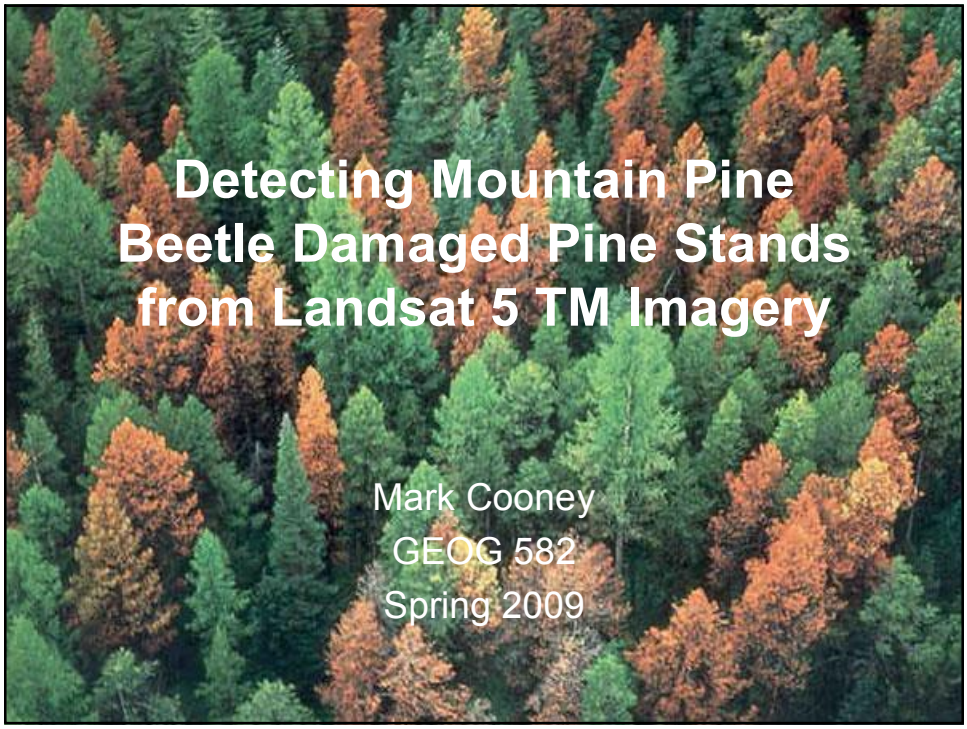

Detecting Mountain Pine Beetle Damaged Pine Stands from Landsat 5 TM Imagery

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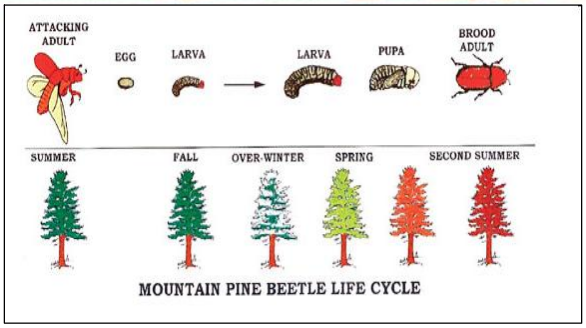
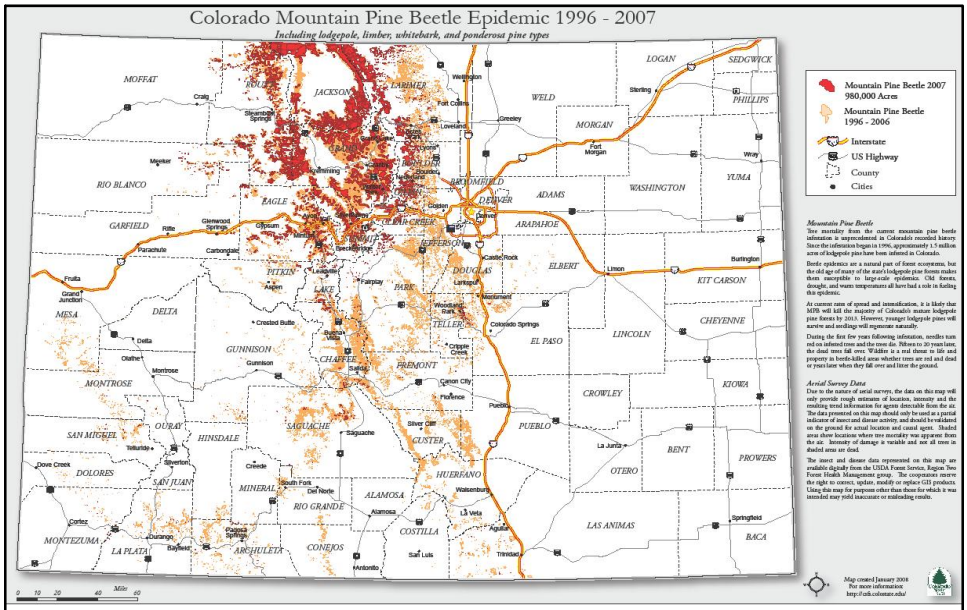
INTRODUCTION

- Mountain Pine Beetle is a Bark Beetle native to forests of Western North America from Mexico to Canada.
  - Inhabits Pines, primarily Ponderosa, Lodgepole, Scots, and Limber.
- Beetles usually attack older, diseased trees or overcrowded stands.
  - Prefer larger trees (>6 inches diameter) but during epidemics, MPB will attack smaller trees.
- Lifespan is about one year; In July/August MPB fly from diseased tree to a healthy tree and bore to phloem layer to feed, lay eggs.
  - Larvae spend Winter under bark; reach pupae stage in Spring.
- MPB carry blue stain fungus that blocks tree's natural defense (resin). Within 2 weeks of attack, phloem layer is damaged enough to cut off flow of water and nutrients.
- 1996-2008: MPB infected 2 million acres in Colorado.



- 10-12 months after attack, trees turn yellow/red.
- Red/brown needles eventually fall off and trees appear grey.
- As trees die, they present fire danger, falling tree hazards, soil stability issues, and negatively affect visual landscape (tourism, real estate).
- Opportunities: Pellets for woodstoves, interesting "Blue Pine" for flooring, furniture, woodworking.

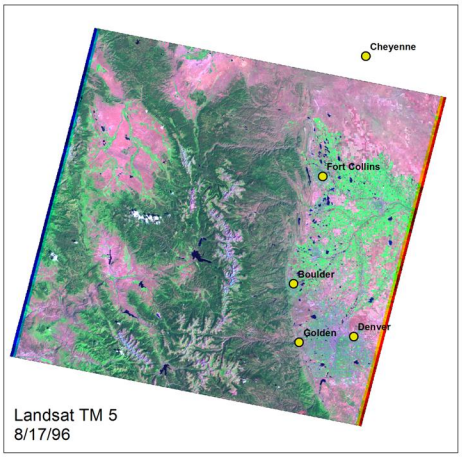


- Mining/logging/settlement in 1910s-20s and fire suppression has led to homogenous Pine stands of larger trees in overcrowded stands.
- Combined with drought conditions and warmer temperatures, perfect for MPB outbreak

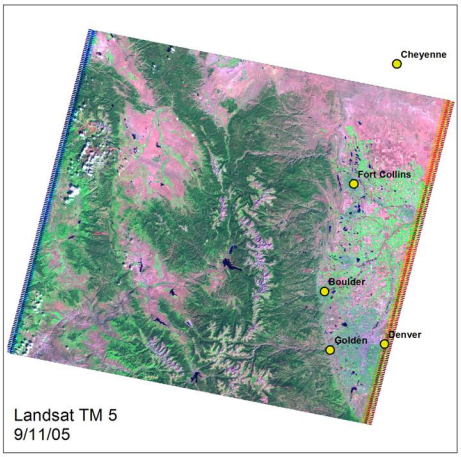
OBJECTIVE

- Detect and assess damage to pine forest stands (presumably from MPB) using NDVI change and Enhanced Wetness Difference Index.
  - EWDI uses wetness images from Tasseled Cap transformation.
  - Certain EWDI values have been found to be strongly correlated strongly with MPB red-attack damage (Franklin et al., 2003; Skakun et al. 2003).

IMAGERY



Landsat TM 5
8/17/96



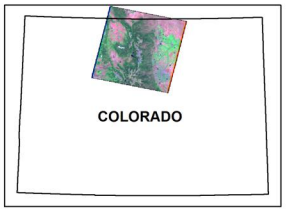
Landsat TM 5
9/11/05

Preprocessing:

•No radiometric normalization

•Check precipitation data

•AutoSynch to georectify



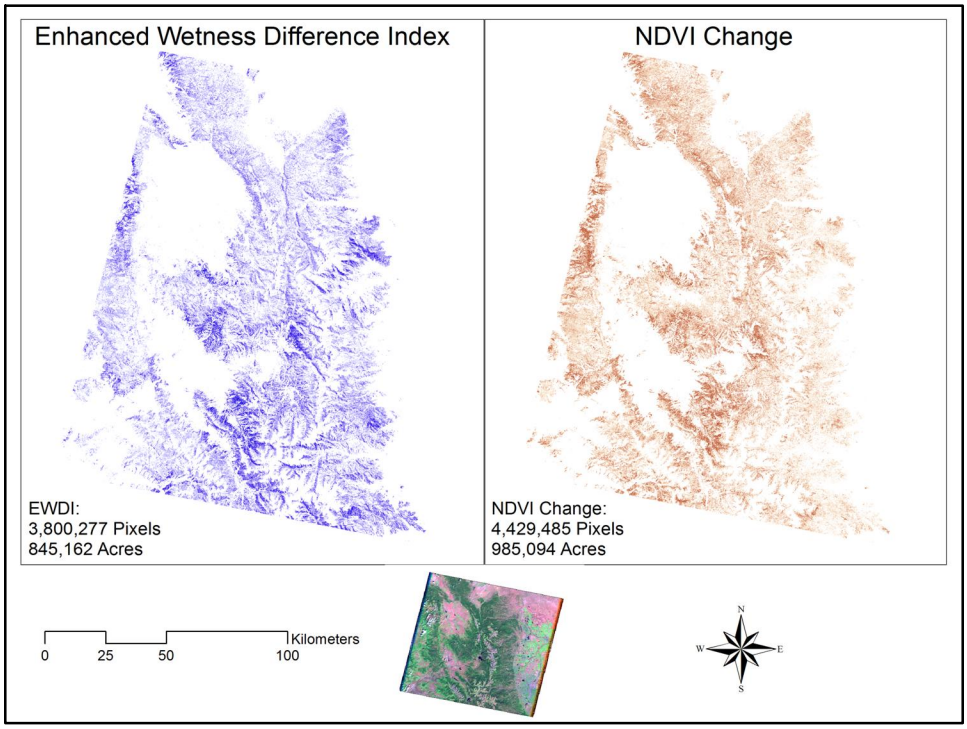
Unsupervised classification to isolate conifers and identify clouds/edges for mask of images

METHODS

- Mask out clouds/edges from both images and non-coniferous areas from 1996 image (from unsupervised classification).
- NDVI and Tasseled Cap Transformation.
- Subtract 05 images from 96 (positive values represent loss in moisture/vegetation).
- Limit pixels to elevations of 2500m to 3657m
  - Healthy and unhealthy Pinon and Juniper vegetation (found in elevations lower than 2500m) tend to exhibit similar spectral reflectance properties to damaged higher elevation pines (Cole, Christopher).
- Eliminate negative values (increase in moisture/vegetation).

METHODS

- Rescale values to 8-bit unsigned (0-255).
- Separate values into 10 quantiles; eliminate top and bottom quantiles.
  - Bottom quantile represents noise in change.
  - Top quantile represents greater magnitude of change; forest fire, logging, etc. (trees in 1996, bare ground in 2005).
  - Resulting values for NDVI change 3-31;
    EWDI 3-37


Enhanced Wetness Difference Index
EWDI:
3,800,277 Pixels
845,162 Acres
NDVI Change
NDVI Change:
4,429,485 Pixels
985,094 Acres
Kilometers
0
25
50
100
N
W
E
S

ACCURACY ASSESSMENT

- Compare “damaged” pixels to polygons from aerial surveys* 1994-2005 (CSFS; CSU).
- Zonal Statistics as Table
  - Assigned all damaged pixels to value of 1
  - Calculated sum of pixels within polygons

Method	# of Pixels	% of Pixels
EWDI	1,121,280	29.50%
NDVI Change	1,280,629	29%
EWDI and NDVI	715,570	35%

*Aerial surveys by the nature of its data collection are not the most accurate data sets

CONCLUSIONS

- Both methods appear effective at detecting damaged pine stands.
  - Uncertainty of exactly what it is detecting (green, red, grey stage).
  - Uncertainty of differences in detection (EWDI vs. NDVI change).
- Better ground truth data would be helpful in interpreting results and determining the most effective method for detecting MPB damage.
  - Would provide more accurate calibration of EWDI and NDVI change values to actual damage.

SOURCES

- Colorado State Forest Service (CSU, USDA, CO counties) contact: Skip Edel
- Cole, Christopher. *Assessment of Conifer Health in Grand County, Colorado using Remotely Sensed Imagery*
- Natural Resources Canada: www.nrcan-rncan.gc.ca
- Wulder et al. 2005 *Surveying mountain pine beetle damage of forests: A review of remote sensing opportunities*
- *Wikipedia:* http://en.wikipedia.org/wiki/Mountain_pine_beetle
- *Professor Geoffrey Duh*