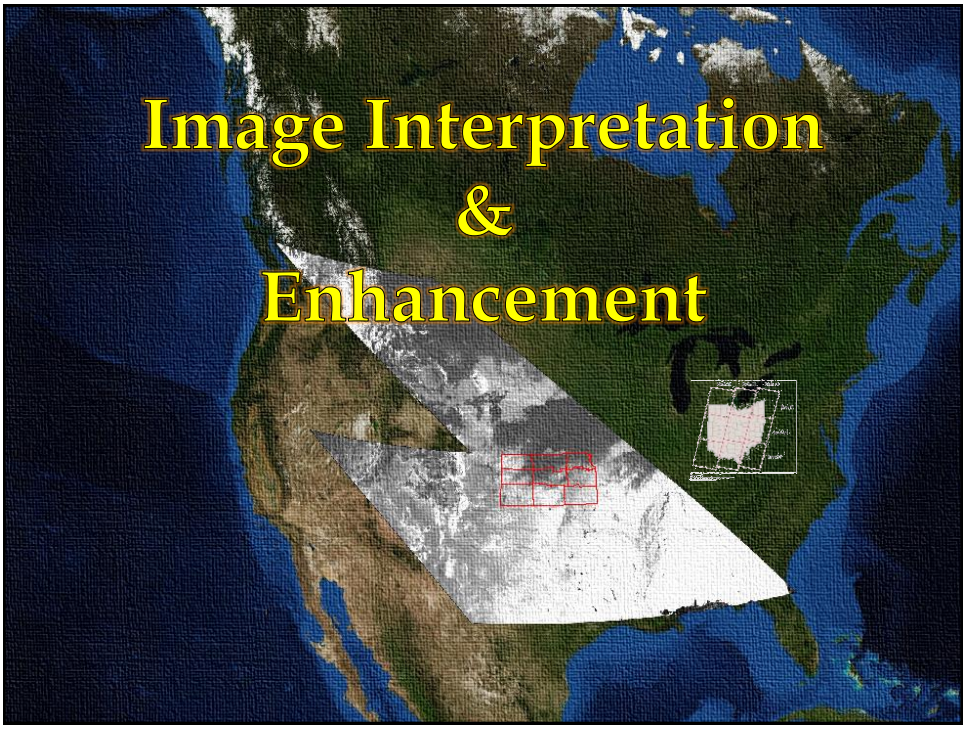
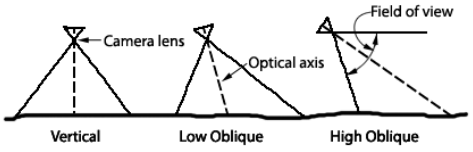
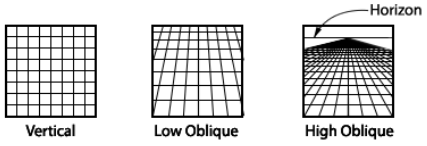


Types of Air Photos

- oblique: at an angle (diverging from vertical) to the ground
  - ✓ high oblique: includes the horizon
- vertical: perpendicular to the ground



Camera orientation for various types of aerial photographs

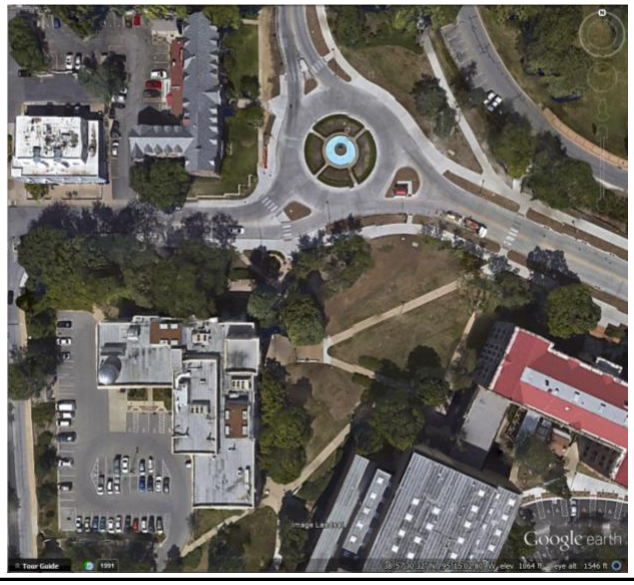


How a grid of section lines appears on various types of photos.

Advantages of Using Each?

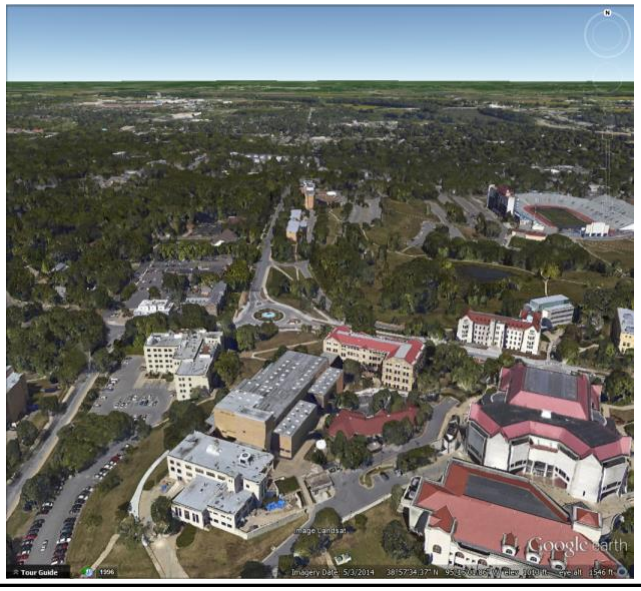
- oblique
  - ✓ covers more area from a given flying height
  - ✓ oblique angle is more familiar to us (more like horizontal)
  - ✓ some objects not visible on vertical photos may be seen
  - ✓ shadows may give clues
- vertical
  - ✓ scale is constant
  - ✓ measurements of directions are easier
  - ✓ easier to use for mapping (positional accuracy)
  - ✓ easier to interpret than and better for stereo (there is no masking)
  - ✓ less atmosphere to penetrate

Vertical Photo



Low Oblique Photo

High Oblique Photo



Air Photo Interpretation

- both an art and a science

- Science
  - ✓ has elements that are measurable, quantifiable, repeatable
- Art
  - ✓ has elements based on hunches, intuition, experience (just because something is unsystematic and not orderly, doesn't mean it's not of value)

We, already experienced interpreters

- but from a horizontal perspective
- most people recognize oil refineries and baseball diamonds on the ground, but not necessarily from the air
- relate experience of flying over western Kansas -> people seeing center pivots
- you have to retrain yourself, to consciously think of what makes an object appear the way it does from the air
- What elements make up a cemetery in the American Midwest?
  - ✓ trees (What kind?)
  - ✓ grass
  - ✓ headstones and monuments
  - ✓ fences
  - ✓ narrow roadways
- one of the most valuable assets of a skilled photointerpreter is *experience*

Campbell says

- we face three challenges in interpretation
  - ✓ Seeing things from an overhead view
  - ✓ Dealing with radiation outside the visible
  - ✓ Unfamiliar scales and resolutions

Oxford Cemetery

Cemetery in Korea

Photo Interpreter Tasks

- Classification - What kind?
  - ✓ detection - there's something there
  - ✓ recognition - general category (aircraft, coniferous forest, etc.)
  - ✓ identification - object
- Enumeration - How many?
  - ✓ How many per unit area (density)?
- Mensuration - What size? (How big? How long? How wide?)
- Delineation - Where is it?
  - ✓ placement of boundaries
  - ✓ determination of level of generalization
    : by category
    : by area – concept of minimum mapping unit

Recognition Elements

- When we interpret an air photo, we usually make our identifications subconsciously and unsystematically, but there are visual cues that we use and that we can train ourselves to use in a systematic way.
- Recognition Elements
  - ✓ shape
  - ✓ size
  - ✓ pattern
  - ✓ shadow
  - ✓ tone / color
  - ✓ texture
  - ✓ association
  - ✓ site
  - ✓ time
  - ✓ 3D

Shape: external form or configuration

- Cultural objects
  - ✓ geometrical shapes (straight lines, regular curves)
  - ✓ distinct boundaries
  - ✓ examples: airports, cloverleafs, center-pivot irrigation fields
- Natural objects
  - ✓ irregular shapes
  - ✓ poorly defined boundaries
  - ✓ examples: alluvial fans, volcanic cones, sand dunes
- But, note there are exceptions to the general guidelines above.

Size: dimensions of an object

- Absolute
  - ✓ how long, how wide, perimeter, how much area?
- Relative
  - ✓ bigger than, smaller than (buildings, roads, rivers)

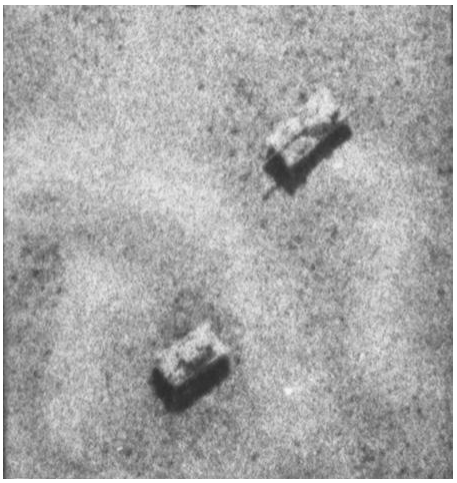
Pattern

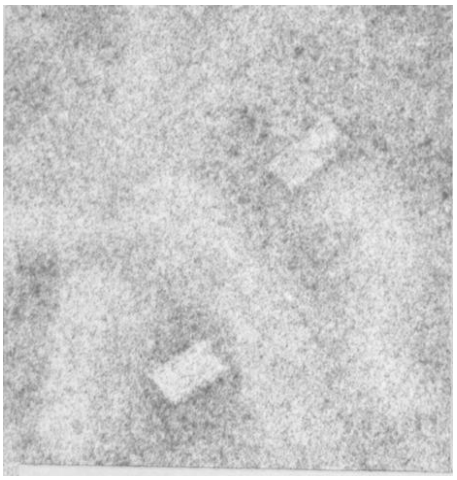
- overall spatial form of related features
  - ✓ repetition, arrangement, order
- Cultural: orderly, regular arrangements common



Shadow

- oblique illumination by sun
  - ✓ helpful in identifying some vertical features (water and electrical towers, tree species, oil tanks
  - ✓ illumination of subtle topographic changes
- NOTE
  - ✓ shadow can be a hindrance in many situations
  - ✓ but, stereo viewing can also address many of these issues



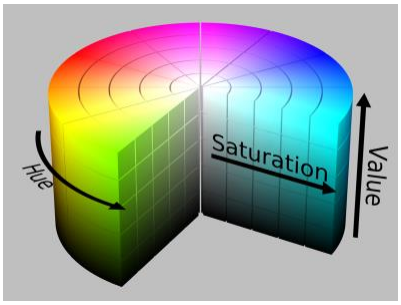


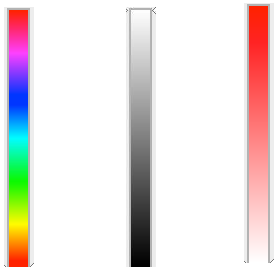
Tone / Color

- reflective characteristics of an object
  - ✓ relative brightness or color
- BW: tone (shades of gray)
- Color:
  - ✓ hue (dominant wavelength)
  - ✓ chroma (strength of color) – saturation, intensity, purity
  - ✓ value (lightness of color) – tint, shade, tone
- Spectral response pattern (visual or digital) can give cues to ID
  - ✓ ex) natural vs. artificial turf on color IR film

Definitions for Colour Systems

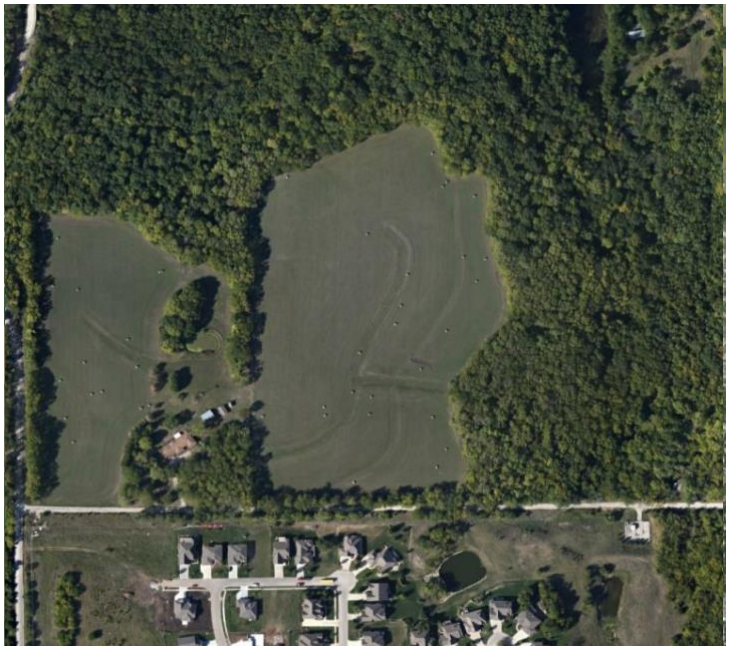
- ***Hue***: the base pigment
- ***Lightness (Value)***: the darkness of the pigment
- ***Chroma***: the depth of the pigment





Texture

- variability in tone (by frequency, intensity, regularity) over a spatial area
- texture is relative: changes with photo scale (coarse at one scale may be smooth at another scale)
- Do a wheat field and a patch of natural prairie look the same on an air photo? Why?
- Cropland (crops and bare soil) tend to have smooth textures
- Woodland, natural veg. tend to have coarser textures



Association

- linked functions of different objects
- can be used to draw conclusions about both *identification* and *function*
  - ✓ example: piles of raw materials at factories, coal piles at power plants, round hay bales on edges of grass fields

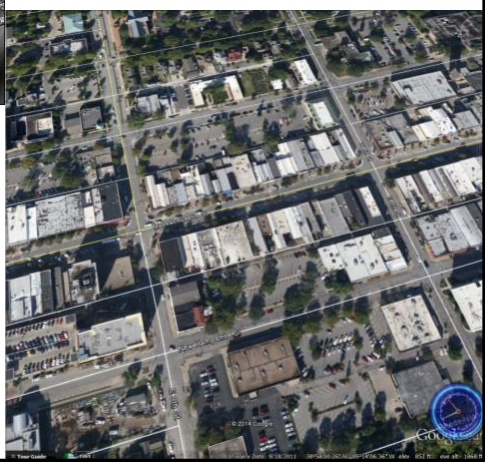
Site

- location of an object in relation to its immediate environment
  - ✓ applies also to natural vegetation (e.g., north and south facing slopes)


http://blog.daum.net/cognos57

Time

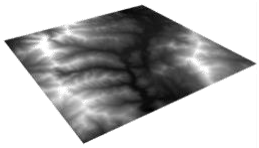
- variability of all the above factors as a function of time
- time of day
  - ✓ e.g., a large complex of low flat-roofed buildings with large parking lots. What might it be?
  - ✓ parking lot filled at 3 a.m. Now what do you think?
  - ✓ parking lot full at 2 pm but empty at 6 p.m. Now what do you think?
- seasonal differences (crops, natural vegetation, seasonal recreation)
- change over time

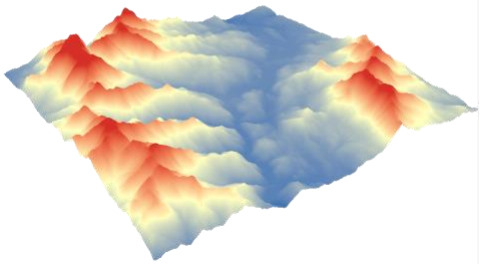


3D

- seeing an object in all three dimensions

- stereopairs
- perspective views using DEMs
- oblique photos (not exactly 3D)
- Geowall for visualization





Making Judgements

- many people find this difficult without being 100% sure
- *Convergence of Evidence* principal
  - ✓ The sum of multiple clues adds up to a single answer.
  - ✓ Therefore, it is always important to look for as many clues as possible.
- Whenever possible, *go to the field* or talk to someone who has been there
- In drawing conclusions about human land use, beware of making simplistic conclusions

Image Interpretation: example

- This is the Statue of Liberty on Liberty Island. The site of an island can be easily identified (surrounded by water) and the size of the island indicates that it is relatively small (compare the length of the boats to a structure). It is relatively undeveloped as well. The star-shaped base is the most prominent feature. The statue's green tone is distinctive, and the shadow cast by the statue allows you to make out that it is holding something (i.e., the torch).

Digital Image Processing

- Goal is to take raw data values and modify them to:
  - ✓ make them easier to interpret visually
  - ✓ extract information
- Topics
  - ✓ inspection
  - ✓ enhancement
  - ✓ radiometric adjustments
  - ✓ transformation
  - ✓ rectification
  - ✓ filtering
  - ✓ resolution merge
  - ✓ mosaicking

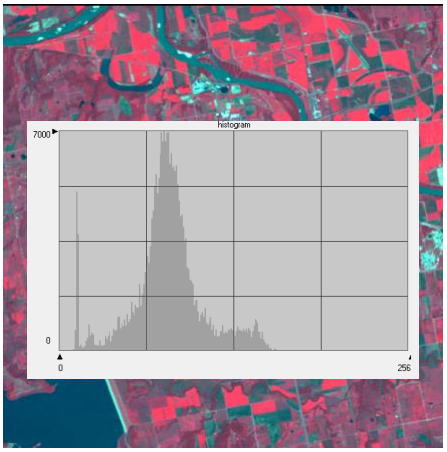
Inspection

- Examine metadata documentation: Histograms and Statistics
  - ✓ histograms give information about the scene itself
  - ✓ about the atmosphere
  - ✓ and about the quality of the image itself
- Data quality
  - ✓ clouds
  - ✓ noise – periodic, random
  - ✓ missing data

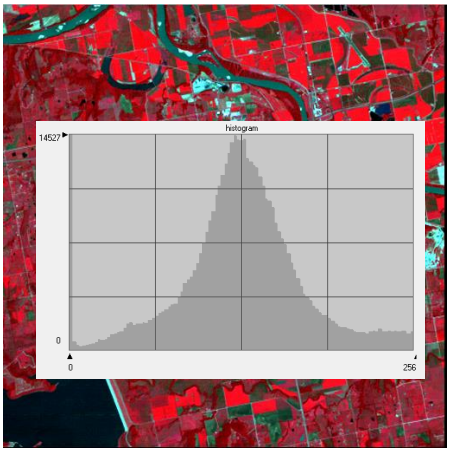
Enhancement

- Many Types
- Contrast stretching is one type
- *Contrast stretching* stretches values in the image histograms to cover a larger area of the available range of values (for example, from an original range of 15 to 70 to 0 to 255)
- The whole histogram can be stretched, or specific parts of the histogram can be stretched to emphasize specific features in an image.

Contrast Stretching

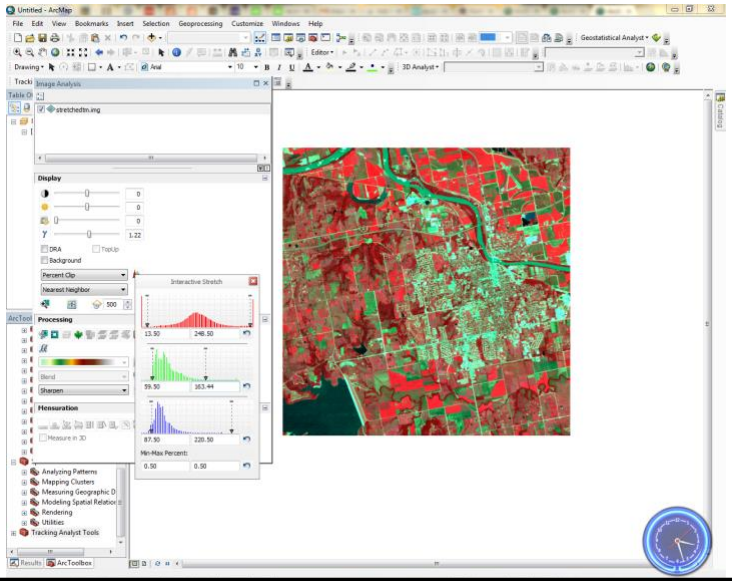


Min: 6 Max: 159 Mean: 78.556
Median: 78 Mode: 76 Std. Dev: 26.830



Min: 0 Max: 255 Mean: 128.151
Median: 126 Mode: 0 Std. Dev: 58.270

in ArcGIS



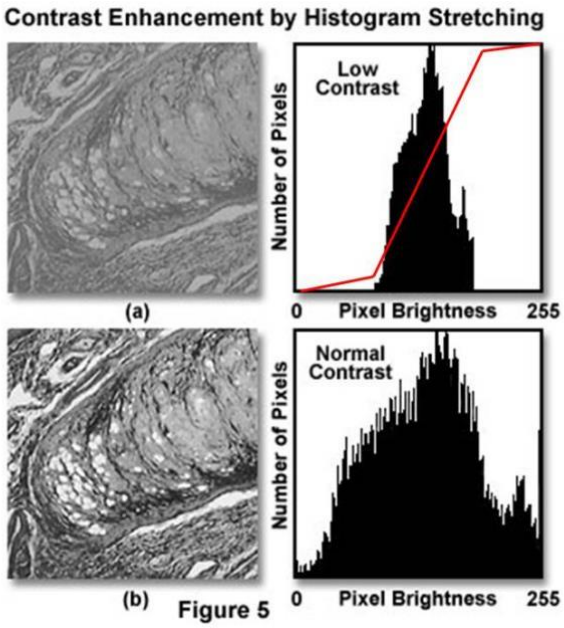


Figure 5

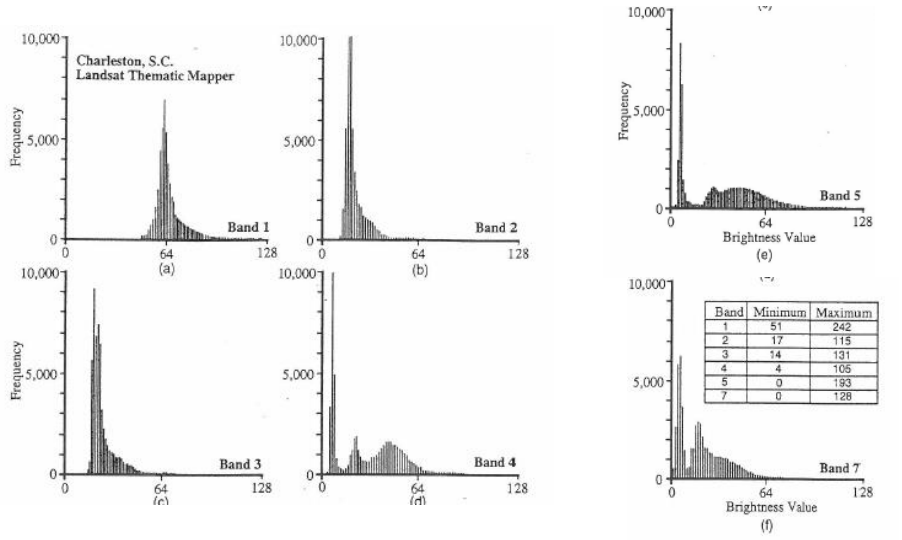
Vegetation Indexes - NDVI

- Importance of vegetation monitoring on a regular basis
  - ✓ crop progress
  - ✓ grassland condition
  - ✓ forest (fire fuel, condition, deforestation)
- An early goal was to develop a single numerical index to create a new image that would correspond to specific canopy measurements: green biomass, LAI, % vegetative ground cover
- Based on the relationships among the bands
- Note the spectral curves and relationships – e.g., what happens to the vegetation curve when it goes from actively growing green vegetation to dying or dead vegetation.
- Some vegetation indices have been single bands, but most have been ratios of bands.
- NDVI (Rouse, et al., '73) - developed it initially with MSS data
- NDVI is far and away the most common vegetation index.

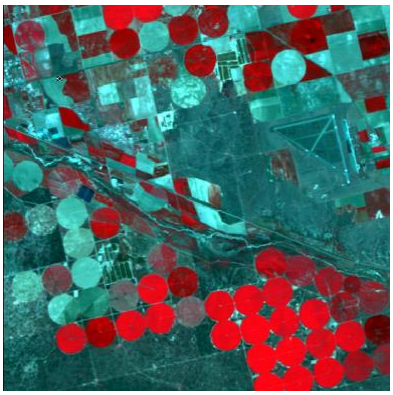
Vegetation Indexes - NDVI

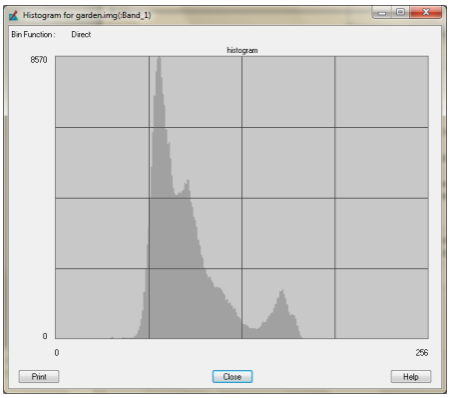
- Formula: (NIR – Red) / (NIR + Red)
- Potential values range from -1.0 to +1.0
  - ✓ low values (around .20 or less) have little or no green vegetation
  - ✓ higher values (around .30 or greater) have increasing amounts of green vegetation
- What bands would be used for calculating NDVI using TM?
- NIR = 24, Red = 20, NDVI = ?
- NIR = 34, Red = 12, NDVI = ?

Histograms of Six Bands, TM scene



Garden.img





Statistics Info:			
	Min: 31	Max: 197	Mean: 89.995
	Median: 83	Mode: 70	Std. Dev: 25.656
		Skip Factor X: 1	Skip Factor Y: 1

Process Summary

- **Enhancing images**
  : Displaying and enhancing Landsat imagery of the Chesapeake Bay

1. Examine the data and complete the metadata chart.
2. Document the project and set the environments.
3. Produce a map of the Chesapeake Bay with states and rivers labeled.
4. Display individual Landsat bands with histograms.
5. Match DN values to land features.
6. Use the Pixel Inspector to view pixel values.
7. Create individual frequency histograms and an all band image frequency histogram.
8. Perform image enhancement.