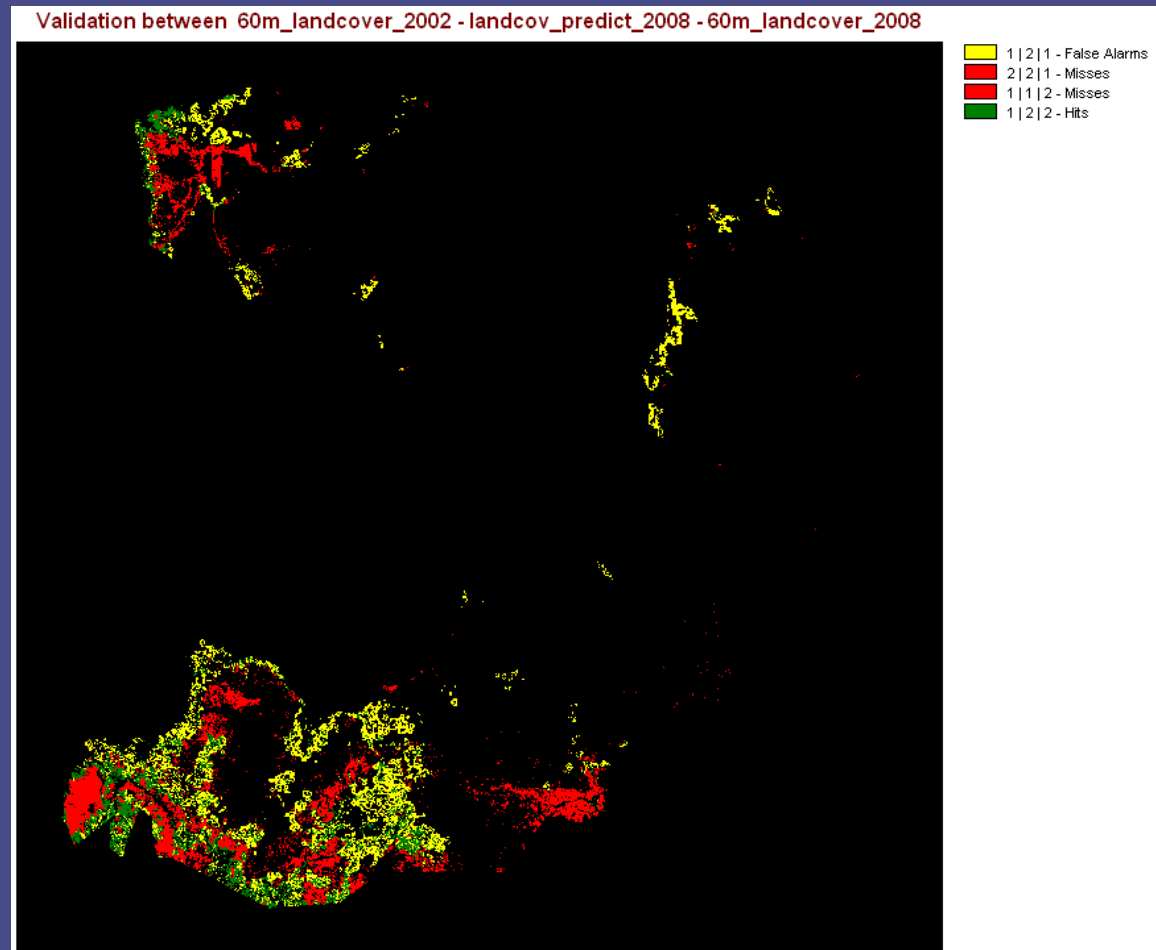
# Prediction - Soft

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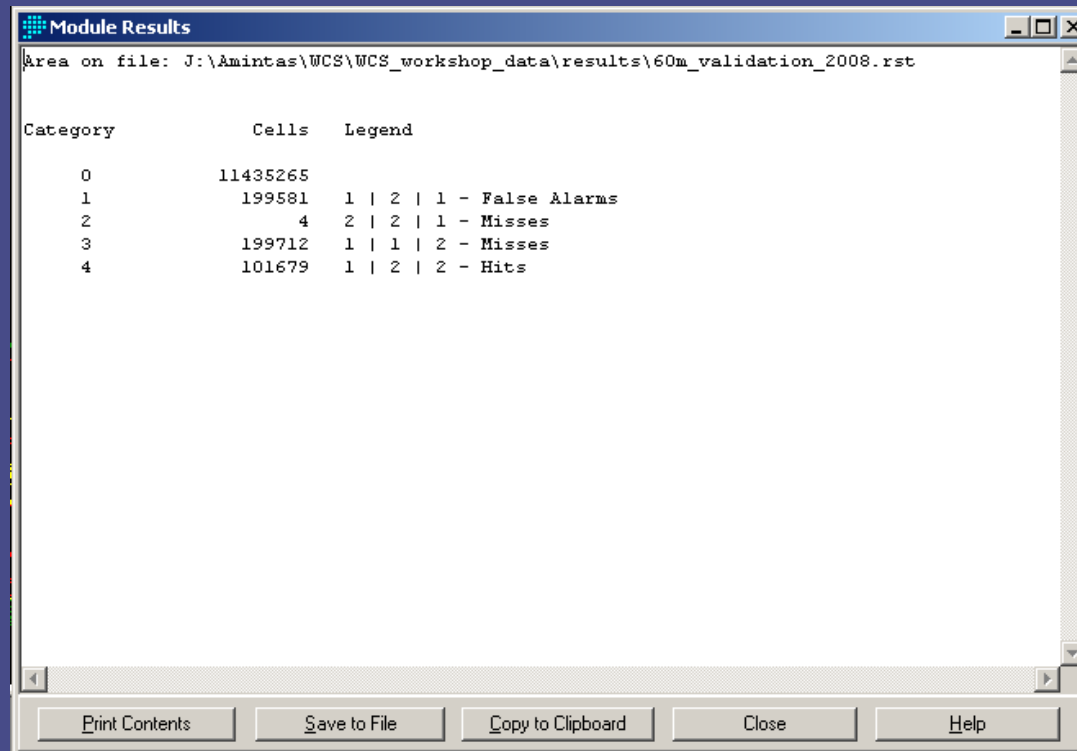




# Validation - Crosstabulation



# Validation – Area



Module Results

Area on file: J:\Amintas\WCS\WCS\_workshop\_data\results\60m\_validation\_2008.rst

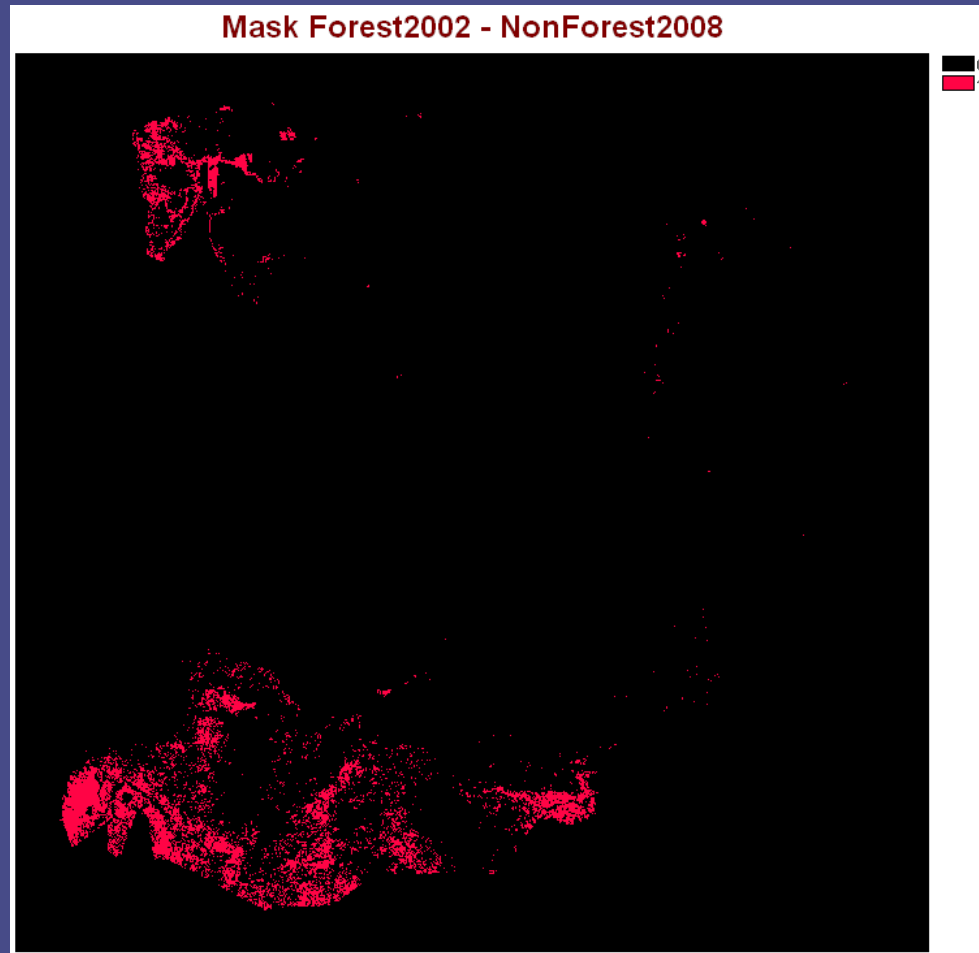
Category	Cells	Legend
0	11435265	
1	199581	1   2   1 - False Alarms
2	4	2   2   1 - Misses
3	199712	1   1   2 - Misses
4	101679	1   2   2 - Hits

Print Contents   Save to File   Copy to Clipboard   Close   Help

# Validation – Histogram

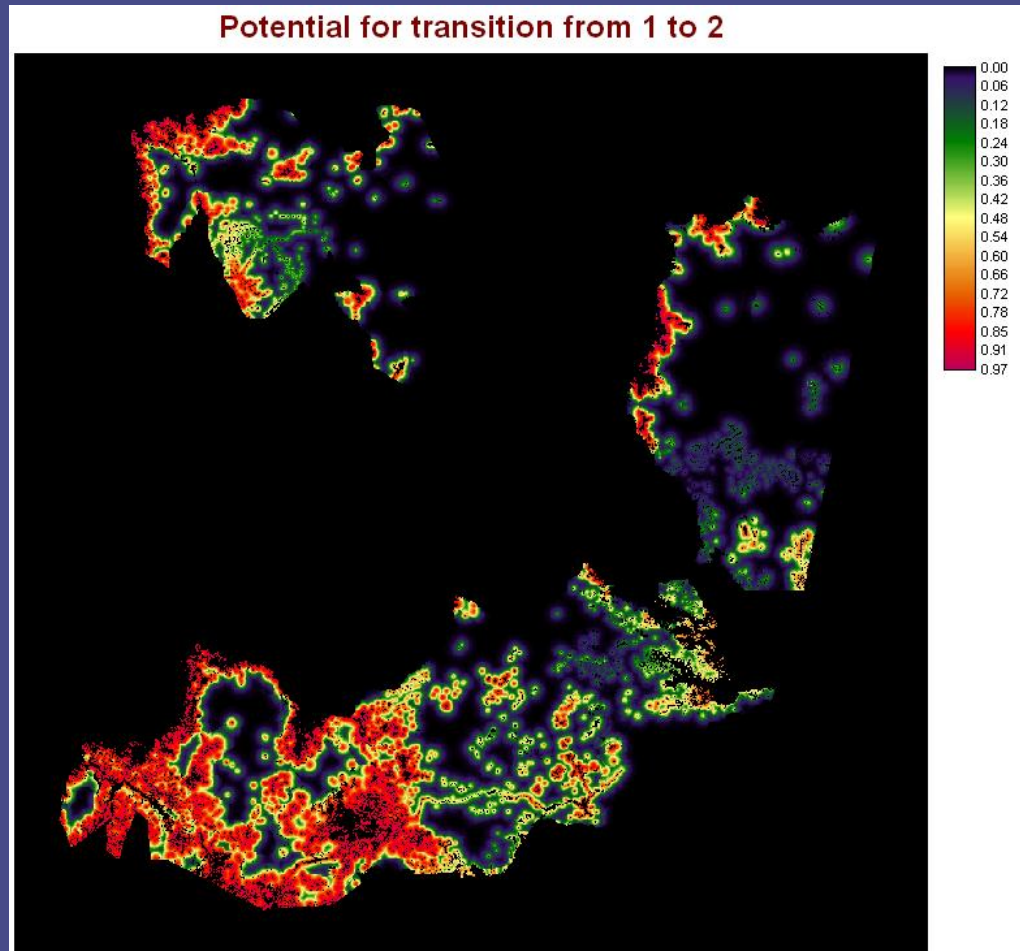
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Forest 2002 – Non Forest 2008



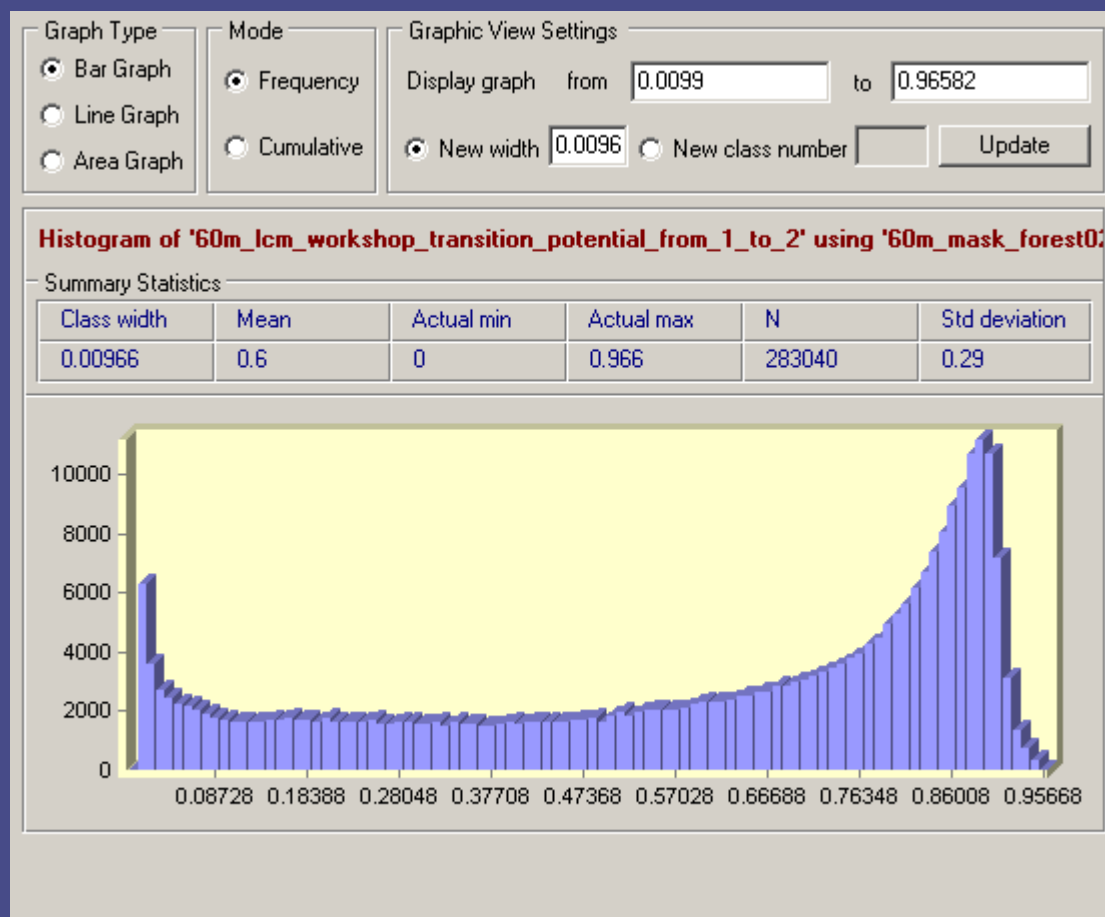
# Validation – Histogram

## Transition Potential 2002



# Validation – Histogram

## Forest 2002 – Non Forest 2008 vs. Transition Potential



# Validation – Histogram

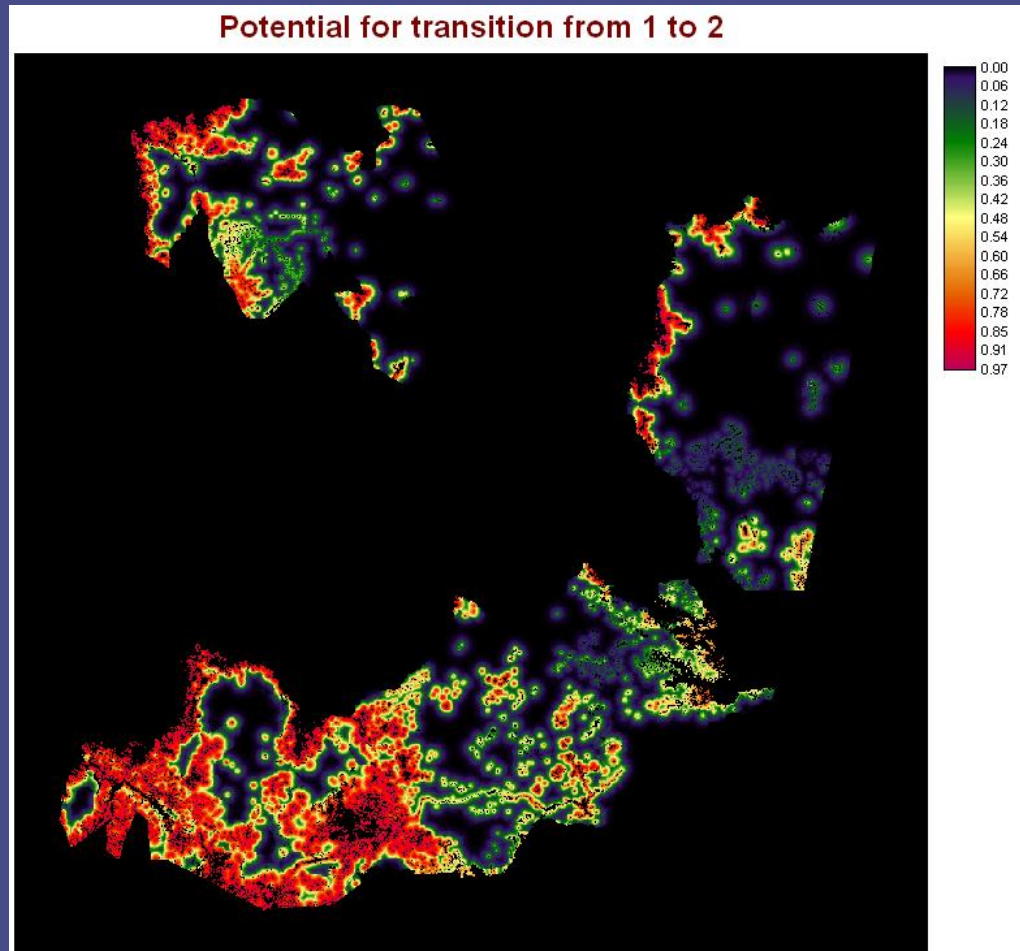
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Persistence 2002 – 2008



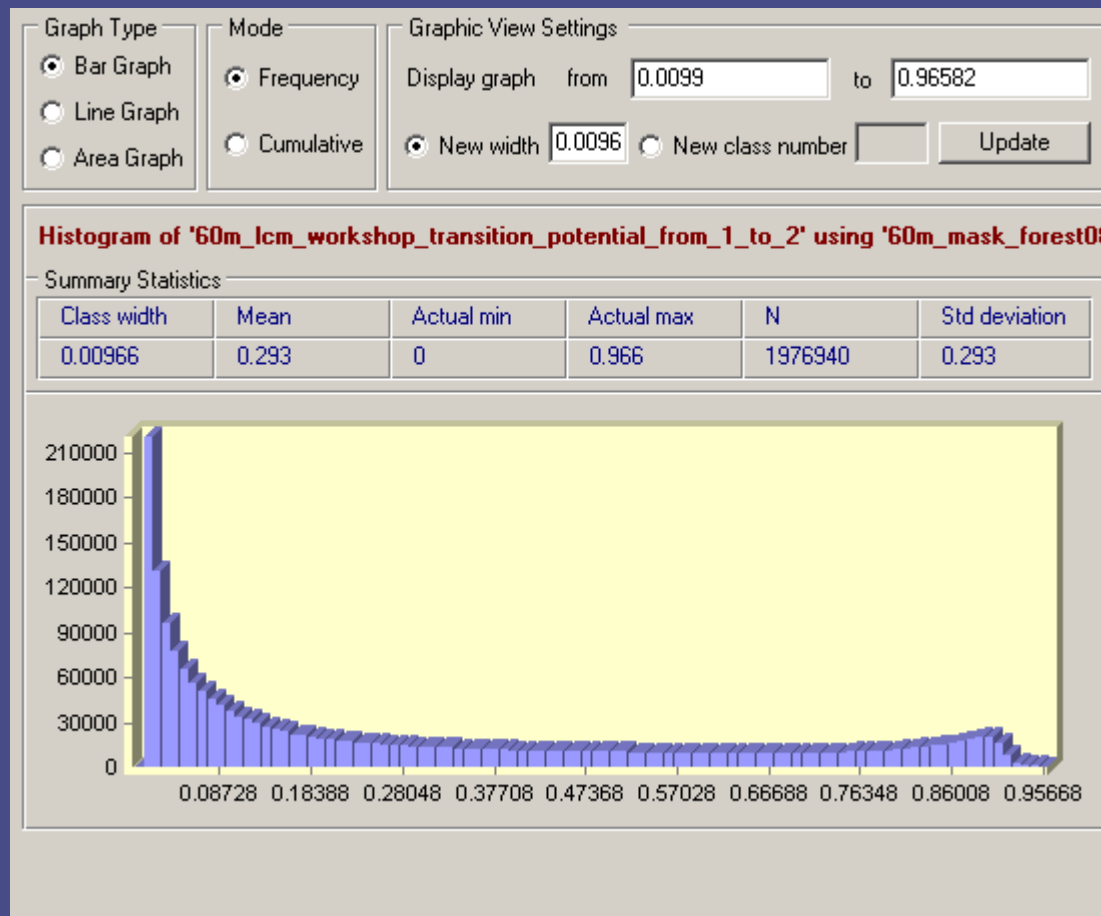
# Validation – Histogram

## Transition Potential 2002



# Validation – Histogram

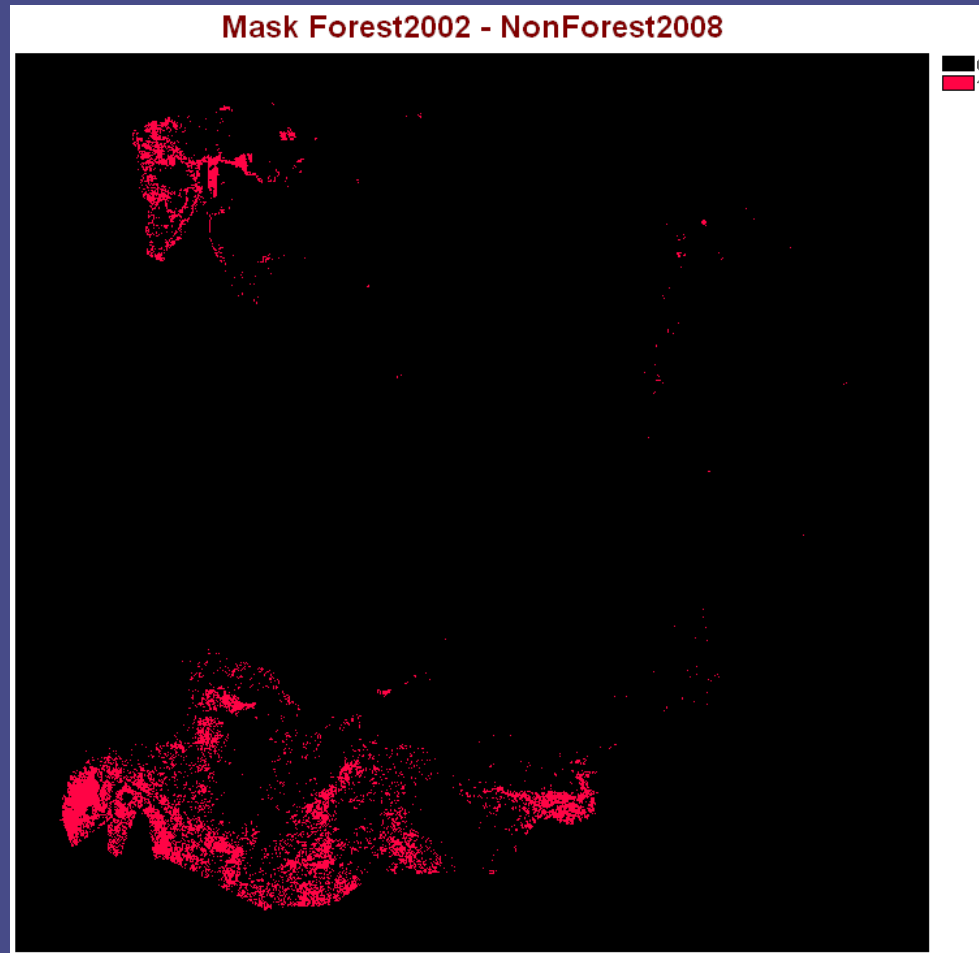
## Persistence 2002 – 2008 vs. Transition Potential





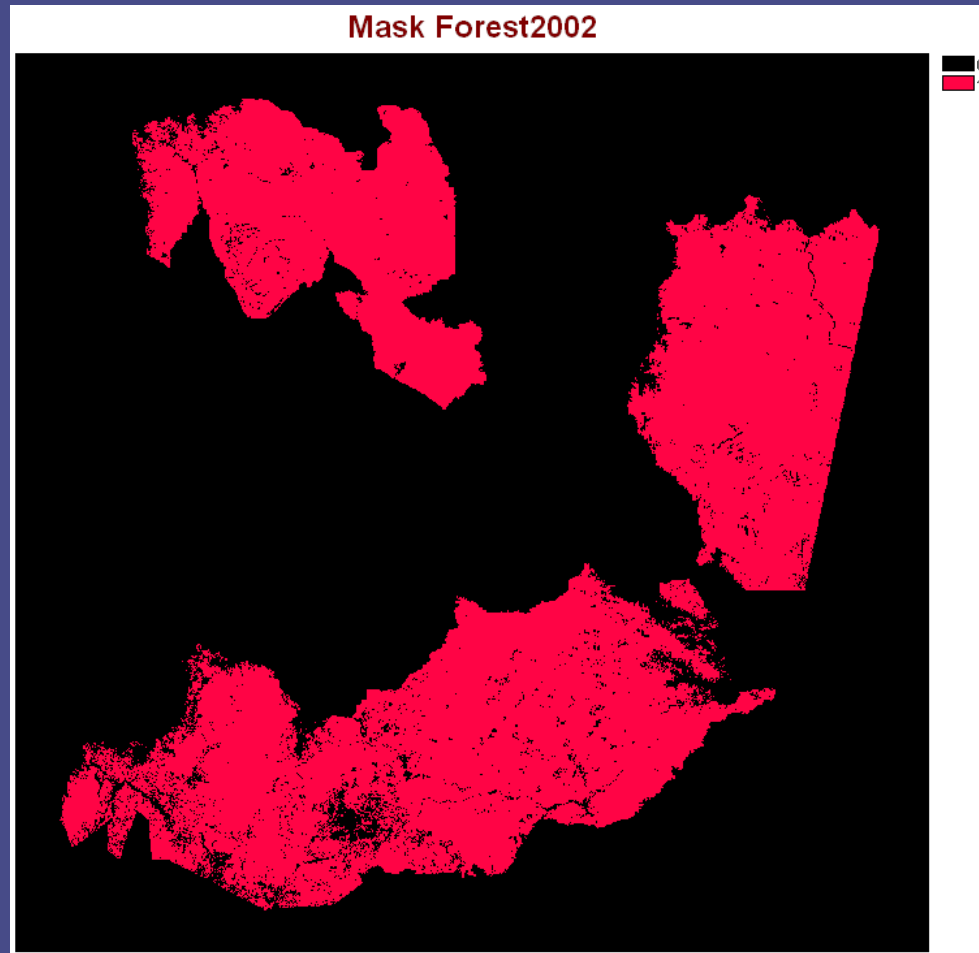
# ROC – Relative Operating Characteristic

Forest 2002 – Non Forest 2008



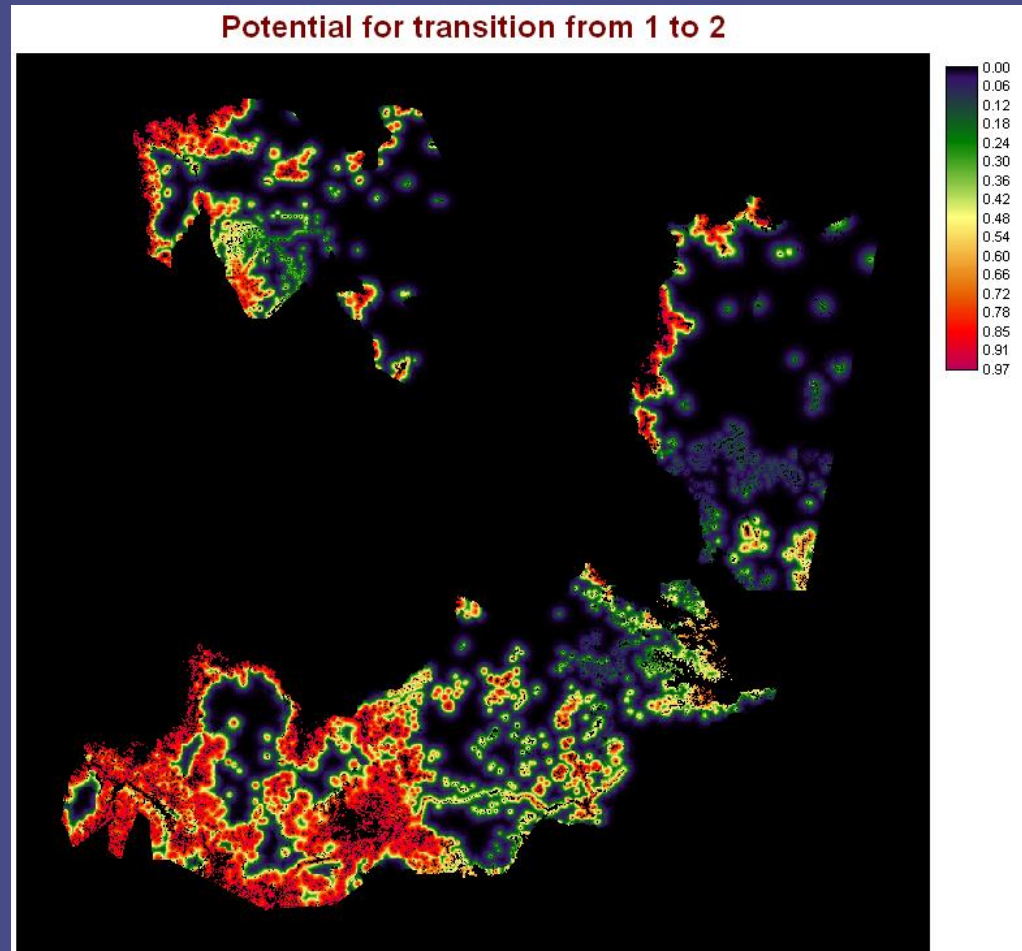
# ROC – Relative Operating Characteristic

Forest 2002

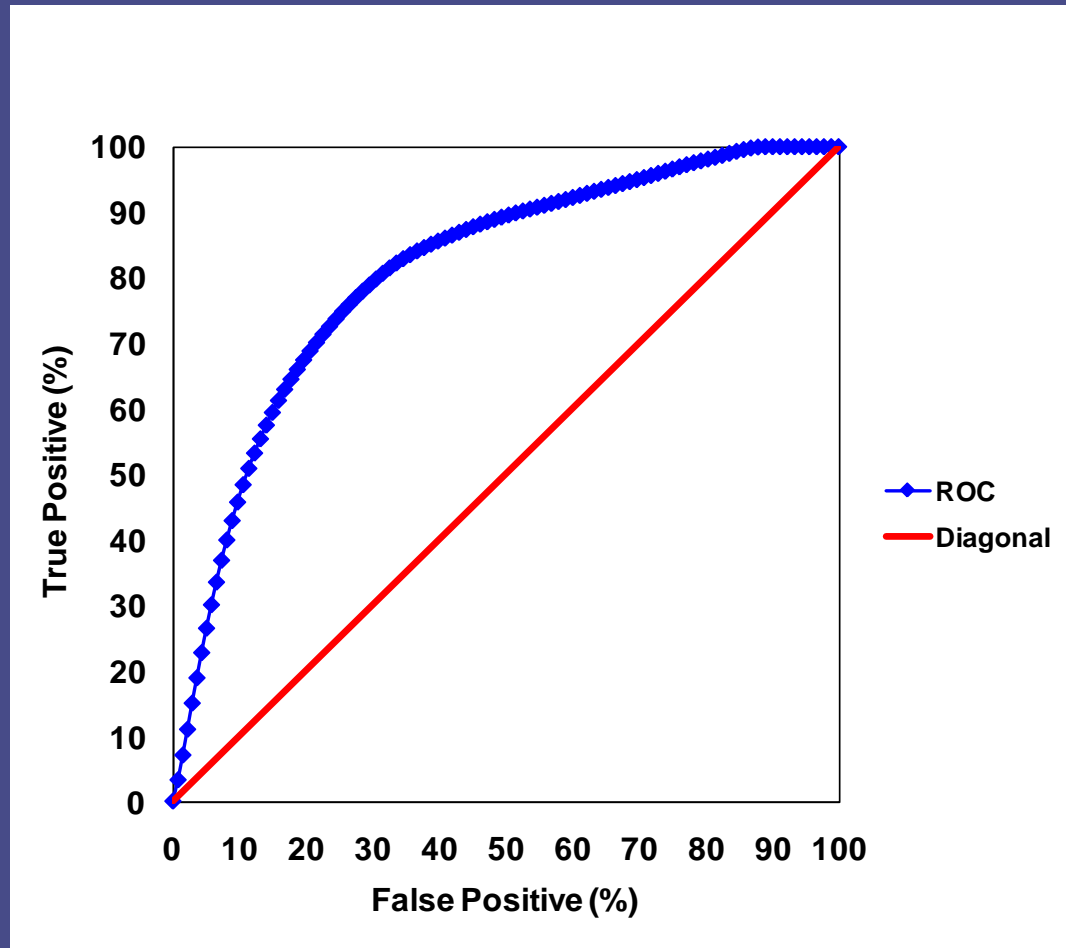


# ROC – Relative Operating Characteristic

Transition Potential 2002



# ROC – Relative Operating Characteristic



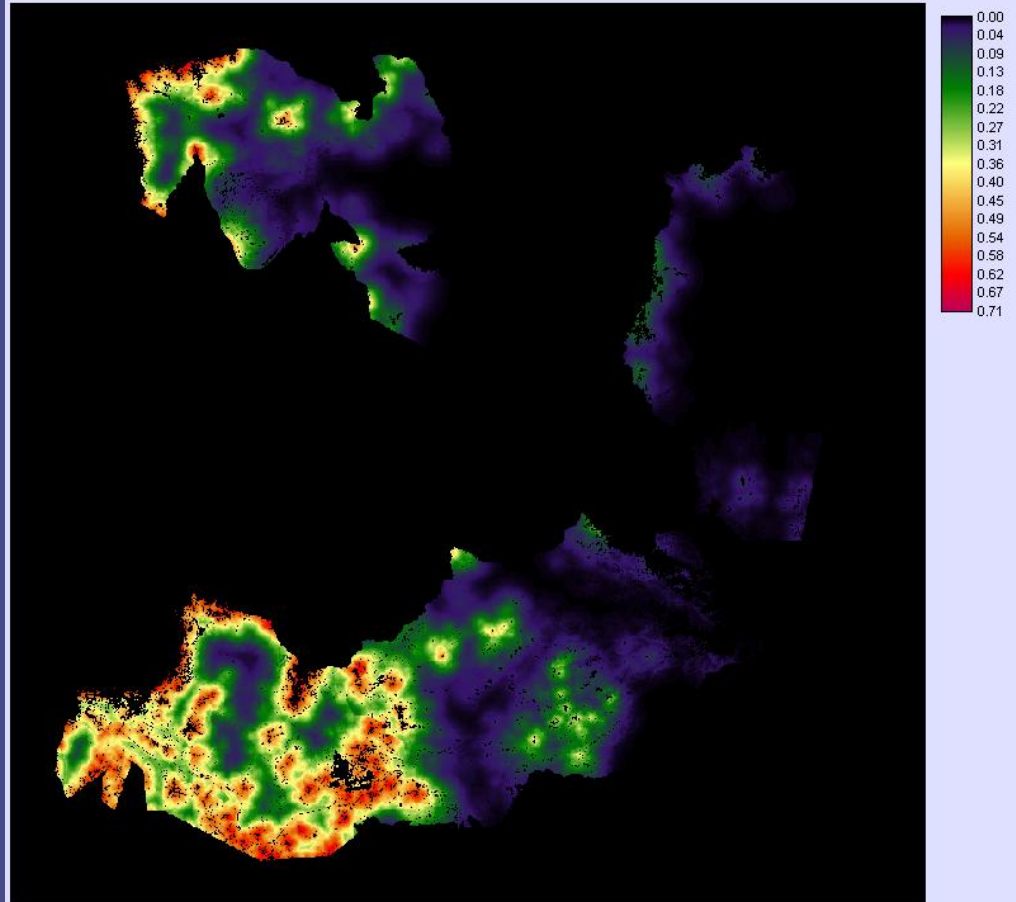
*AUC – Area Under the Curve*

IDRISI Taiga

# Transition Potential - LR

## Logistic Regression

Predicted Image of 60m\_lcm\_98\_08\_lr\_Train\_Fores\_to\_Non F



# Weights

**Logistic Regression Results**

Regression Equation :

$$\text{logit}(60a\_m0\_02\_lr\_Train\_Forest\_to\_Non F) = -1.4634 - 0.001516460a\_distance\_nonforest1998 + 1.471295460a\_m1\_m01\_98\_02 - 0.000175460a\_distance\_villages + 0.000001460a\_distance\_roads1998 - 0.003916460a\_elevation - 0.002743646a\_slope$$

Individual Regression Coefficient

Variables	Coefficient
Intercept	-1.46343067
60a\_distance\_nonforest1998	-0.00151642
60a\_m1\_m01\_98\_02	1.47129495
60a\_distance\_villages	-0.00017544
60a\_distance\_roads1998	0.00000064
60a\_elevation	-0.00391633
60a\_slope	-0.00274320

Regression Statistics :

Number of total observations	= 3396535
Number of 0s in study area	= 3299461
Number of 1s in study area	= 97054
Percentage of 0s in study area	= 97.1626
Percentage of 1s in study area	= 2.8374
Number of auto-sampled observations	= 321353
Number of 0s in sampled area	= 321014
Number of 1s in sampled area	= 3339
Percentage of 0s in sampled area	= 97.1081
Percentage of 1s in sampled area	= 2.8919

~log(0)  
~log(Likelihood)  
Pseudo R square  
Goodness of Fit  
ChiSquare( 6 )

-2ln(0)	= 84952.6622
-2ln(Likelihood)	= 62565.8016
Pseudo R square	= 0.2582
Goodness of Fit	= 362872403241.0370
ChiSquare( 6 )	= 21787.6666

Mean and Standard Deviations

	Mean	Standard Deviation
60a\_distance\_nonforest19981998	479849	2457.643144
60a\_m1\_m01\_98\_02	0.58892	0.182803
60a\_distance\_villages	8852.158222	4368.001331
60a\_distance\_roads1998	11919.099109	42704.899101
60a\_elevation	345.22159	189.177496
60a\_slope	3.317468	3.190539
60a\_m0\_02\_lr\_Train_F00	0.228999	0.147895

Classification of cases & odds ratio

Observed	Fitted_0	Fitted_1	Percent Correct
0	312034	0	100.0000
1	9129	0	0.0000

Odds Ratio = Not Applicable

Reclassification of cases & ROC (Sample-based computation when applicable):

(1) Select a new threshold value such that, after reclassification, the number of fitted is matches the number of observed is in the dependent variable

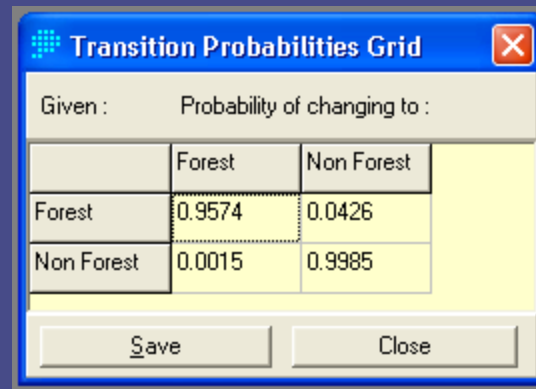
New cutting threshold = 0.1883

Classification of cases & odds ratio by using the new threshold

Observed	Fitted_0	Fitted_1	Percent Correct
0	305372	7563	97.5832
1	6662	1756	20.8661

# Transition Probabilities

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A screenshot of a software dialog box titled "Transition Probabilities Grid". The dialog box has a blue title bar with a close button (red X) on the right. Below the title bar, there are two labels: "Given :" and "Probability of changing to :". Below these labels is a table with two columns and two rows. The columns are labeled "Forest" and "Non Forest". The rows are labeled "Forest" and "Non Forest". The table contains the following values: Forest to Forest is 0.9574, Forest to Non Forest is 0.0426, Non Forest to Forest is 0.0015, and Non Forest to Non Forest is 0.9985. At the bottom of the dialog box, there are two buttons: "Save" and "Close".

	Forest	Non Forest
Forest	0.9574	0.0426
Non Forest	0.0015	0.9985

Save Close

# Quantity of change

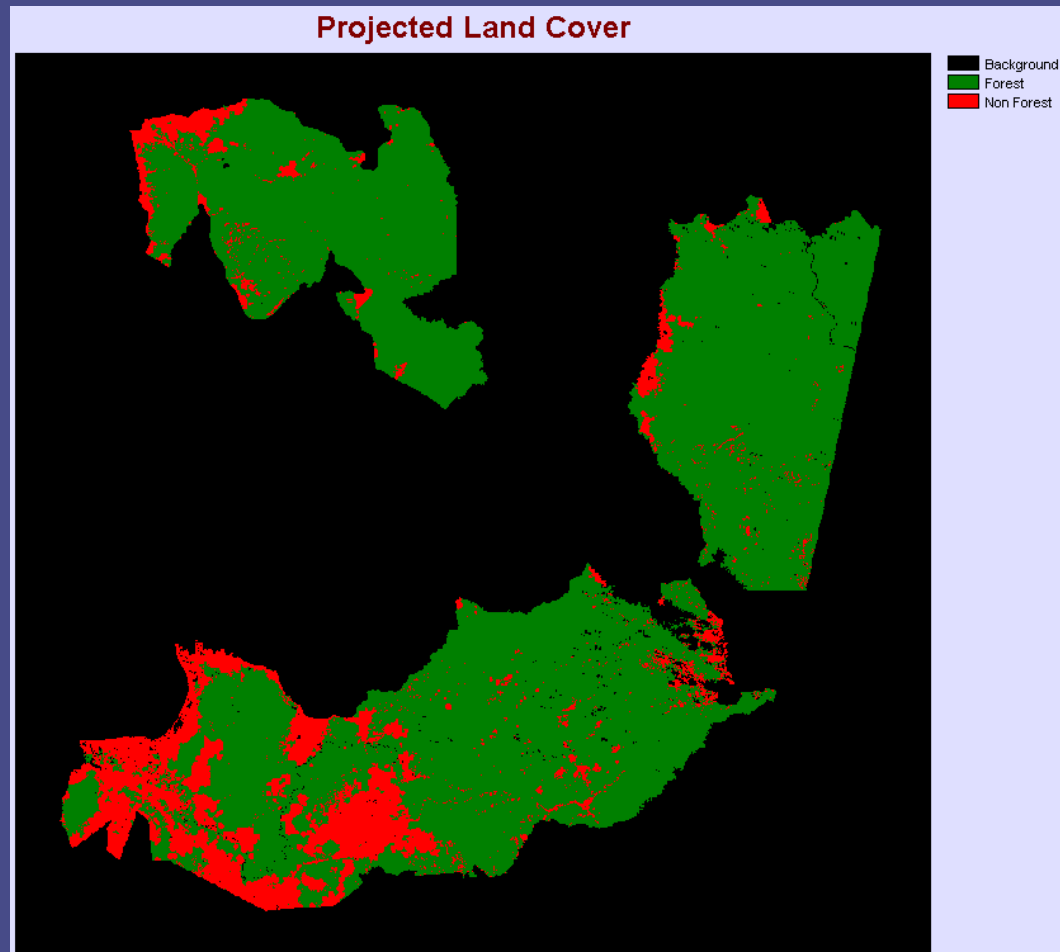
---

Probability of change	Value	Unit
Forest2002-NonForest2008	301,391	cells
Forest2002	3,299,668	cells
Transition potential to validate 2002 and 2008		
Persistence of Forest	0.9087	
Change to NonForest	0.0913	



# Prediction - Hard

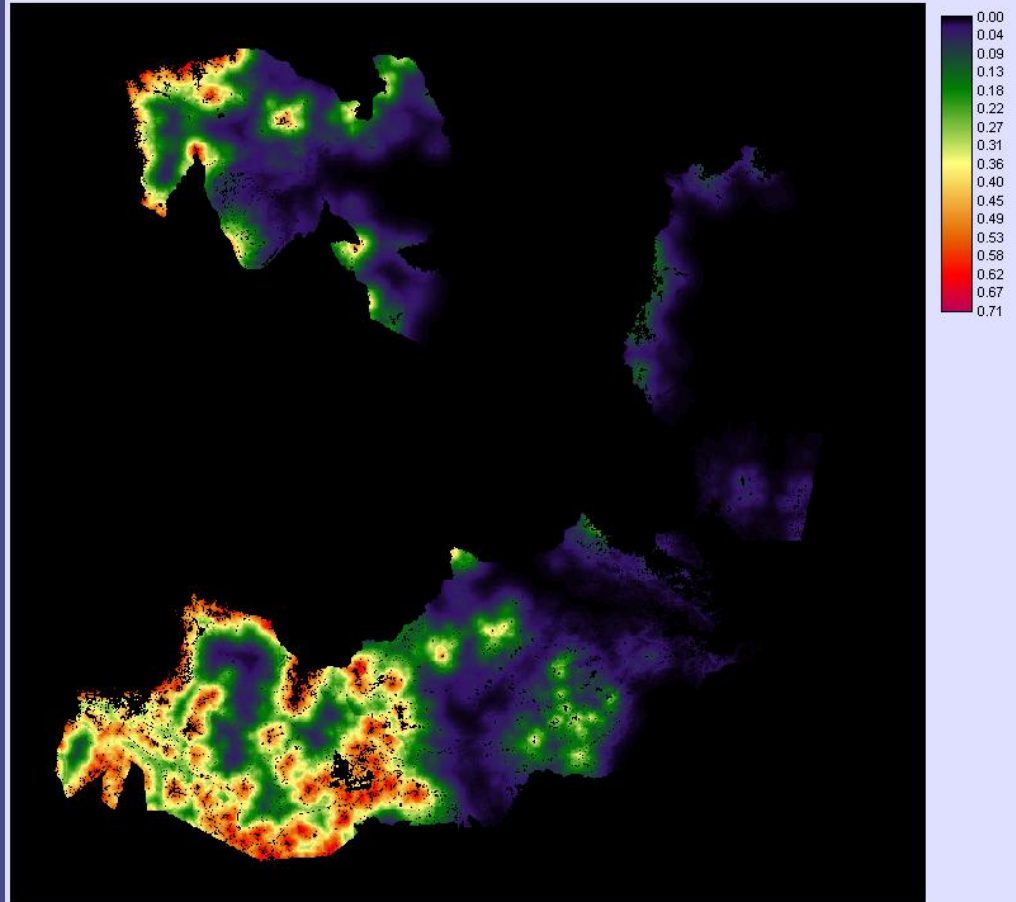
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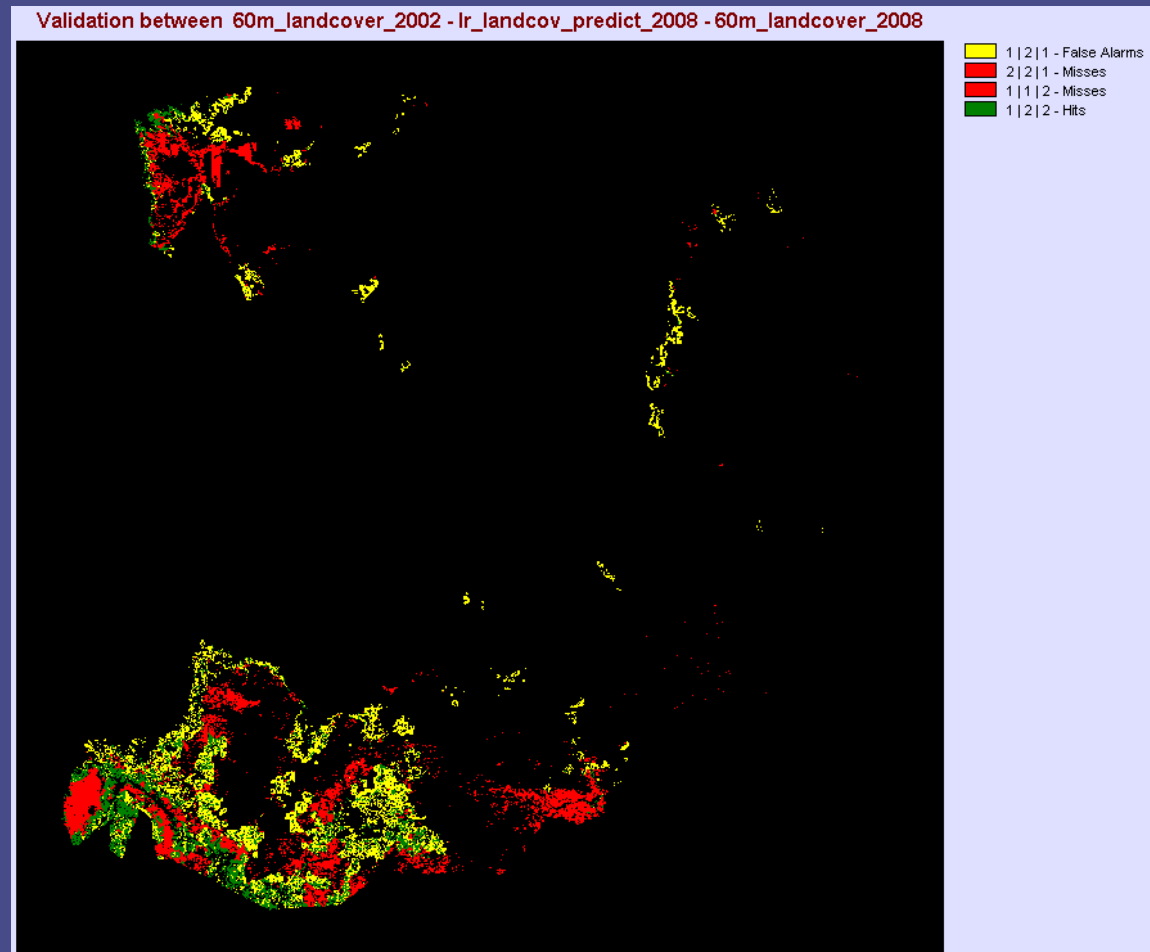
# Prediction - Soft

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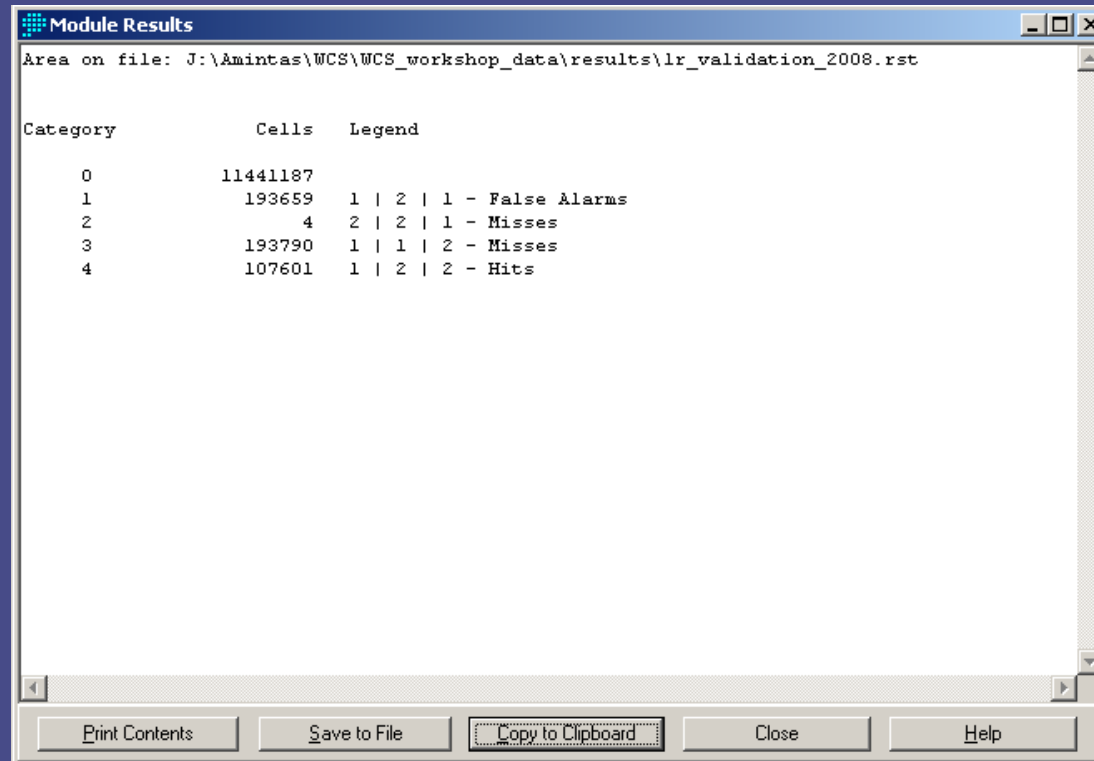
Predicted Image of 60m\_lmc\_98\_08\_lr\_Train\_Fores\_to\_Non F



# Validation - Crosstabulation



# Validation – Area



Module Results

Area on file: J:\Amintas\WCS\WCS\_workshop\_data\results\lr\_validation\_2008.rst

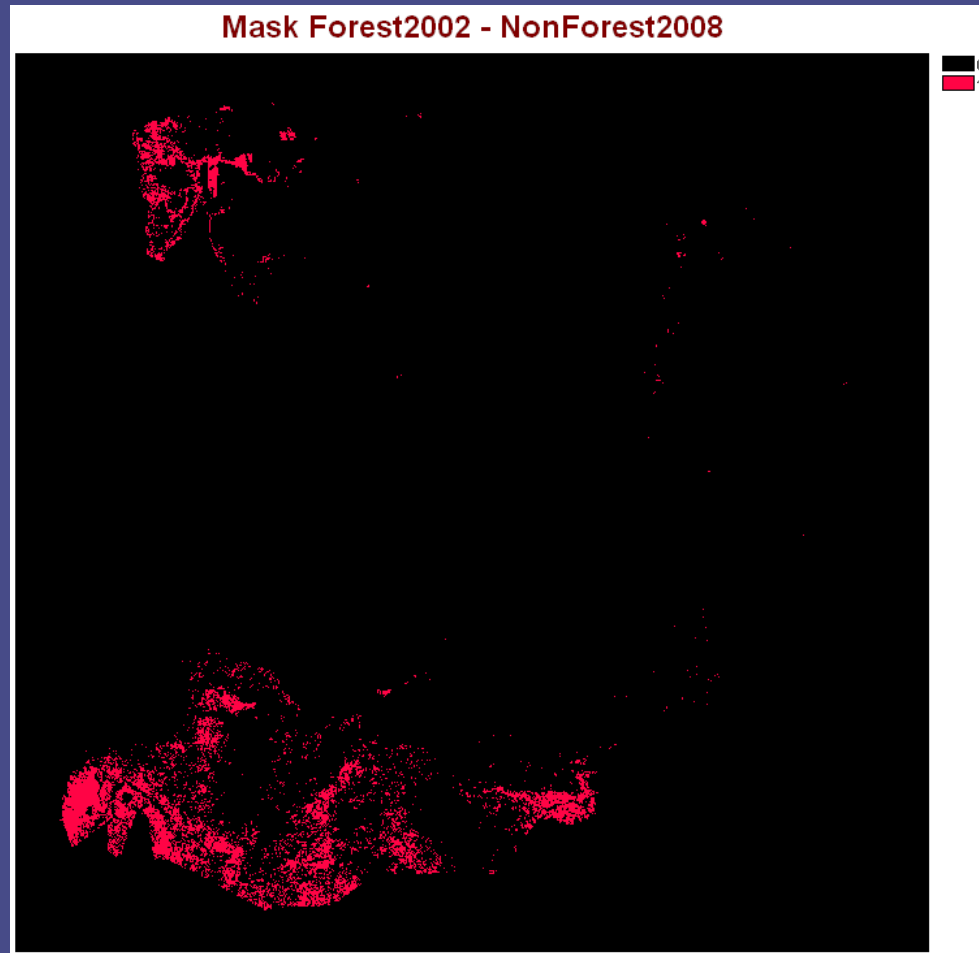
Category	Cells	Legend
0	11441187	
1	193659	1   2   1 - False Alarms
2	4	2   2   1 - Misses
3	193790	1   1   2 - Misses
4	107601	1   2   2 - Hits

Print Contents Save to File Copy to Clipboard Close Help

# Validation – Histogram

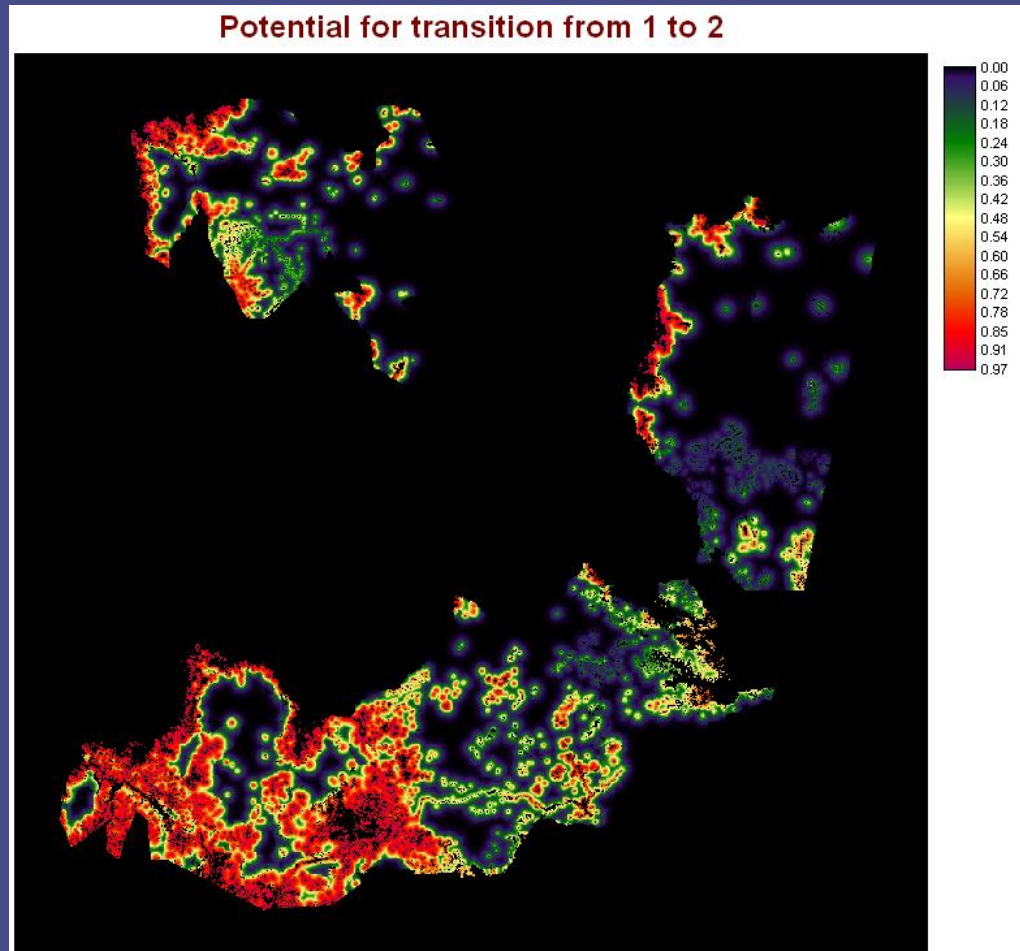
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Forest 2002 – Non Forest 2008



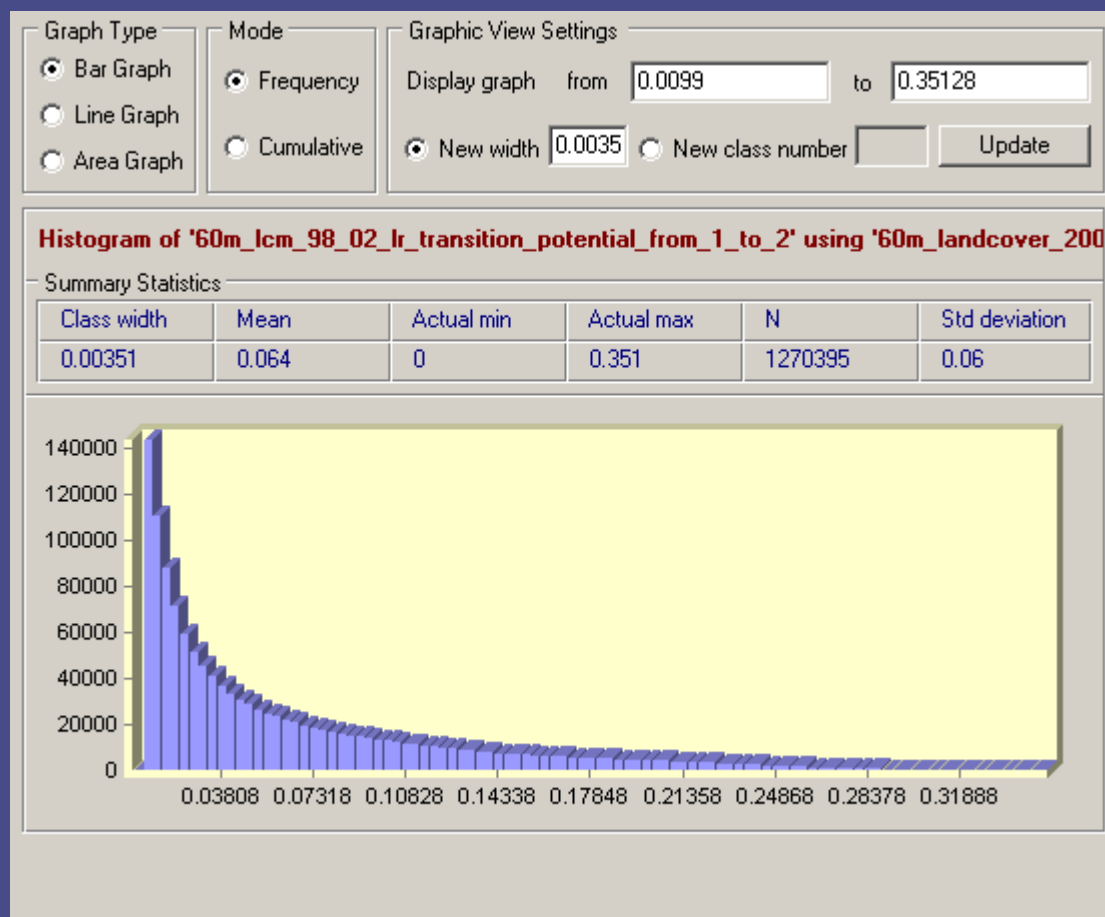
# Validation – Histogram

## Transition Potential 2002



# Validation – Histogram

## Forest 2002 – Non Forest 2008 vs. Transition Potential



# Validation – Histogram

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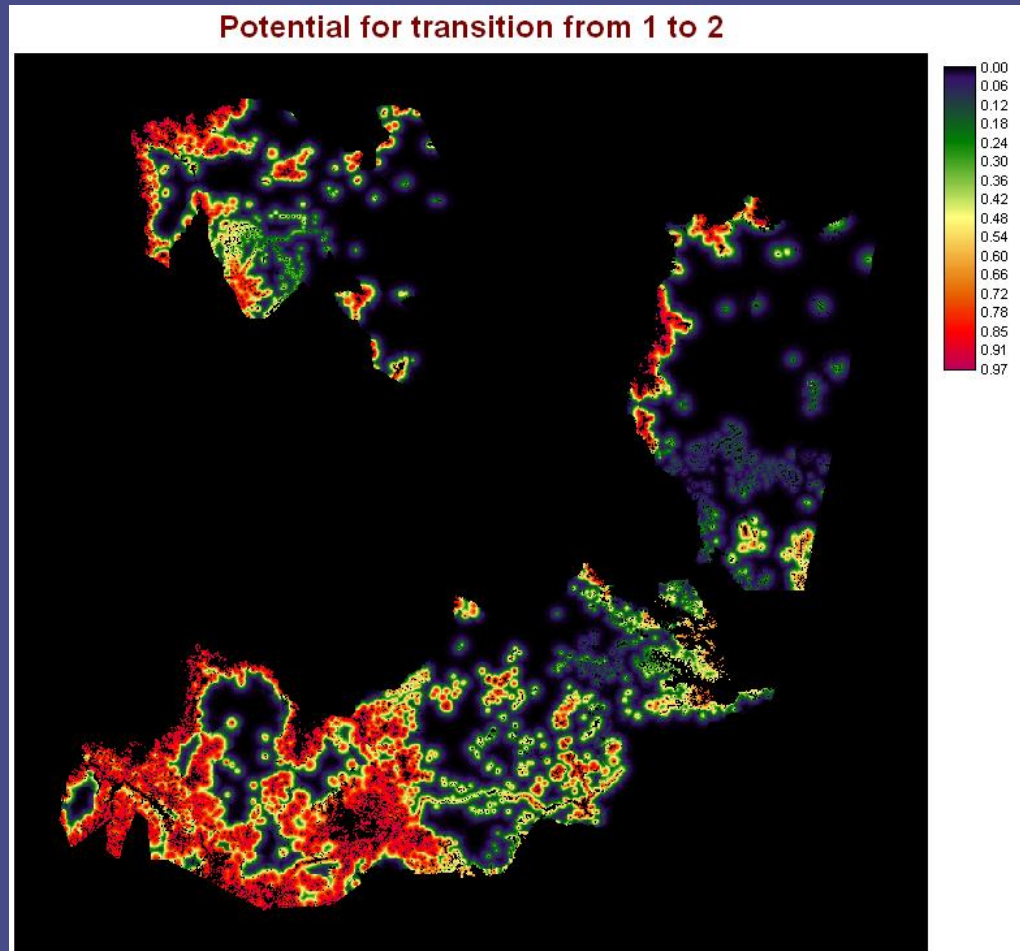
Persistence 2002 – 2008





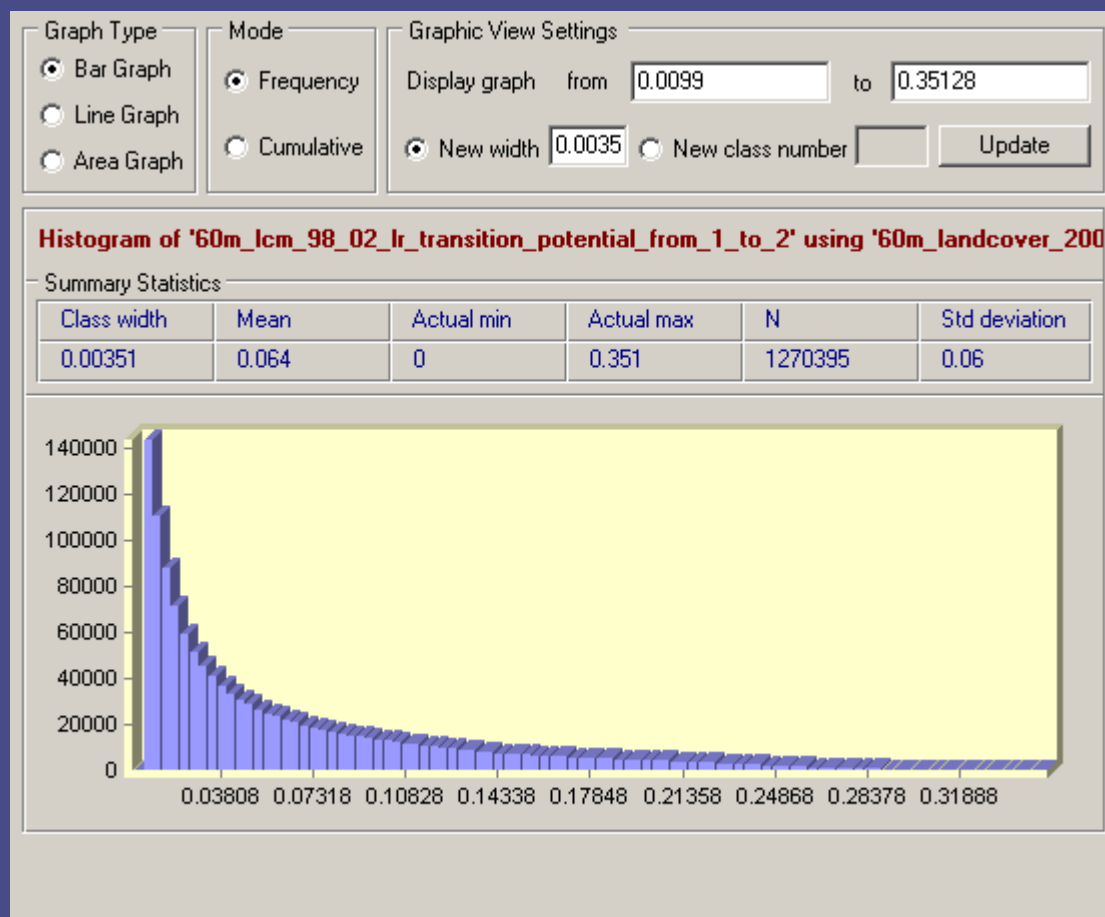
# Validation – Histogram

## Transition Potential 2002



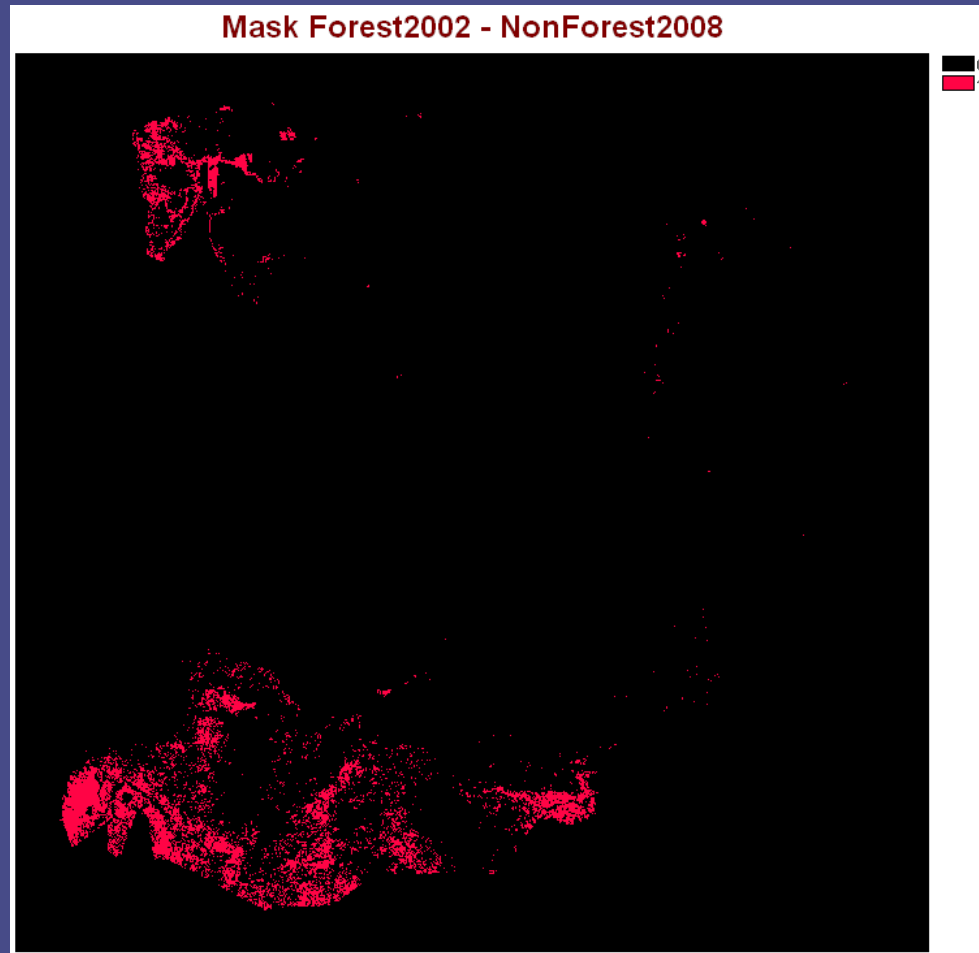
# Validation – Histogram

## Persistence 2002 – 2008 vs. Transition Potential



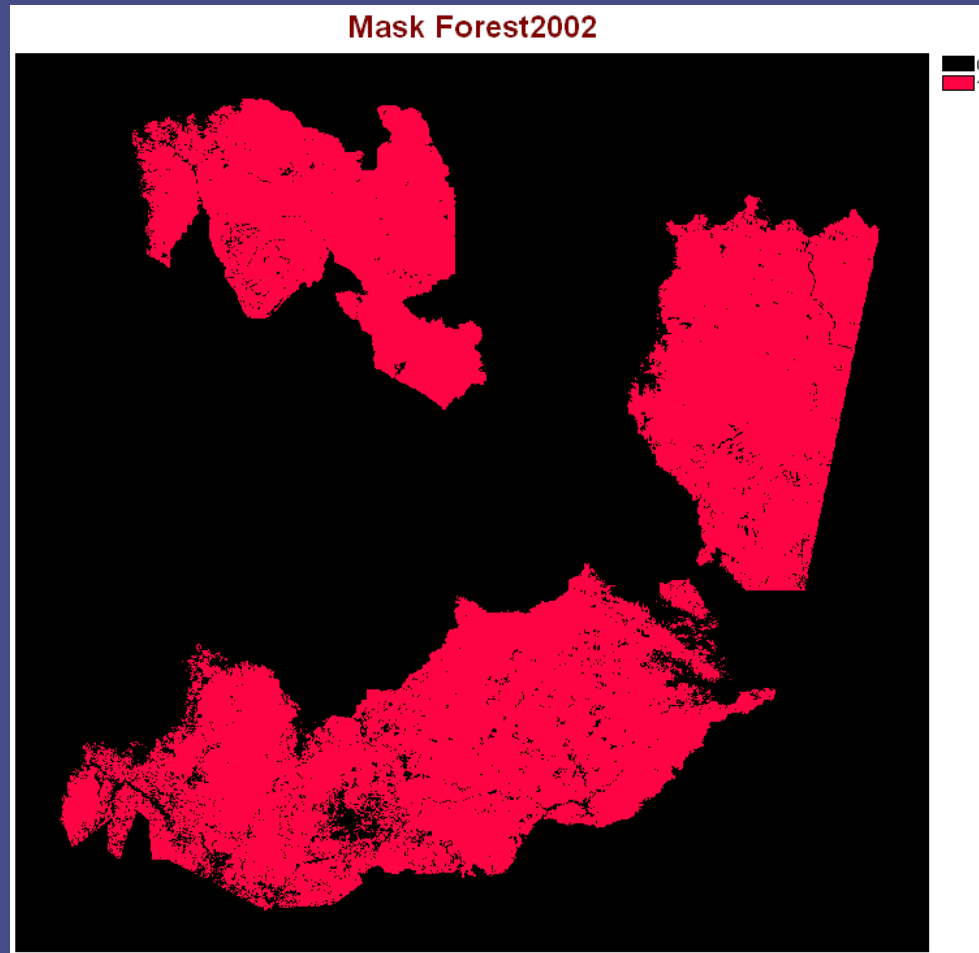
# ROC – Relative Operating Characteristic

Forest 2002 – Non Forest 2008



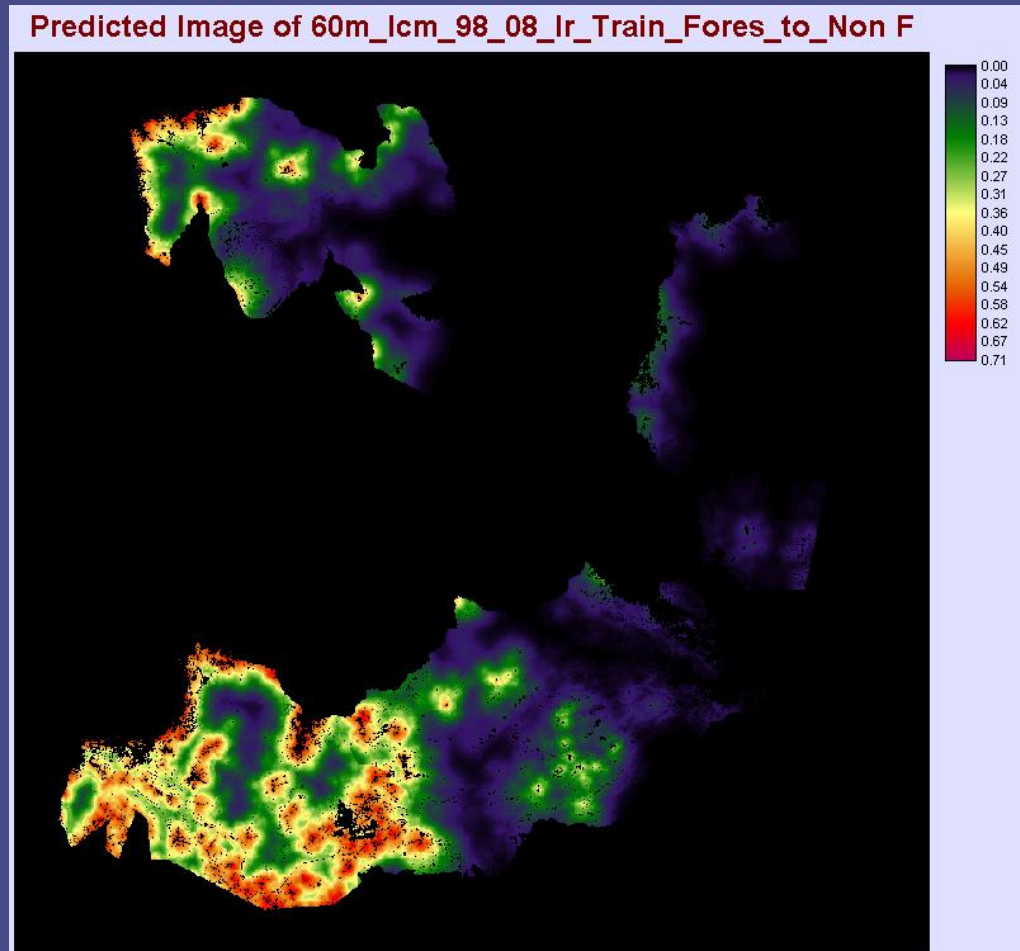
# ROC – Relative Operating Characteristic

Forest 2002

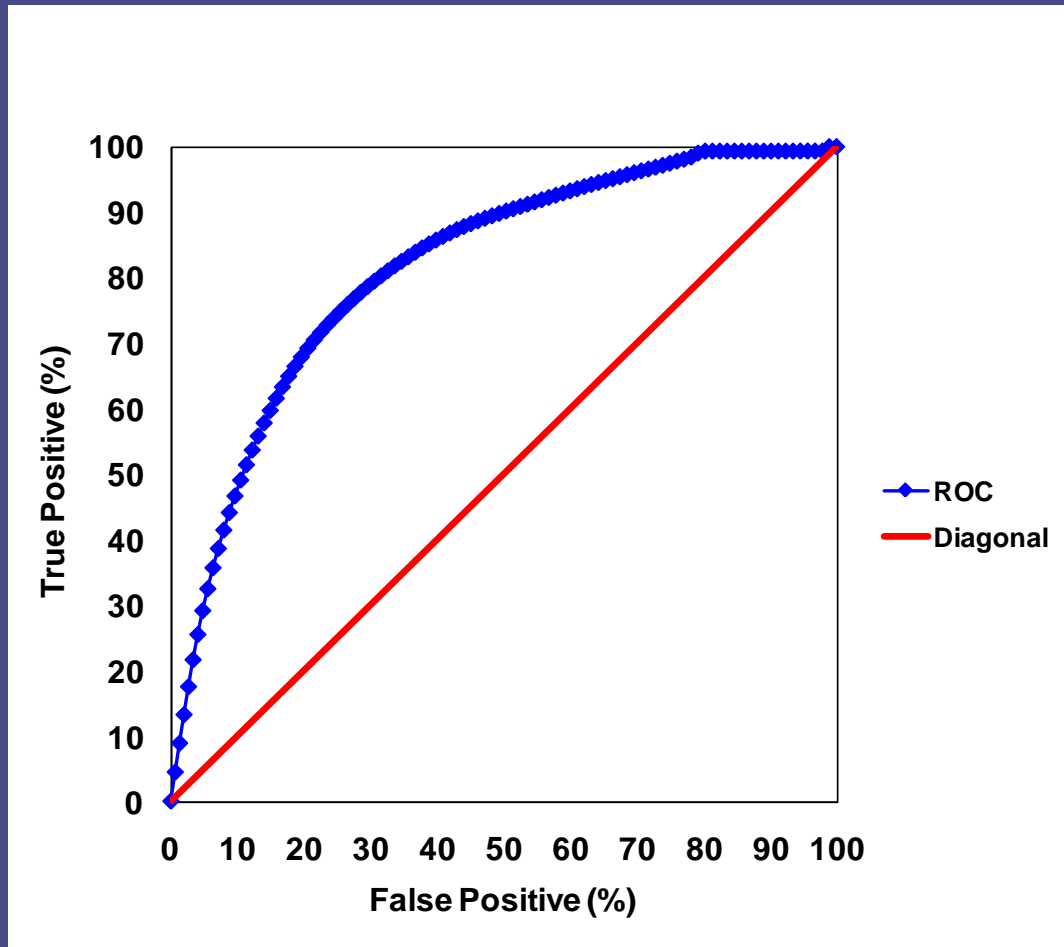


# ROC – Relative Operating Characteristic

Transition Potential 2002



# ROC – Relative Operating Characteristic



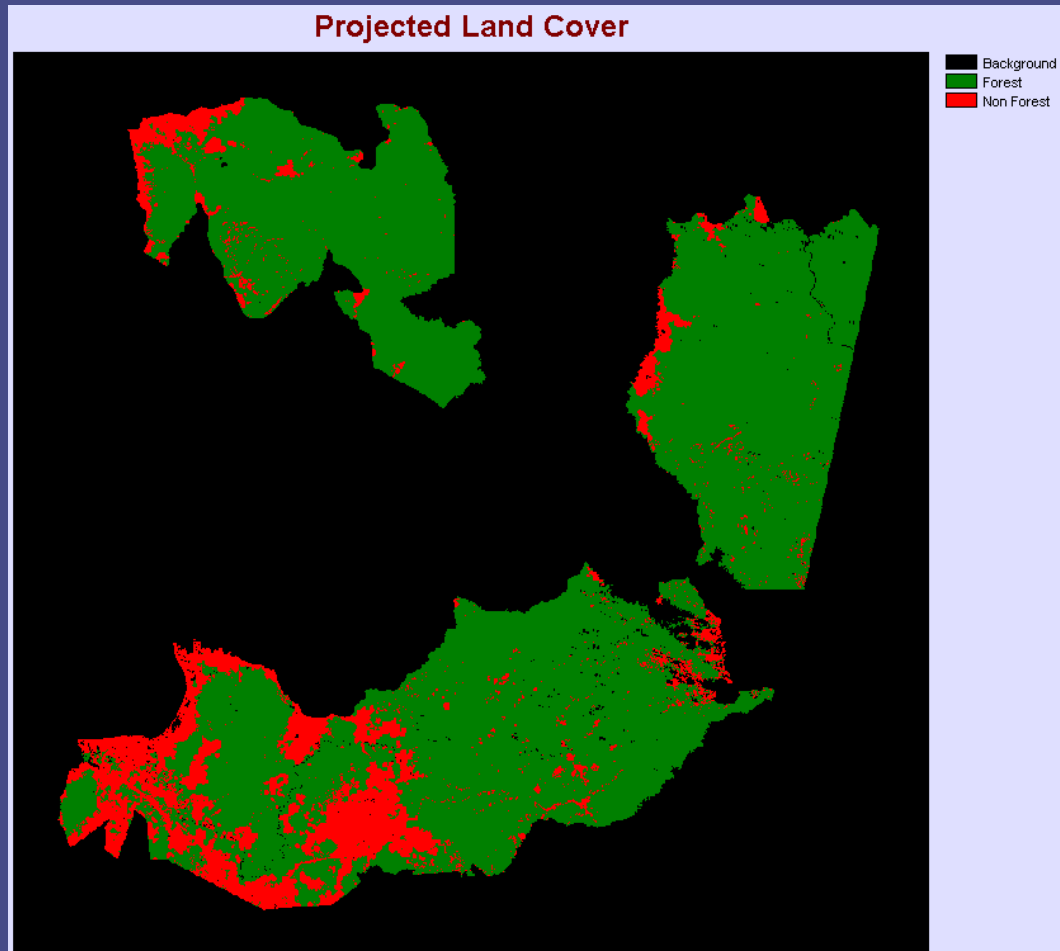
*AUC – Area Under the Curve*

# Side by Side Comparison – MLP & LR

# Prediction - Hard

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## Multi-Layer Perceptron

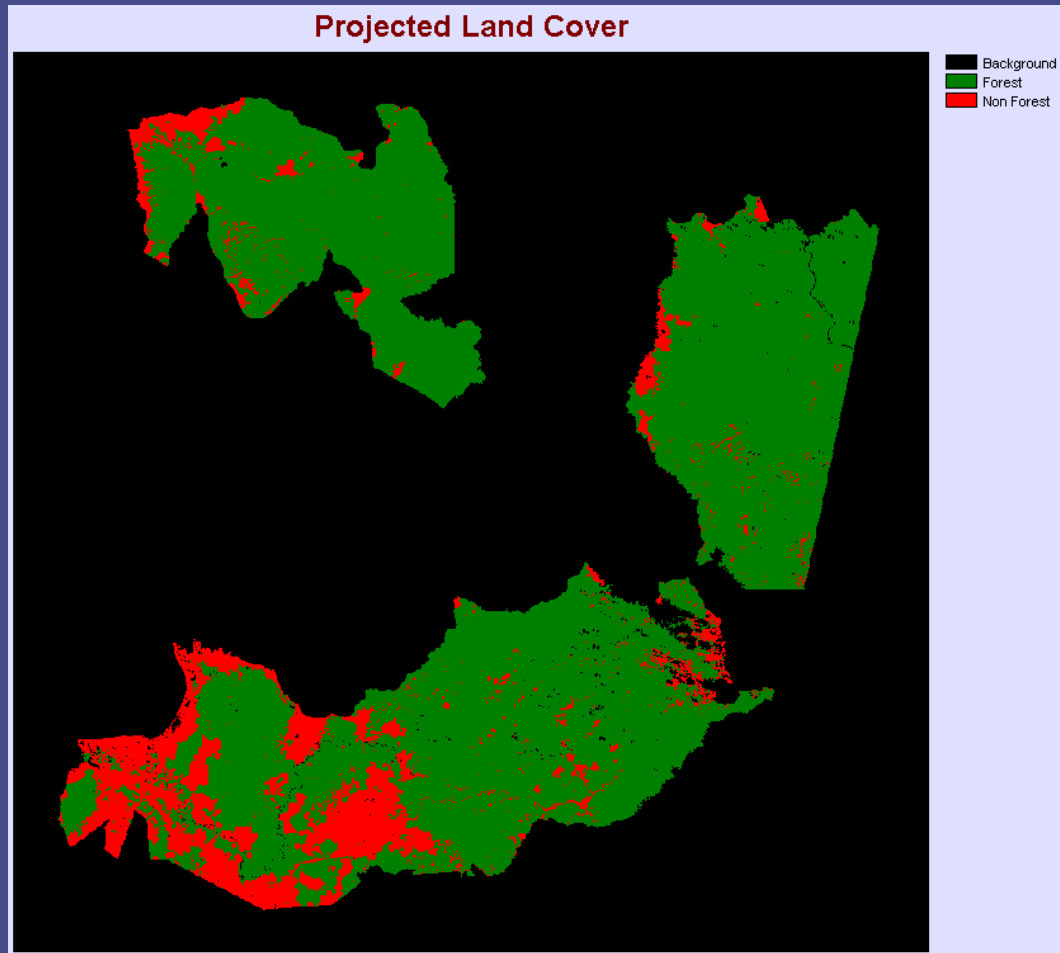




# Prediction - Hard

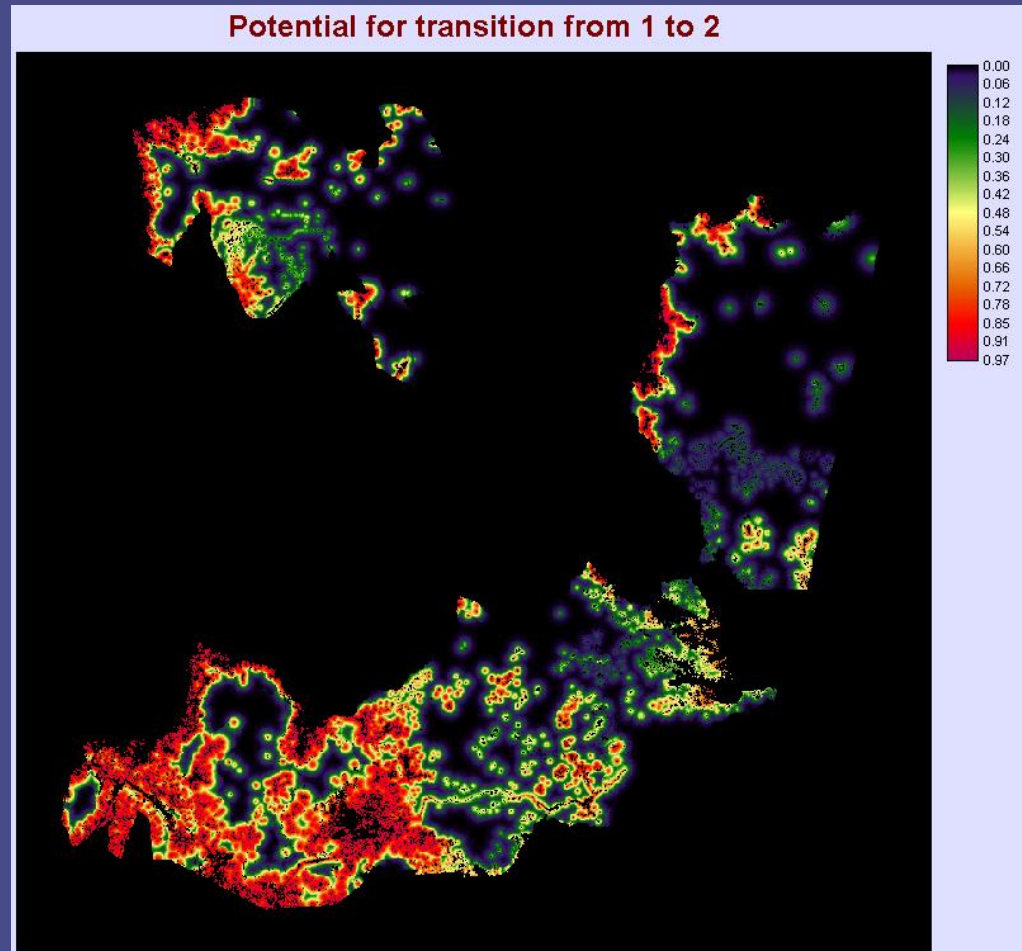
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## Logistic Regression



# Transition Potential - MLP

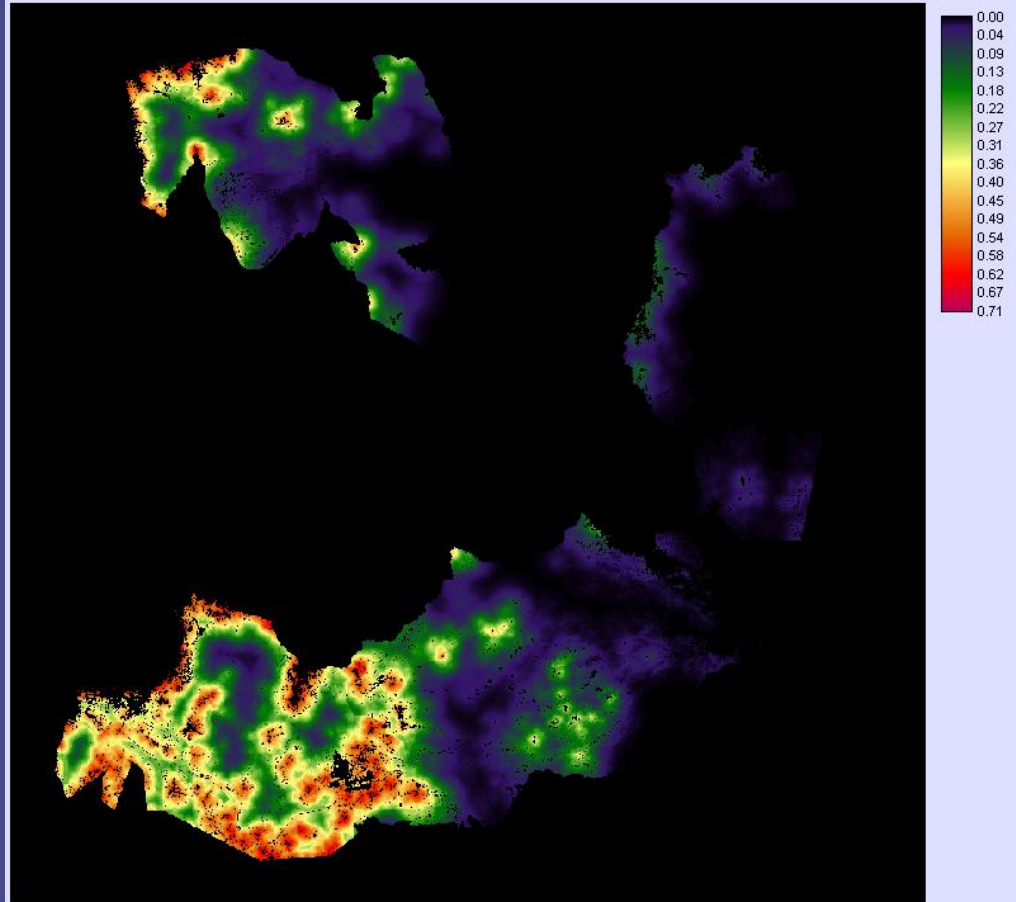
## Multi-Layer Perceptron



# Transition Potential - LR

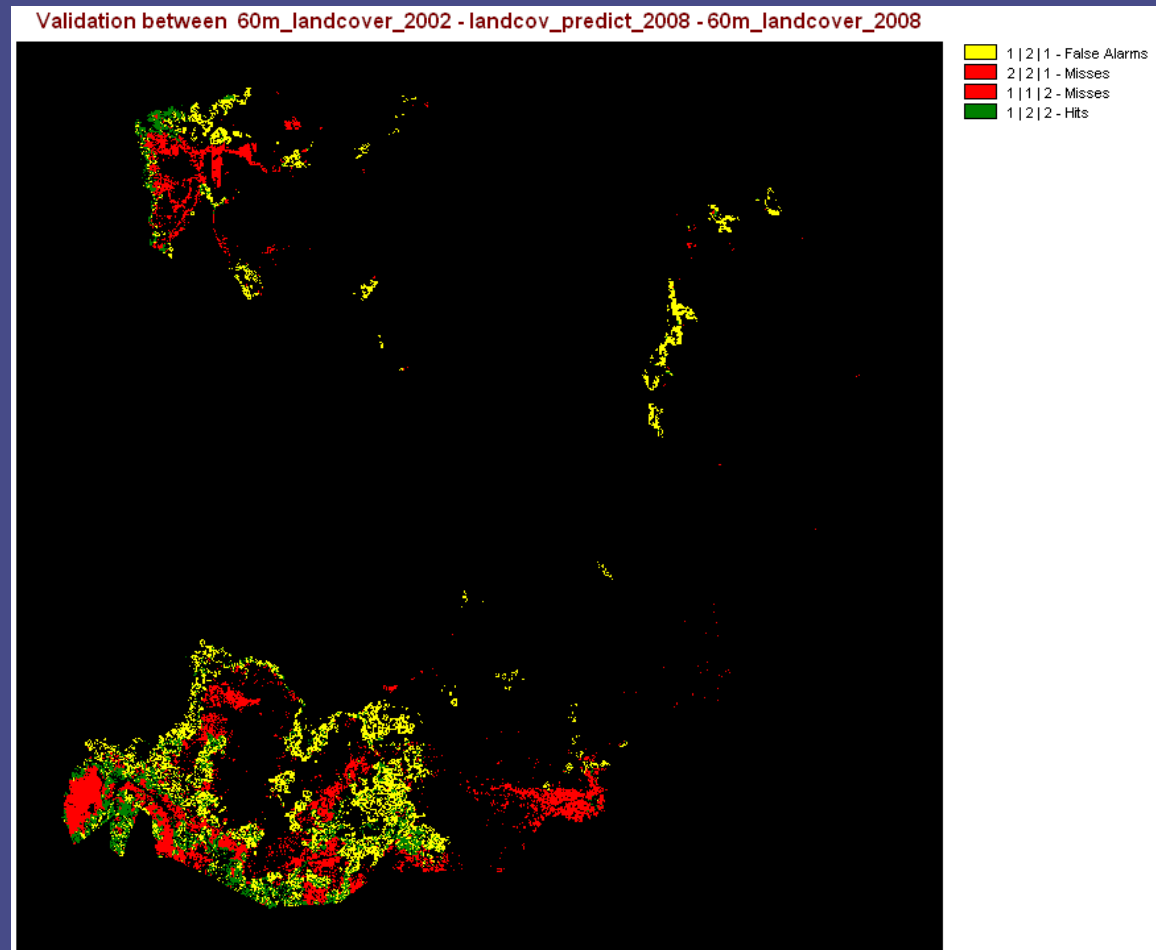
## Logistic Regression

Predicted Image of 60m\_lcm\_98\_08\_lr\_Train\_Fores\_to\_Non F



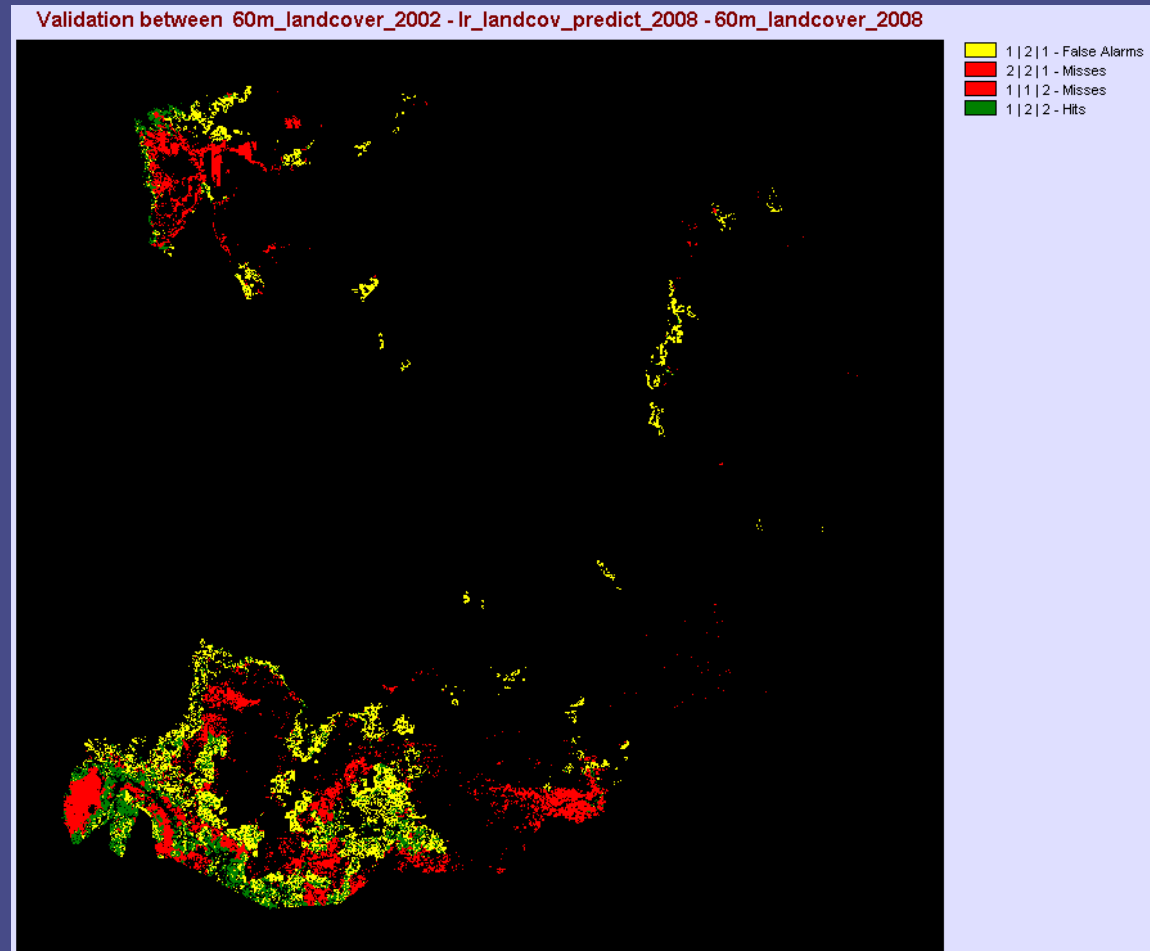
# Validation - Crosstabulation

## Multi-Layer Perceptron



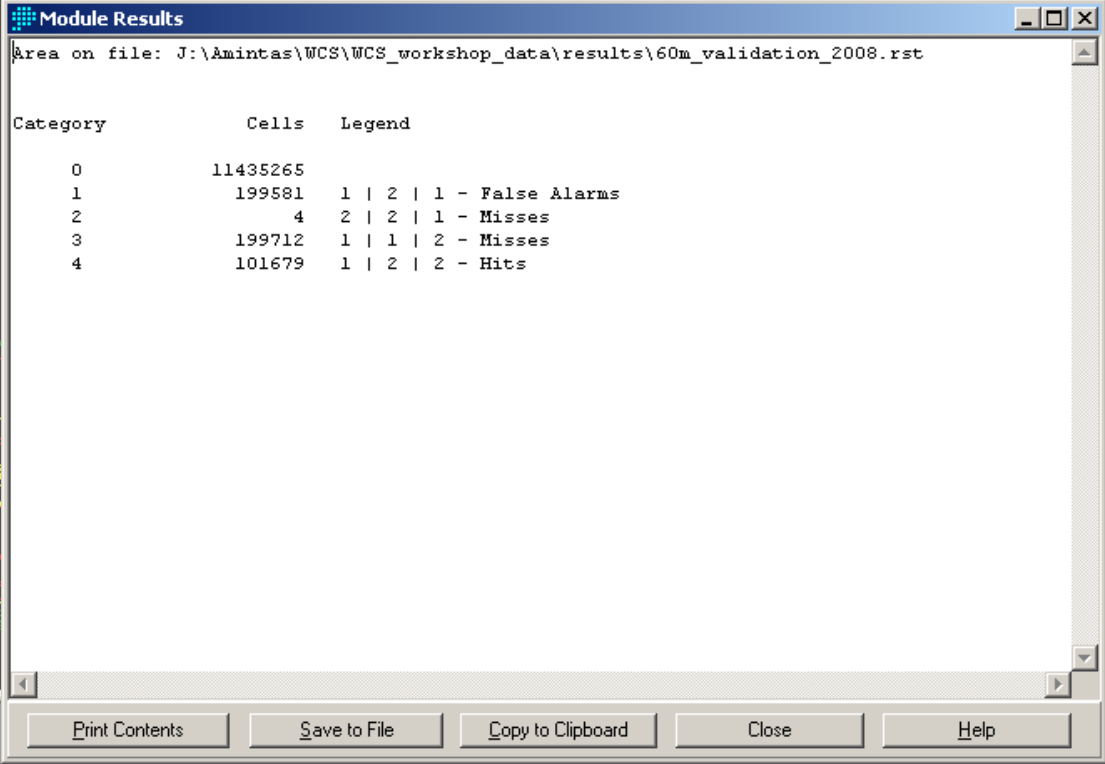
# Validation - Crosstabulation

## Logistic Regression



# Validation – Area

## Multi-Layer Perceptron



Module Results

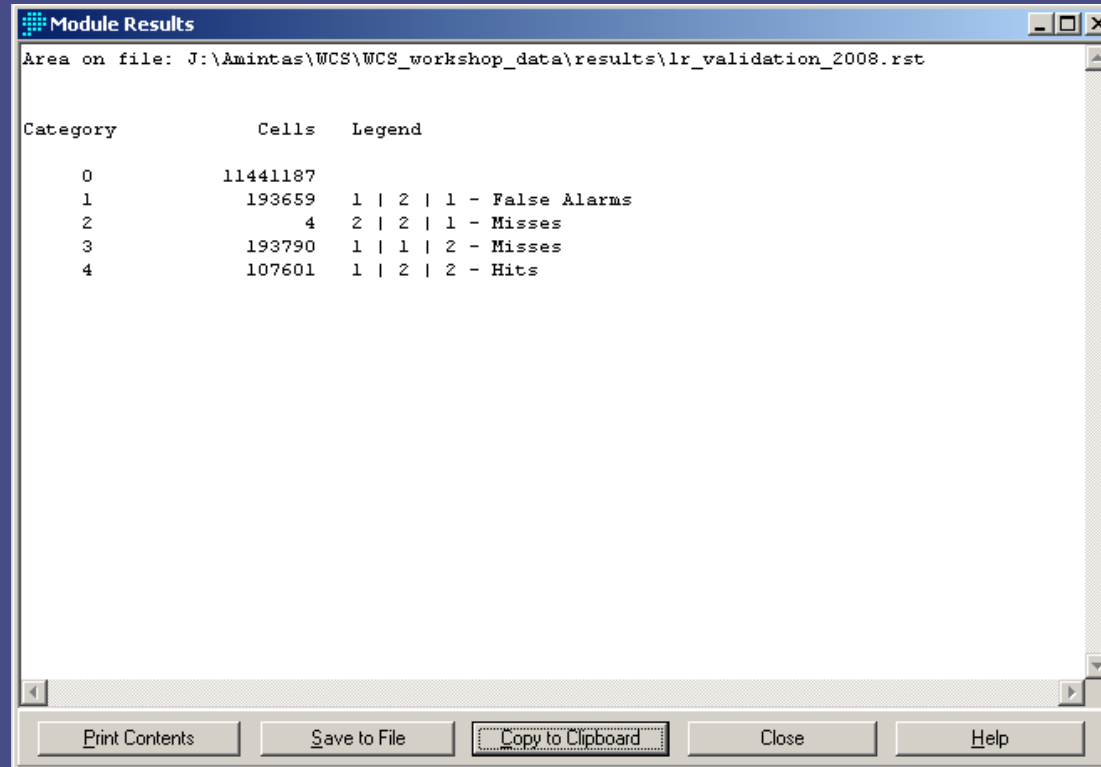
Area on file: J:\Amintas\WCS\WCS\_workshop\_data\results\60m\_validation\_2008.rst

Category	Cells	Legend
0	11435265	
1	199581	1   2   1 - False Alarms
2	4	2   2   1 - Misses
3	199712	1   1   2 - Misses
4	101679	1   2   2 - Hits

Print Contents Save to File Copy to Clipboard Close Help

# Validation – Area

## Logistic Regression

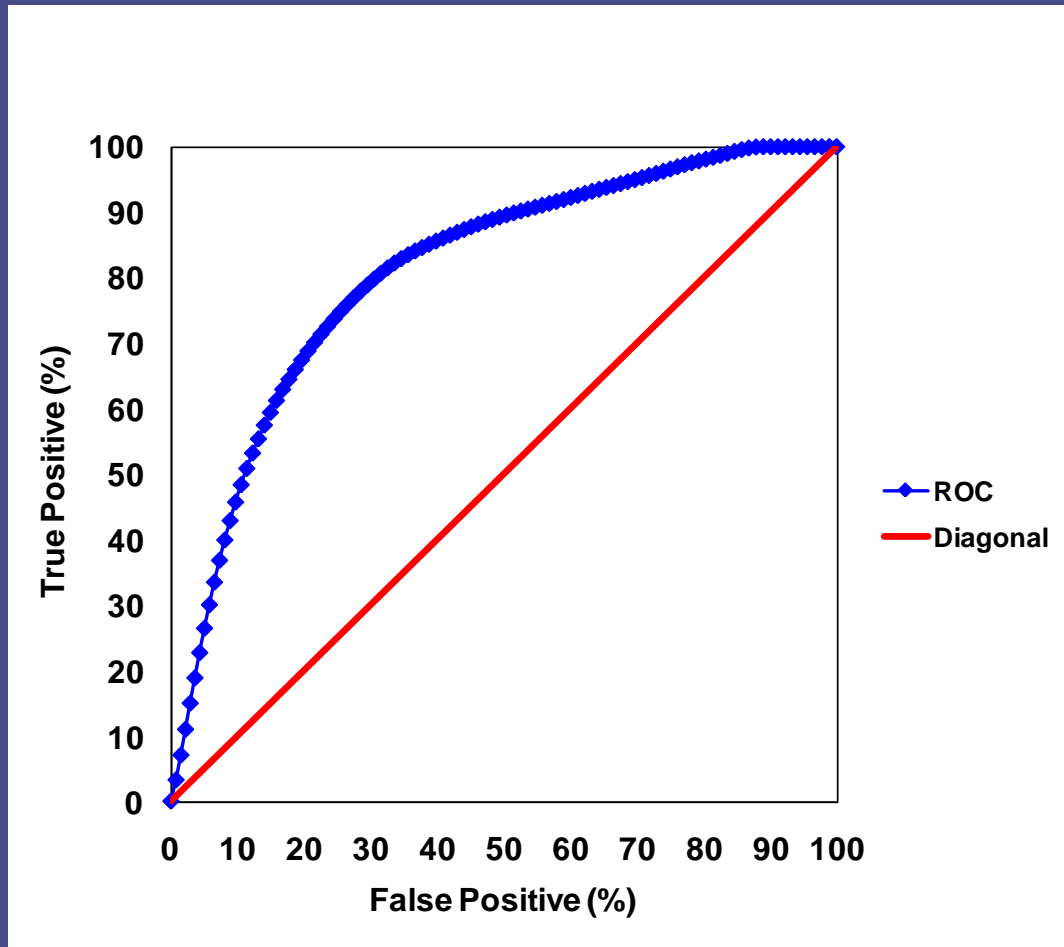


The screenshot shows a window titled 'Module Results' with a text area containing the following data:

Category	Cells	Legend
0	11441187	
1	193659	1   2   1 - False Alarms
2	4	2   2   1 - Misses
3	193790	1   1   2 - Misses
4	107601	1   2   2 - Hits

At the bottom of the window, there are five buttons: 'Print Contents', 'Save to File', 'Copy to Clipboard', 'Close', and 'Help'.

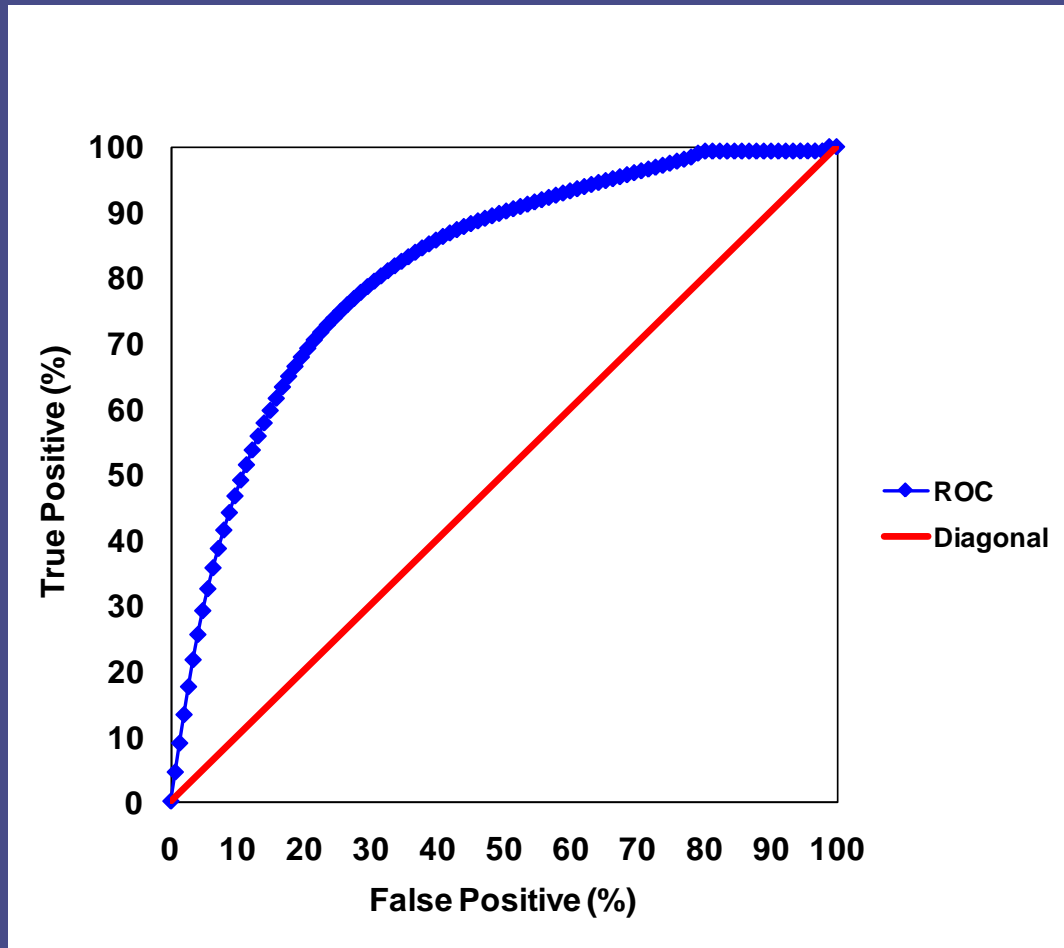
# ROC – Multy-Layer Perceptron



*AUC – Area Under the Curve*



# ROC – Logistic Regression



*AUC – Area Under the Curve*