# Monitoring Western Juniper (*Juniperus occidentalis*) Aforestation using Landsat Imagery

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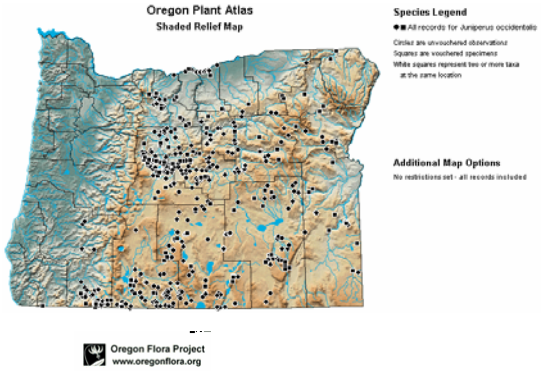
*Geog. 582/522*

## What does Western Juniper look like??

Sagebrush & Moon

Distribution of Western and Sierra Juniper



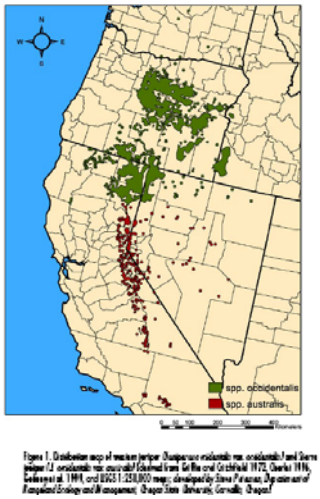




Figure 1. Distribution map of western juniper (*Juniperus occidentalis* var. *occidentalis*) and Sierra juniper (*J. occidentalis* var. *australis*) [illegible]

## Google Earth Map


Approximate study area

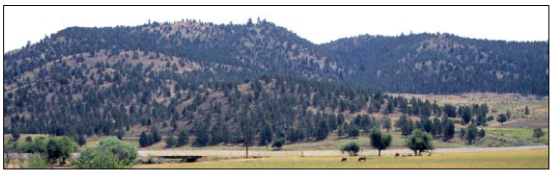
Photographic Evidence for Western Juniper Expansion

Keystone Ranch east of Prineville, OR

1890

Figure 2a. Keystone Ranch, about 1890.

1989



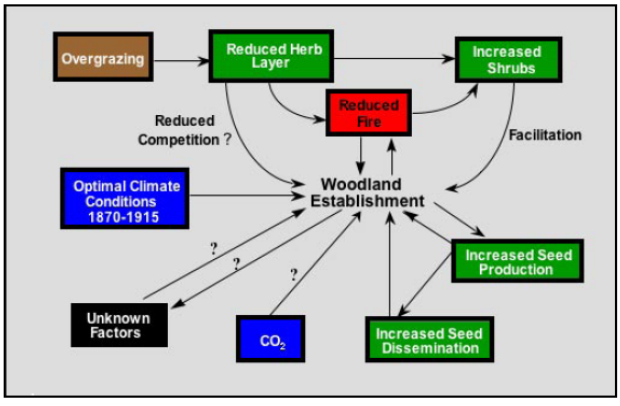
# Reasons for Expansion

- Altered Fire Regimes
- Overgrazing
- Favorable weather conditions in the 1800's
- Climatic Shifts ($CO_2$ increases)
- Copious amounts of berries produced


# Concerns for Expansion

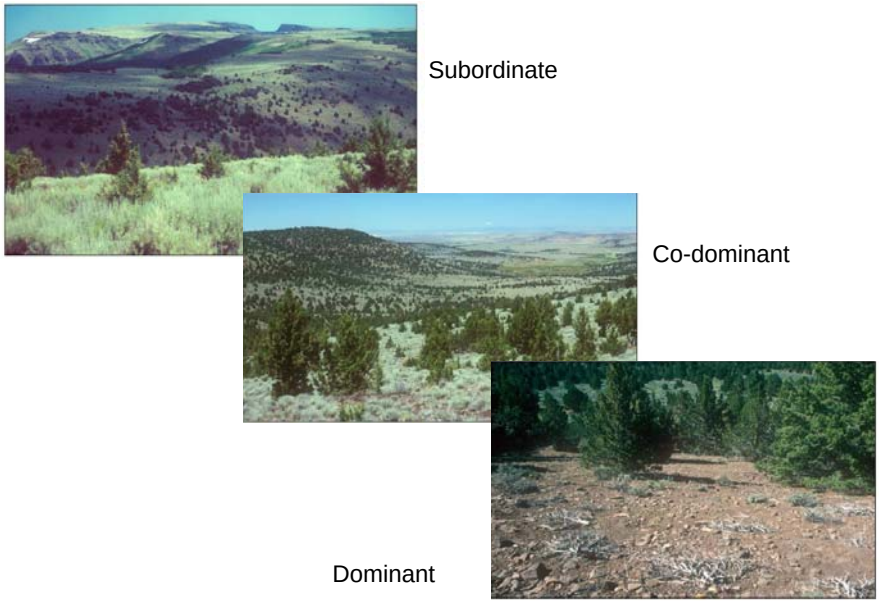
- Decreased biodiversity
- Altered wildlife habitat
- Increased soil erosion
- Reduced stream flows
- Reduced forage production

Model showing factors influencing the expansion of western juniper since 1800's--1900's.



# Juniper invading aspen stand


## Phases of Encroachment



Subordinate

Co-dominant

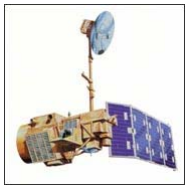
Dominant

# Remote Sensing Techniques for studying western juniper

## Landsat Images

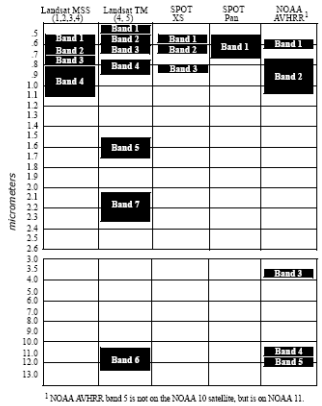
Landsat Metadata

| Satellite | Sensor | Path/Row | Date |
|---|---|---|---|
| Landsat 4 | MSS | 47/33 & 48/33 | 08/08/1973 |
| Landsat 5 | TM | 44/030 | 07/11/1989 |
| Landsat 7 | ETM+ | 44/030 | 07/25/2000 |

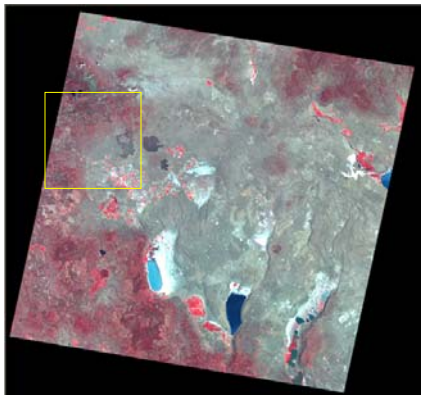


Courtesy of
http://landsat.org

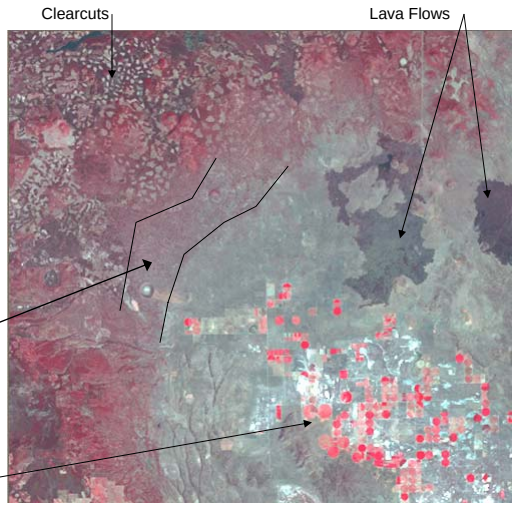
# Multispectral Imagery Comparison




1989 Landsat TM image



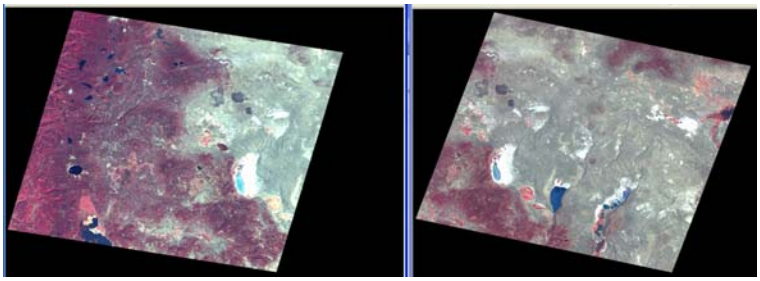
Subset of 1989 Image



## 1973 MSS Images Before Moasicking

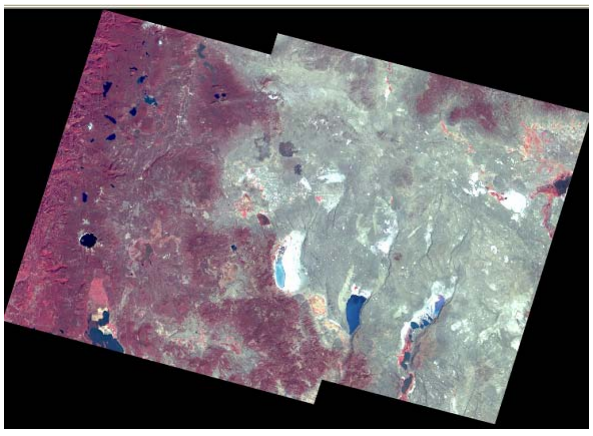
Path/Row

48/30 (western image) 47/30 (eastern image)



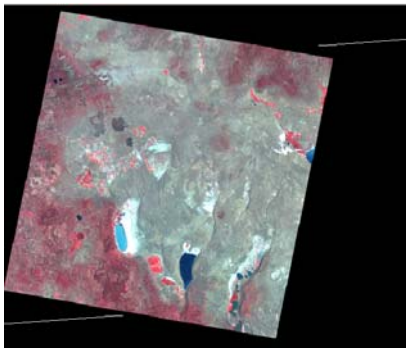
# Moasicked MSS Images

With Histogram Matching

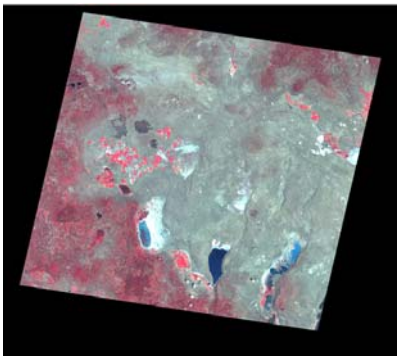


# Post-Classifcation Comparison of 1989 and 2000 image

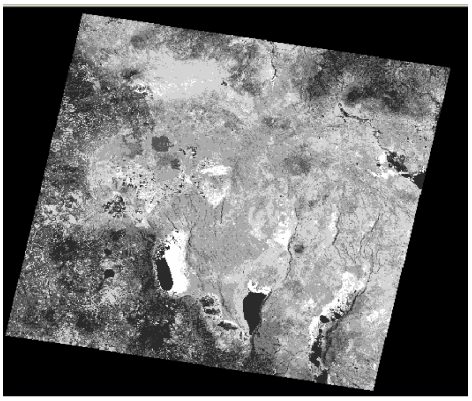
1989 Image



2000 Image



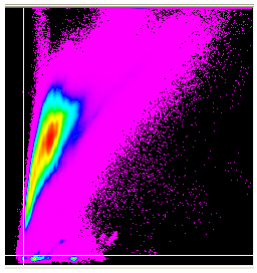
# Unsupervised Classification of 1989 Image



- A combination of class numbers were tried.
- Class numbers ranging from 6-100 were explored
- It was determined that approximately 10 classes would be sufficient this initial study

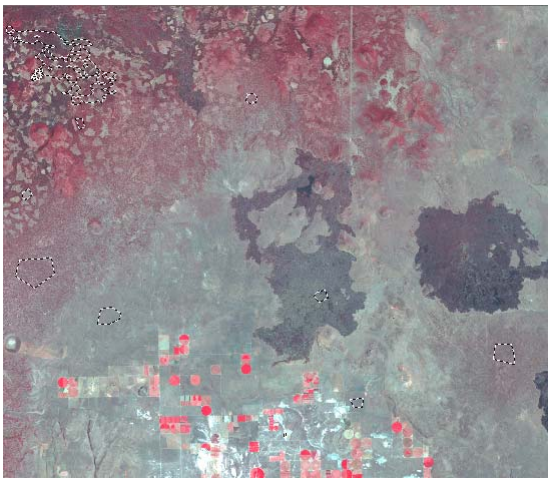
# Two Methods for Creating Training Sites

Feature Space

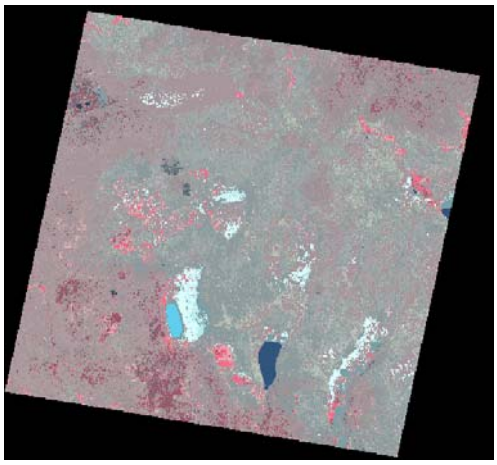



- Each layer was stacked to have only 6 bands
- 26 Training sites were created for each image

AOI

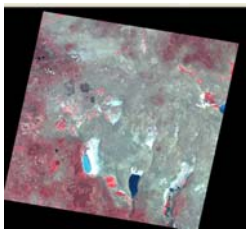


**Classified 1989 Image**



Legend

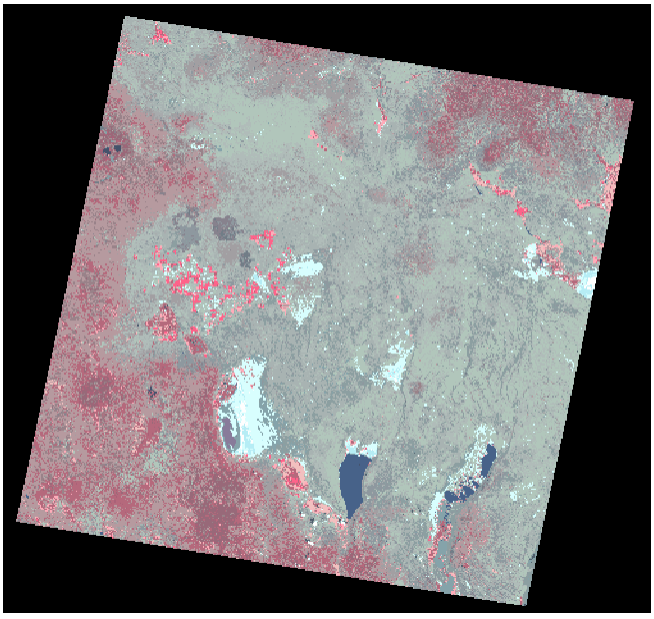
| |
|---|
| water |
| lava |
| clearcut |
| forest |
| forest1 |
| juniper |
| clearcut1 |
| juniper-sage |
| sage |
| sage1 |
| lava1 |
| lava2 |
| ag |
| ag1 |
| ag2 |
| sage2 |
| water1 |
| water2 |
| baresoil |
| baresoil1 |
| soil |
| water3 |
| wetland |
| sage3 |
| juniper1 |
| juniper2 |



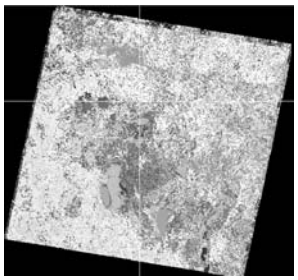
Original Landsat Image

## 2000 Classified Image

| Signature Name | Color |
|---|---|
| lava | |
| lava1 | |
| lava2 | |
| juniper | |
| juniper-sage | |
| lava3 | |
| water | |
| forest | |
| forest1 | |
| water1 | |
| agricult | |
| shadow | |
| water2 | |
| cloud | |
| water3 | |
| sage | |
| sage1 | |
| baresoil | |
| baresoil1 | |
| agricult1 | |
| agricult2 | |
| forest2 | |
| forest3 | |
| clearcut | |
| juniper-sage1 | |
| sage2 | |

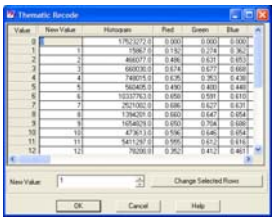


## Change Detection



Using Overlay

- Recode and group similar pixel values
- Create an output file that contains classes that indicate how the class values of the input



## Post-Classification Change Detection

- Add more training sites for each of the different land cover types
- Perform accuracy assessment
- Gather ancillary data

# Change Vector Analysis

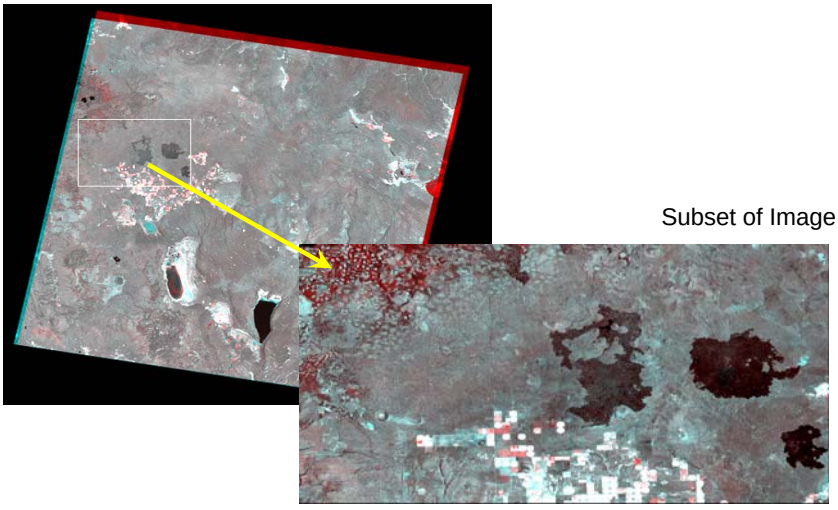
## CVA

- An effective approach for detecting and characterizing land-cover change
- When applied to multi-temporal data, it compares the time-trajectory of a biophysical indicator for successive time periods
- Reveals information about the magnitude and direction of differences in pixel values

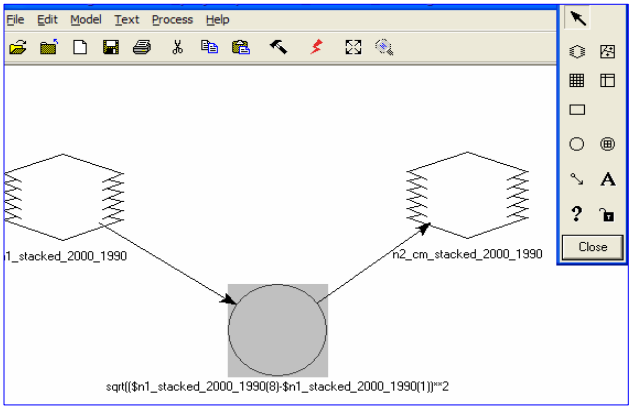
# Procedure

- 1st Stacked 6 bands from the 1989 and 2000 images into one image. This resulted in an image with 12 bands.
- 2nd Then the NIR band 4 from 1989 was displayed by the red color gun and the NIR band 11 from the 2000 image was displayed using green and blue.
- The grey areas in the resulting picture are areas of no-change

# Stacked Landsat Image 2000 (band 11 –blue/green) and 1989 (band 4-red)

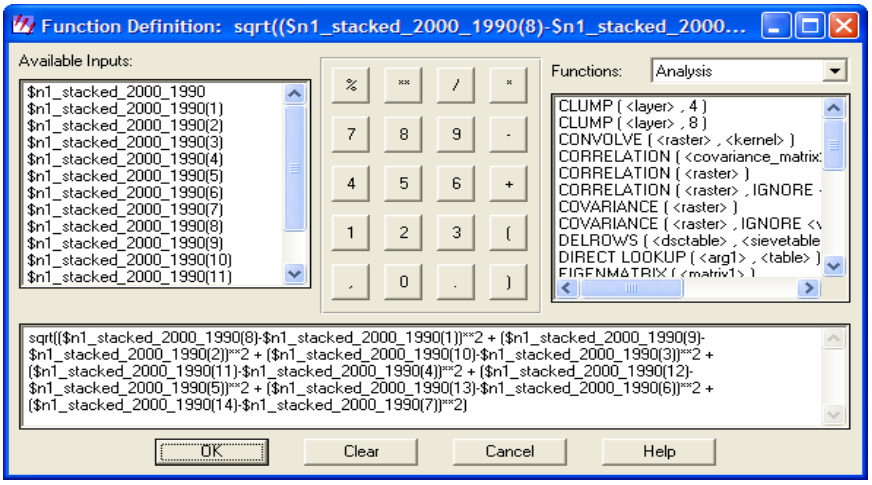


# Change Magnitude Model

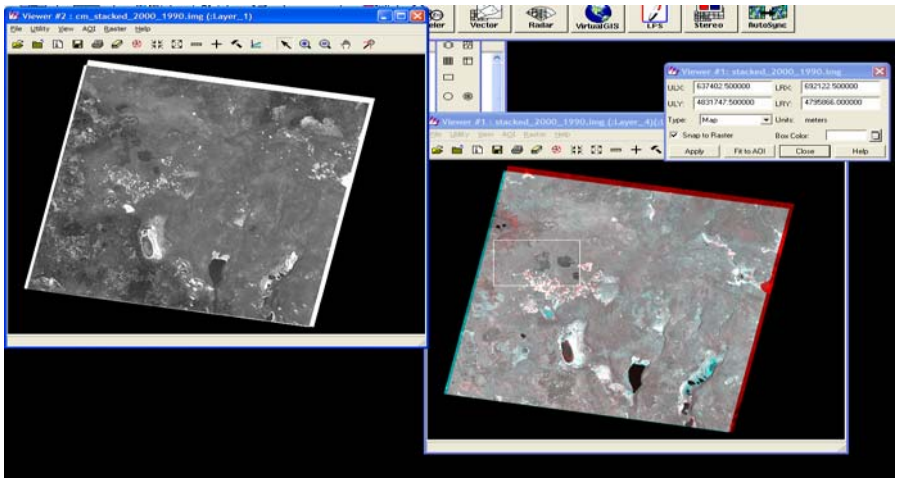



$$CM = \sqrt{(DN_{11} - DN_{21})^2 + (DN_{12} - DN_{22})^2 + (DN_{13} - DN_{23})^2 + (DN_{14} - DN_{24})^2}$$

# Change Magnitude Model



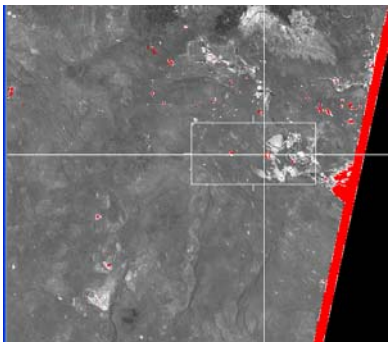
Comparison of CM image and original NIR image

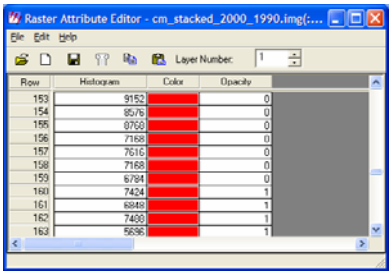


CM image

Oirginal NIR image

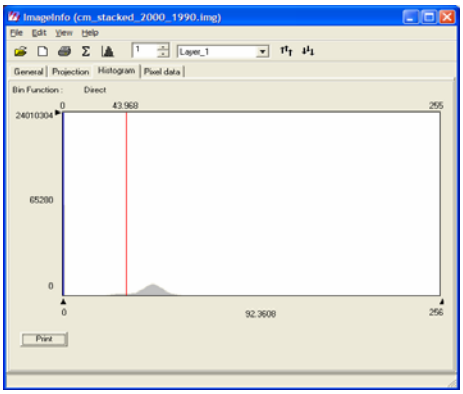
Determining the Threshold Value



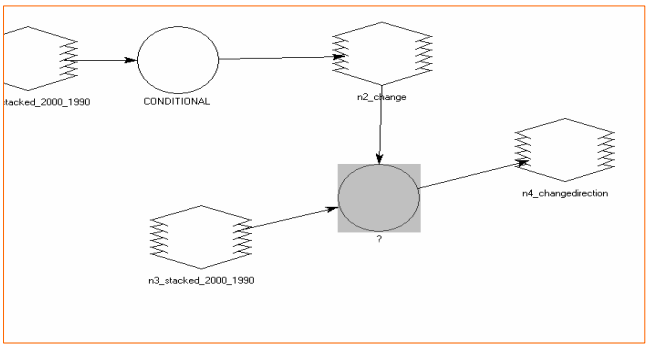



Determined Threshold Value = 160

# Histogram of CM model




# Change direction Model

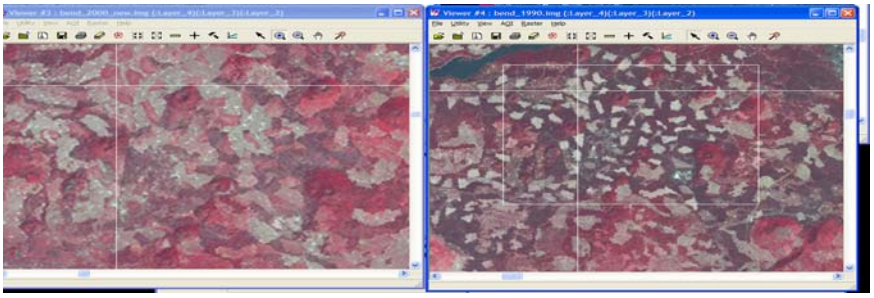



CONDITIONAL { ($n2_fml_chg == 1 and $n3_nalcaa(6) – $n3_nalcaa(2) < 0 and $n3_nalcaa(8) - $n3_nalcaa(4) < 0) 1 , ($n2_fml_chg == 1 and $n3_nalcaa(6) - $n3_nalcaa(2) > 0 and $n3_nalcaa(8) - $n3_nalcaa(4) < 0) 2 , ($n2_fml_chg == 1 and $n3_nalcaa(6) - $n3_nalcaa(2) < 0 and $n3_nalcaa(8) – $n3_nalcaa(4) > 0) 3, ($n2_fml_chg == 1 and $n3_nalcaa(6) – $n3_nalcaa(2) > 0 and $n3_nalcaa(8) - $n3_nalcaa(4) > 0) 4 }

# Conclusions

- Additional training sites are needed to accurately classify juniper.
- Different band combinations should be used to reveal meaning with CVA.
- Which method is best to resolve the different pixel sizes in the MSS, TM and ETM+ images.
- Aerial photography, DEMs, and DOQs would be beneficial for accuracy assessment.

# Forestry Practices



- A grouping of ‘clearcut’ and ‘forest’ classes is necessary.
- *There sure has been a lot of clearcutting in this area!!*

## Philosophical Questions (or Riddles???)

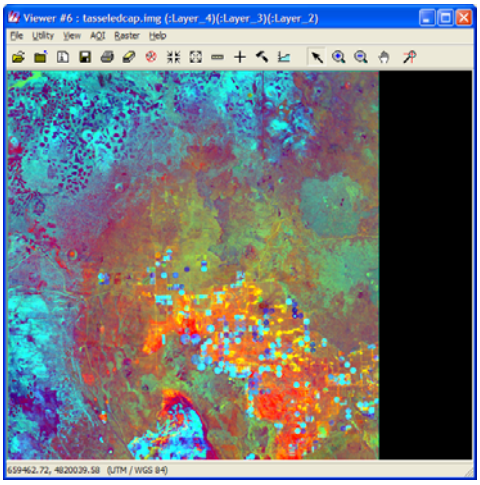
Q: When is a pixel not a mixel?

***When it's a training site!!!***

Q: What/Where is the division between a land cover class and a 'bizarre' geologic formation???

***Yet to be determined --- I will gladly discuss!!***

## Tasseled Cap



Supervised Classification