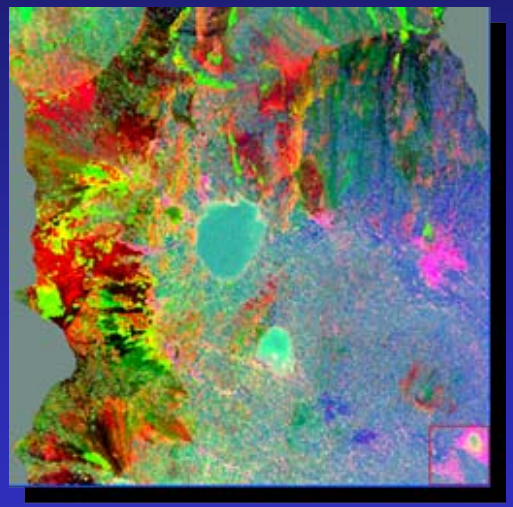
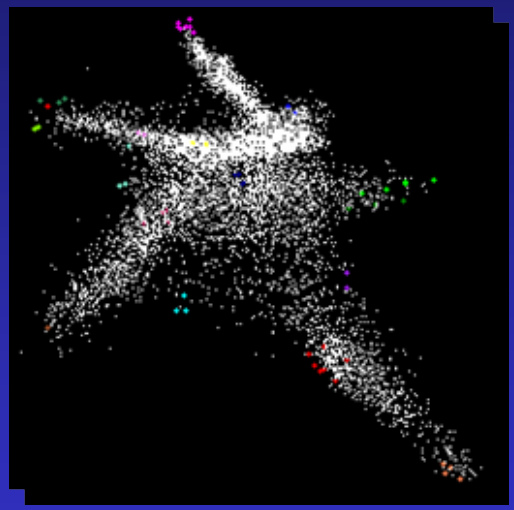
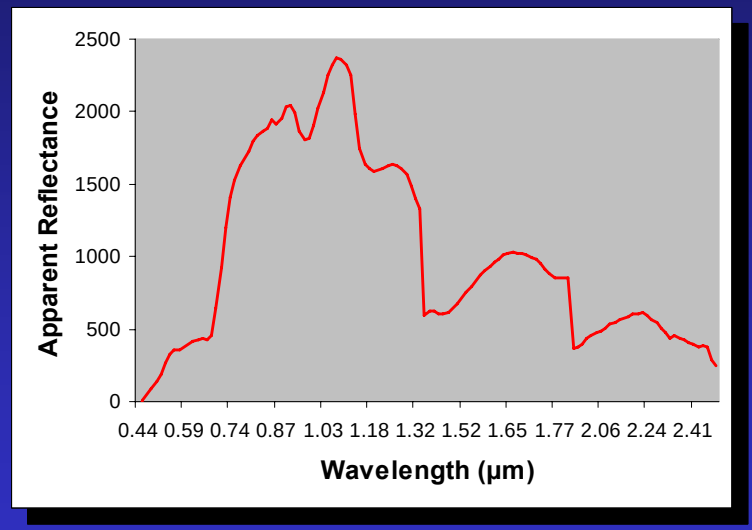
What Exactly is Hyperspectral Remote Sensing?







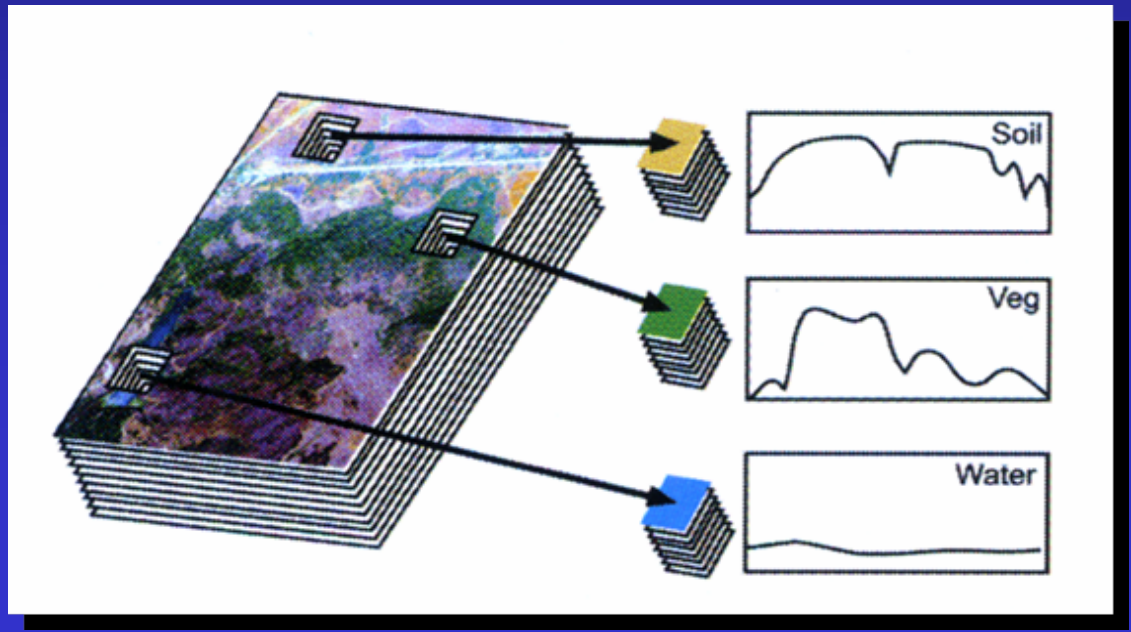
Jeremy P. Shive
Herpetology Laboratory
Department of Biological Sciences,
Idaho State University

Outline

- What is hyperspectral data?
- Hyperspectral Processing “Hourglass”
- My Research

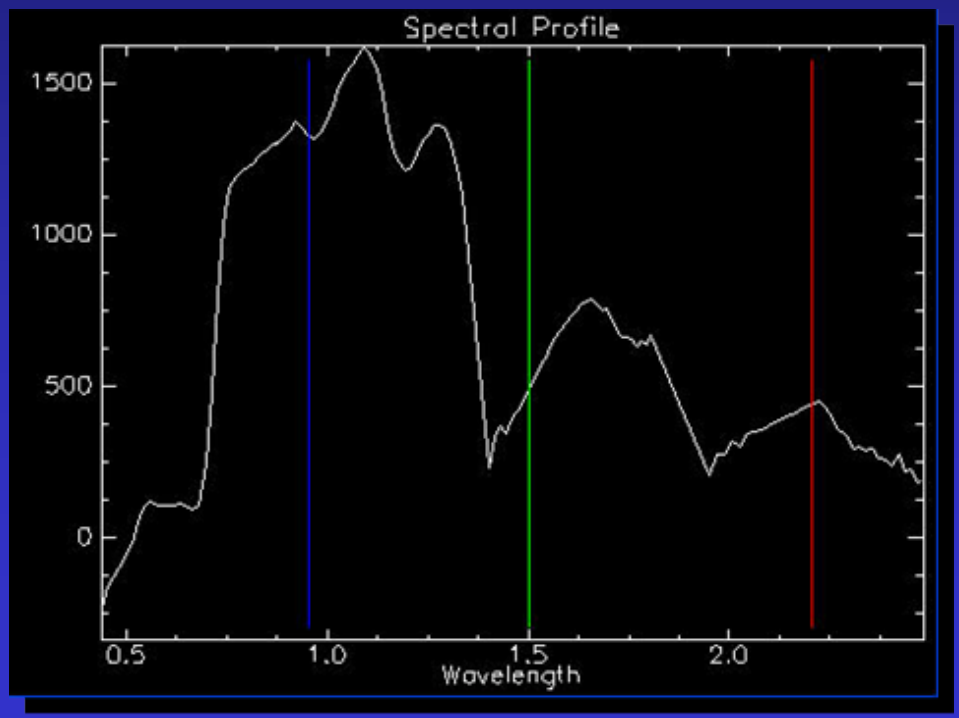
Imaging Spectrometry

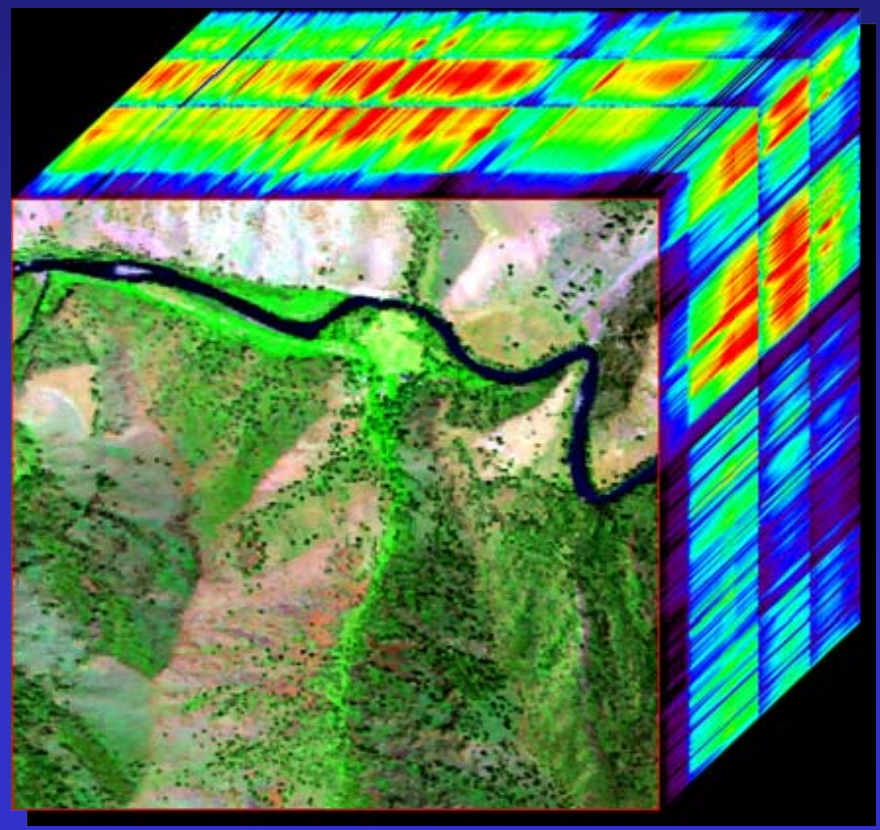
- Definition- The acquisition of images in hundreds of registered, contiguous spectral bands such that for each element it is possible to derive a complete reflectance spectrum (Goetz et al.1985)



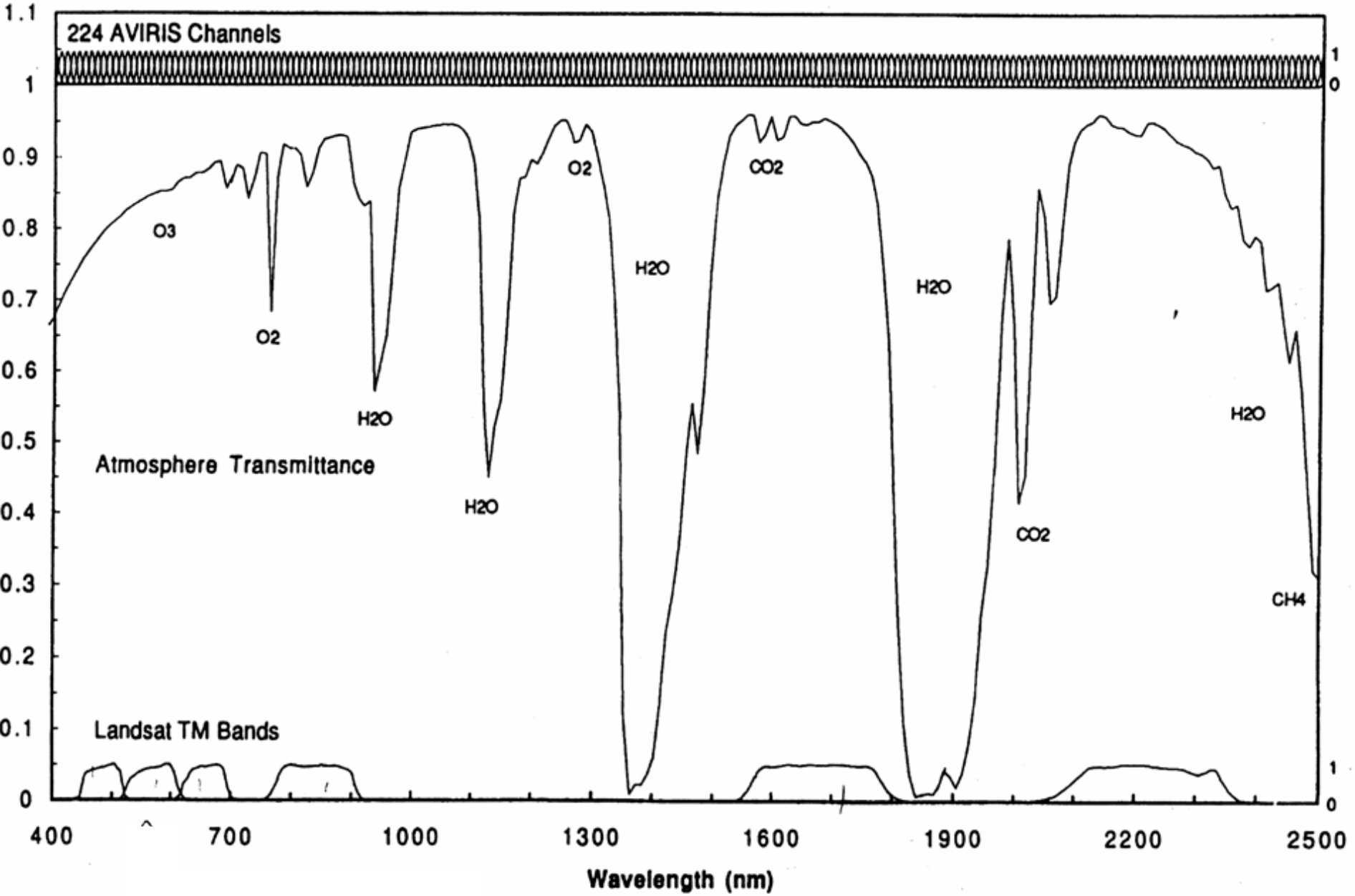
Hyperspectral Data

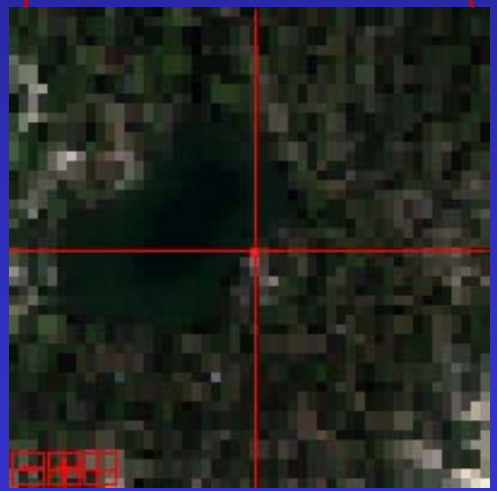
- Multiple images taken simultaneously at successive wavelengths for a single spatial location

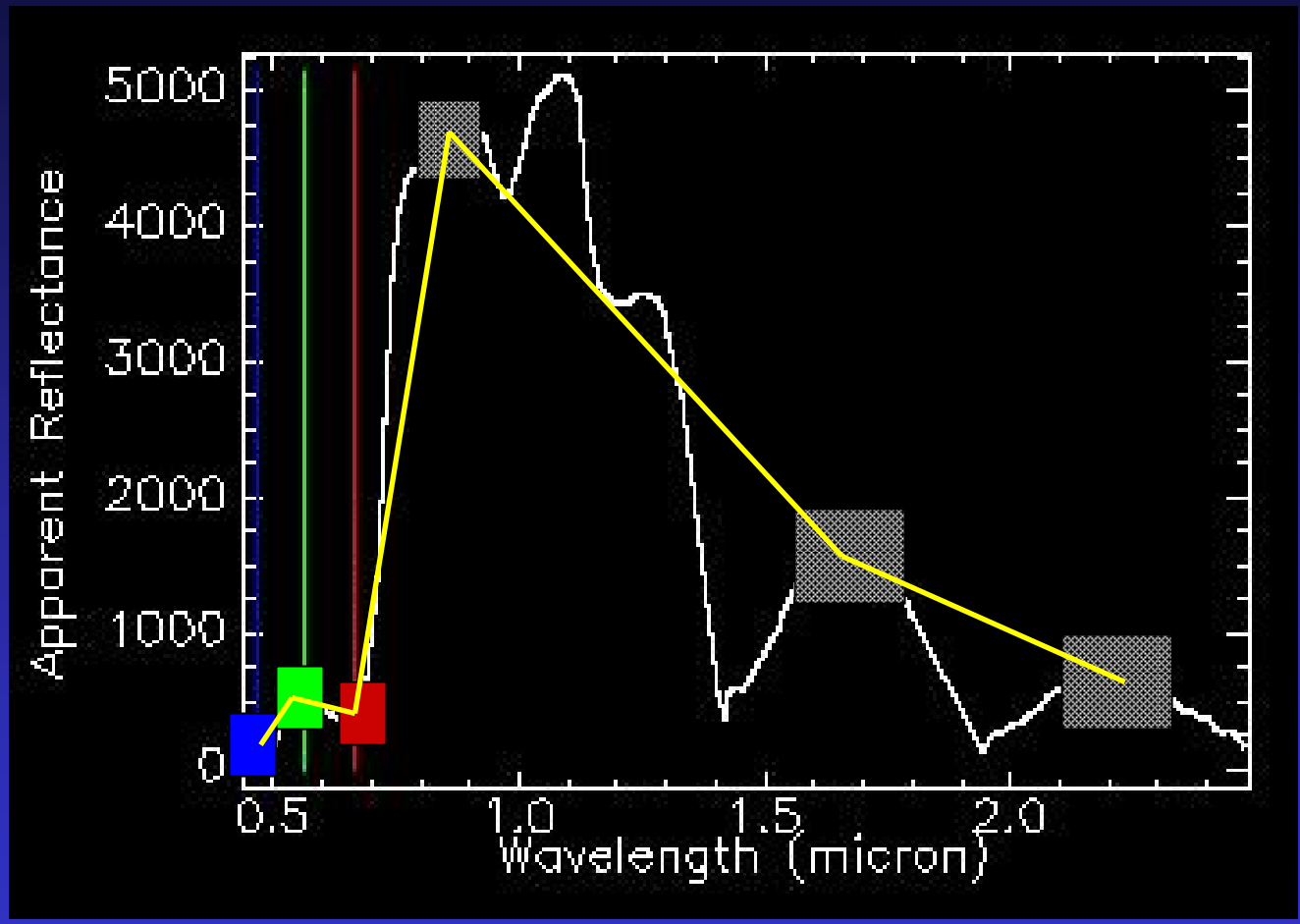




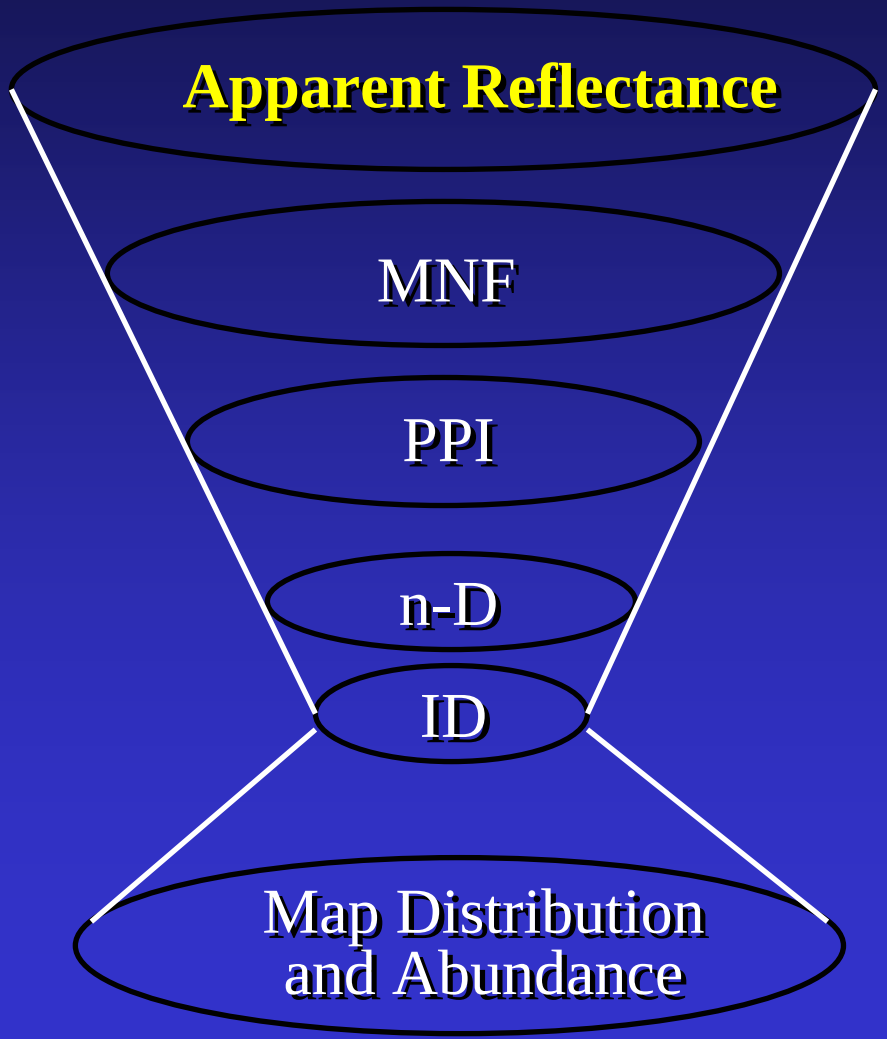
AVIRIS, TM Spectral Measurements






5000
4000
3000
2000
1000
0
Apparent Reflectance
0.5
1.0
1.5
2.0
Wavelength (micron)

Hyperspectral Processing



Atmospheric Correction

Minimum Noise Fraction Transform

Pixel Purity Index

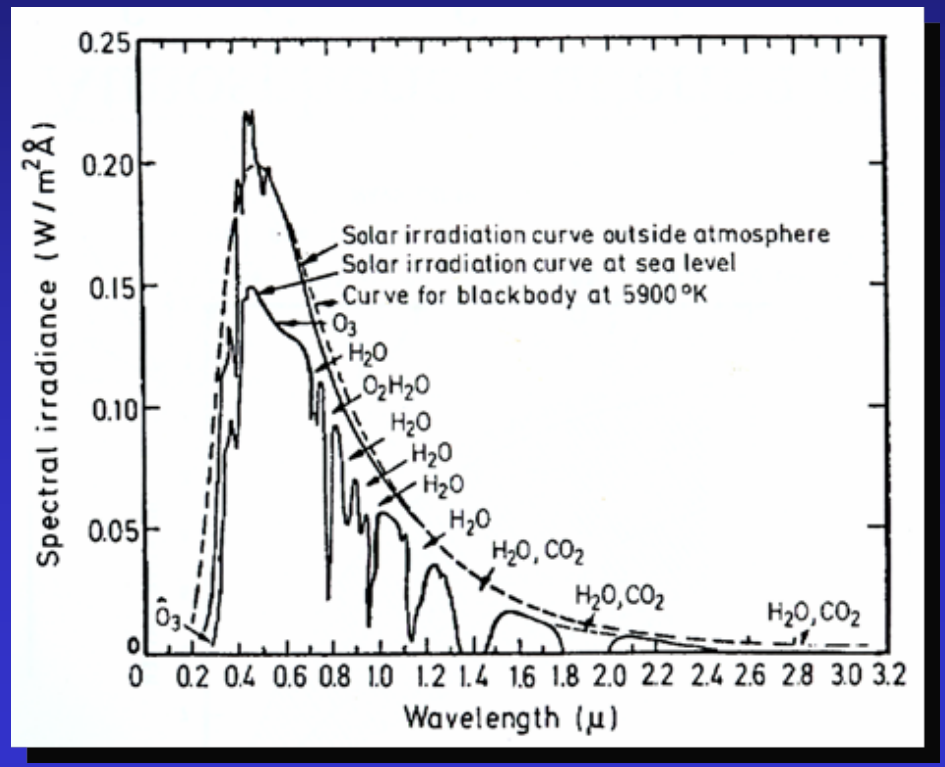
n-Dimensional Visualizer

Identification

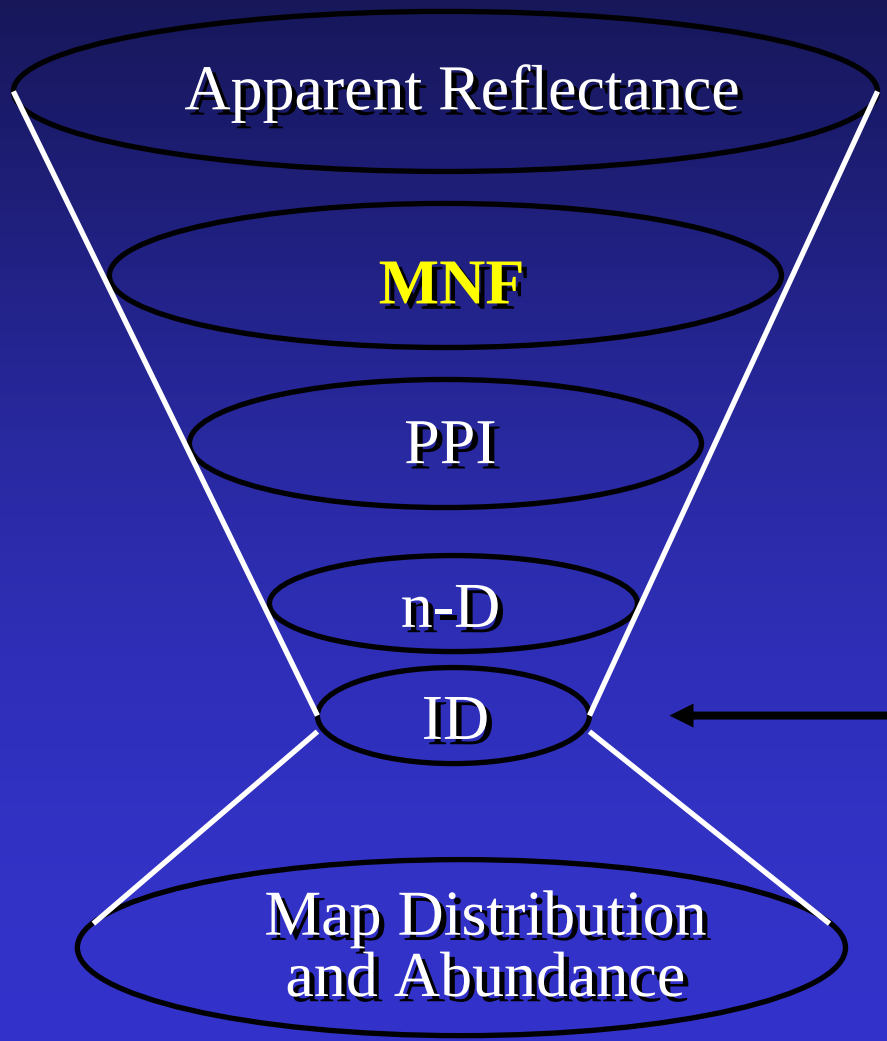
Spectral Angle Mapper, Mixture Tuned Matched Filtering

Apparent Reflectance

- Incorporates solar irradiance curve
- Removes atmospheric scattering and absorption effects



Hyperspectral Processing



Atmospheric Corrections

Spectral Data Reduction

Spatial Data Reduction

Visualization

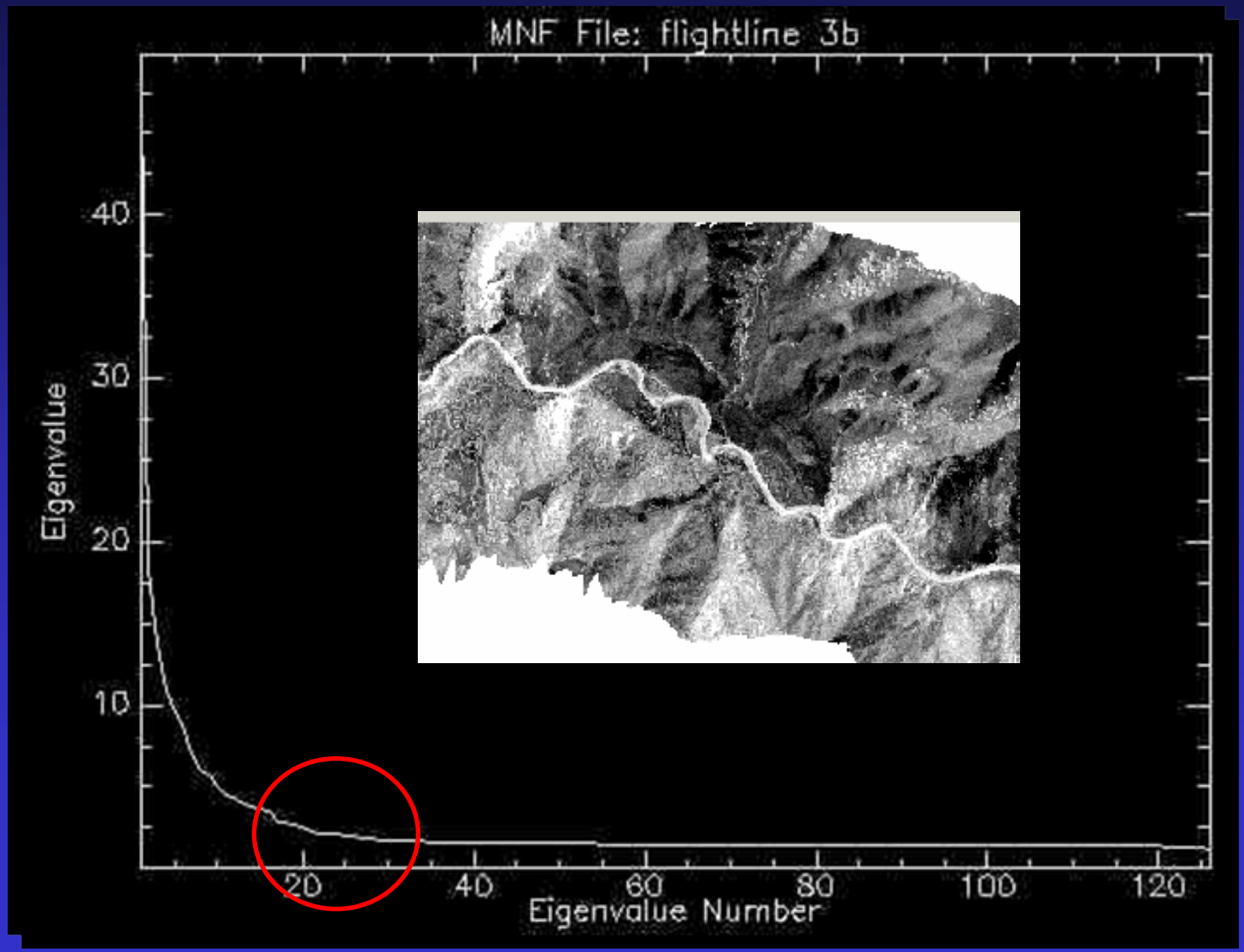
Identification

SAM, MF, SFF,
MTMF

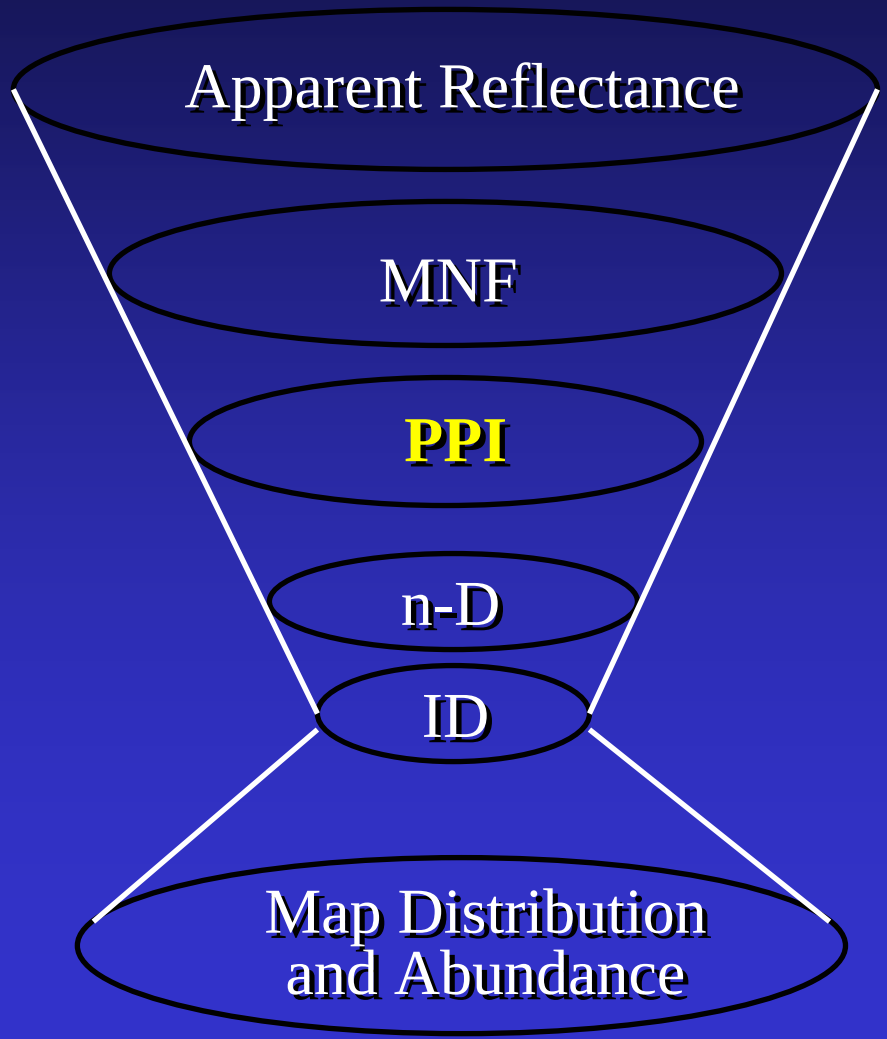
Minimum Noise Fraction (MNF) Transform

- Noise-Whitened Principal Components
- Step 1: Based on an estimated noise covariance matrix, decorrelates and rescales the noise in the data
- Step 2: Standard Principal Components transformation

Data Dimensionality



Hyperspectral Processing



Spatial/Spectral Browsing

Spectral Data Reduction

Spatial Data Reduction

Visualization

Identification

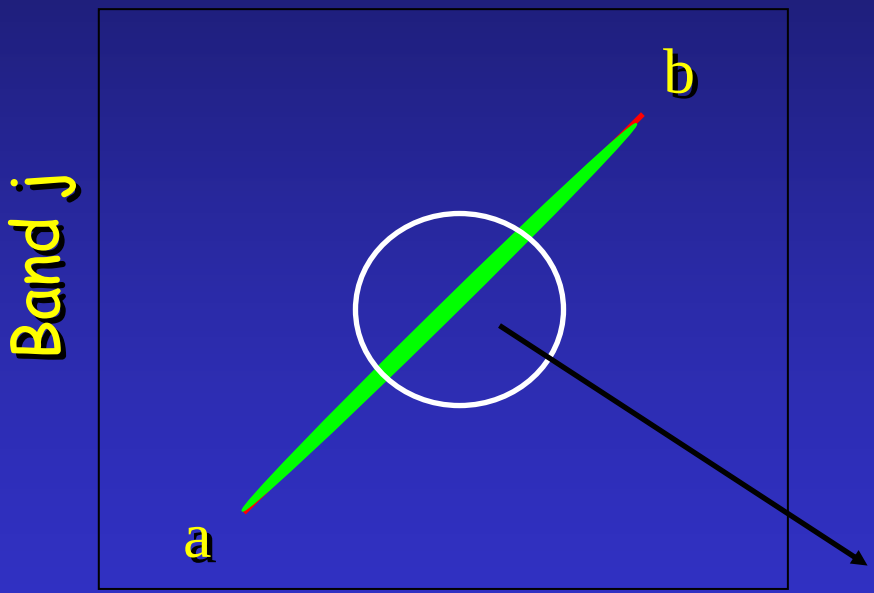
SAM, MF, SFF,
MTMF

Pixel Purity Index (PPI)

- Identifies the most “spectrally pure” or extreme pixels (endmembers)
- Repeatedly projecting n-dimensional scatterplots onto a random unit vector (convex geometry)

Convex Geometry…

100%



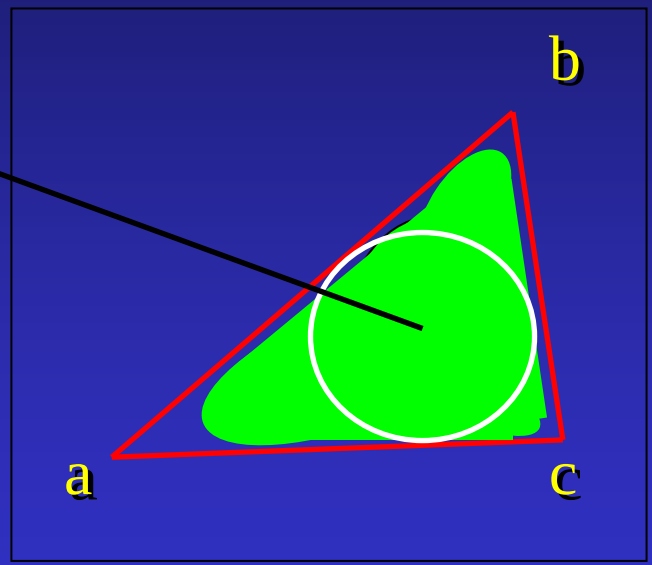
100%

Mixture

Convex Geometry…

100%

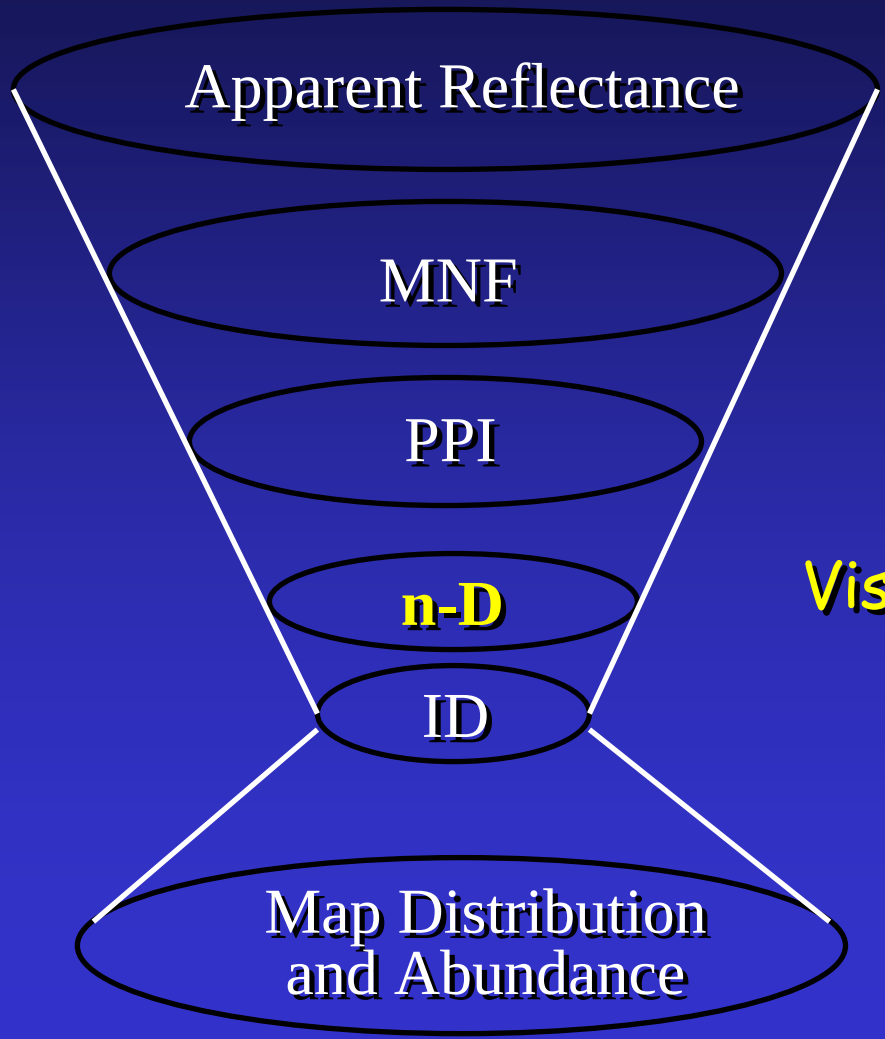
Varying Mixtures



100%

100%

Hyperspectral Processing



Spatial/Spectral Browsing

Spectral Data Reduction

Spatial Data Reduction

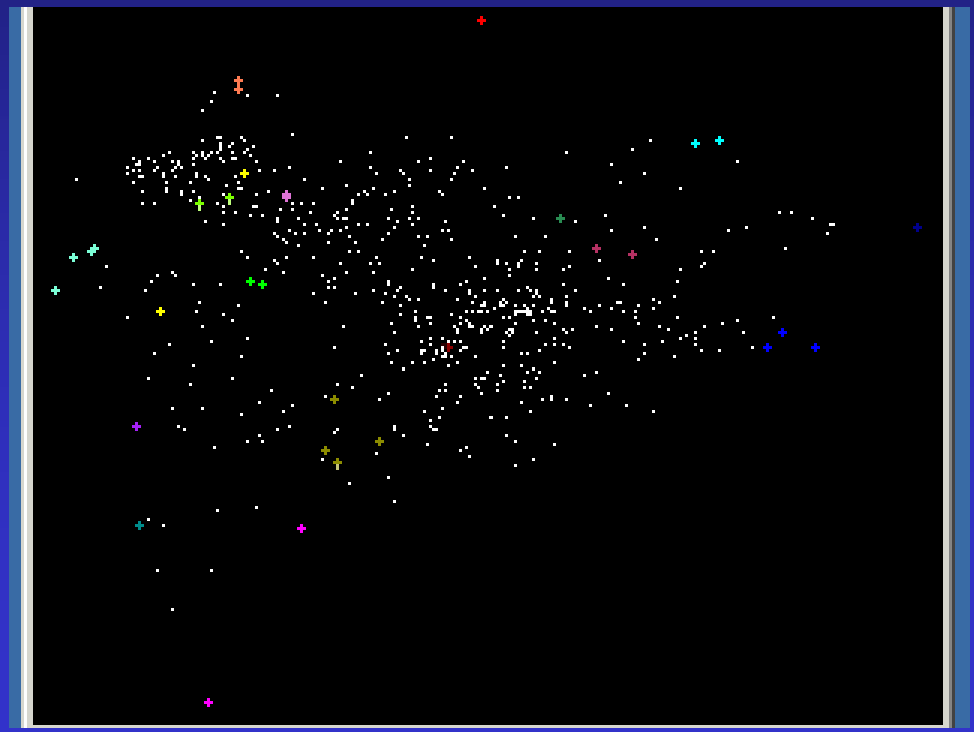
Visualization of Endmembers

Identification

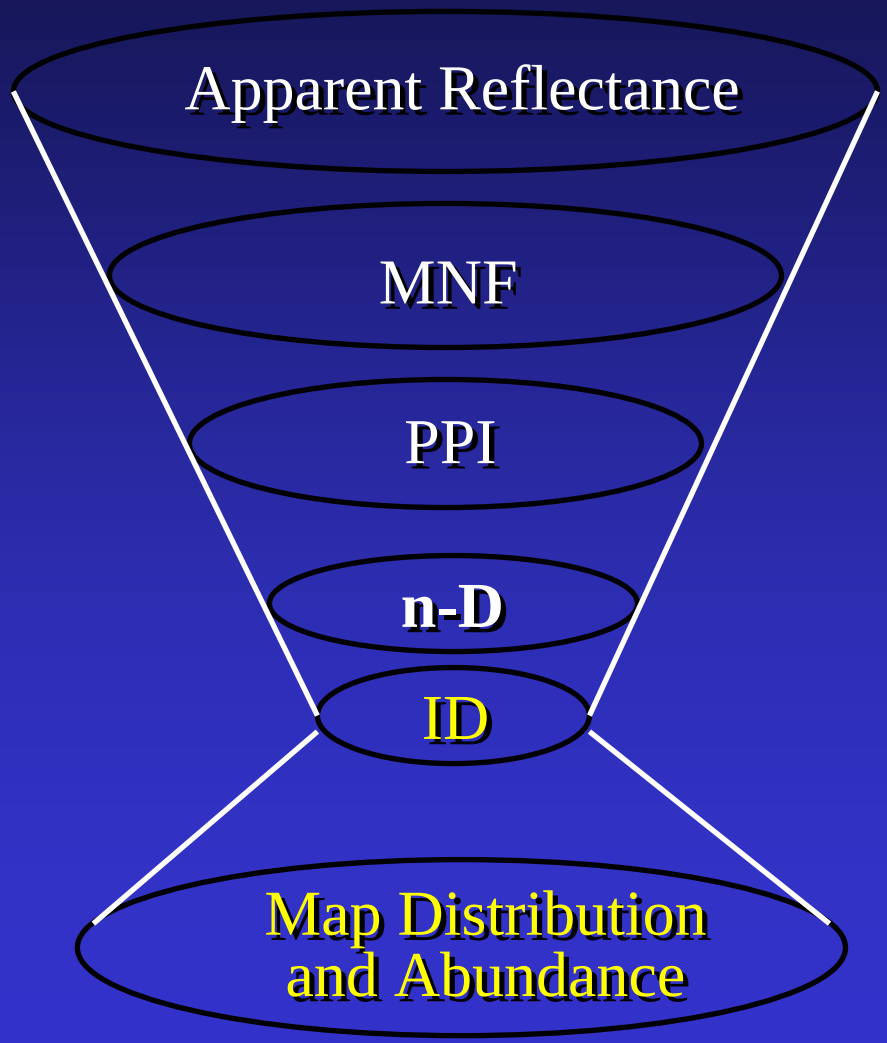
SAM, MF, SFF,
MTMF

n-Dimensional Visualizer

- Interactive tool to locate and cluster “purest pixels” using an n-dimensional scatterplot



Hyperspectral Processing



Spatial/Spectral Browsing

Spectral Data Reduction

Spatial Data Reduction

Visualization

Identification

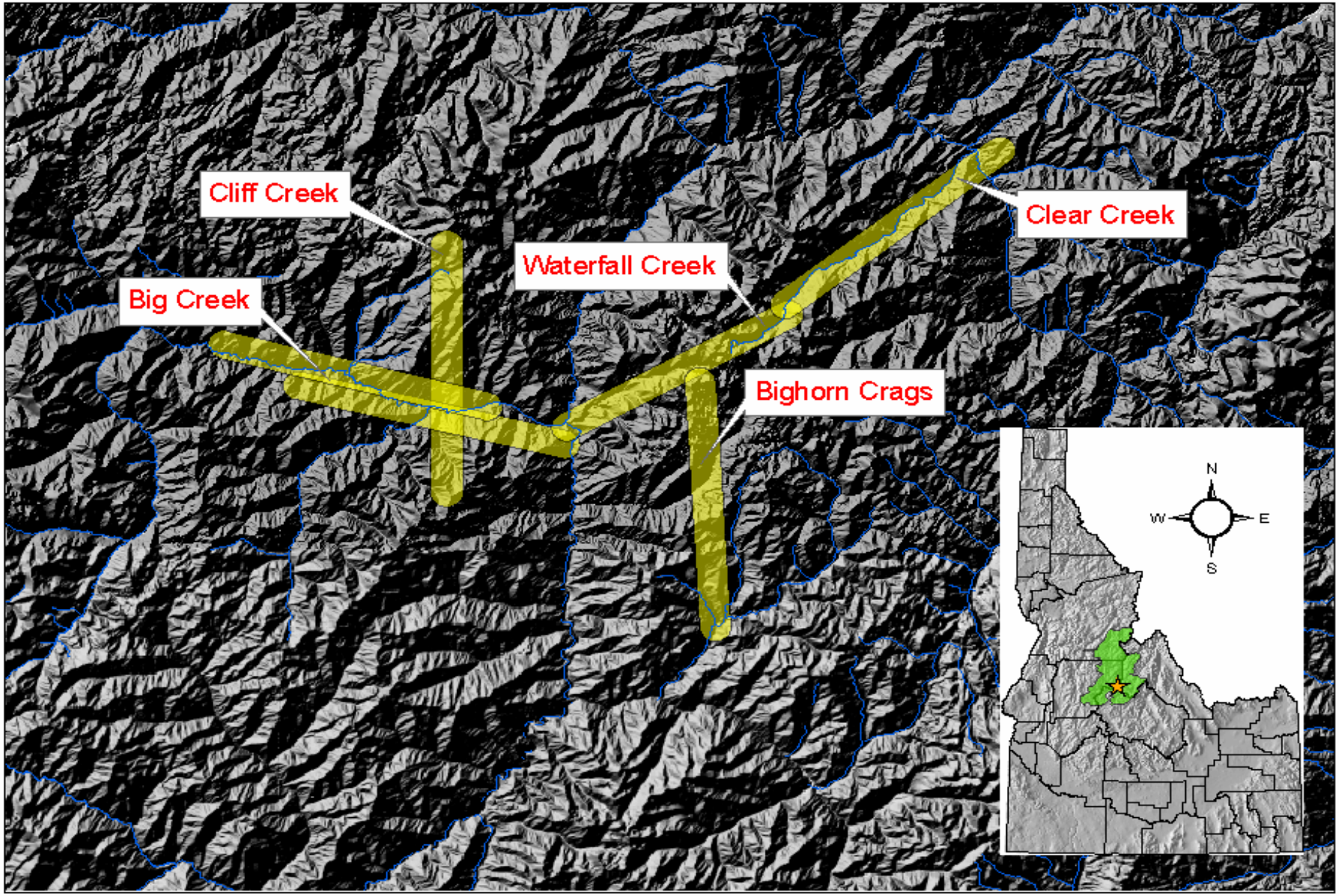
SAM, MF, SFF, MTMF

Hyperspectral Applications

- Oceanography: constituents, sediments, bathymetry
- Geology: mineralogy and rock & soil identification
- Ecology: vegetation species (community) identification, forest health, vegetation water content
- Snow and Ice Hydrology: grain size and runoff/snow pack
- Agricultural: crop type, yield, stress

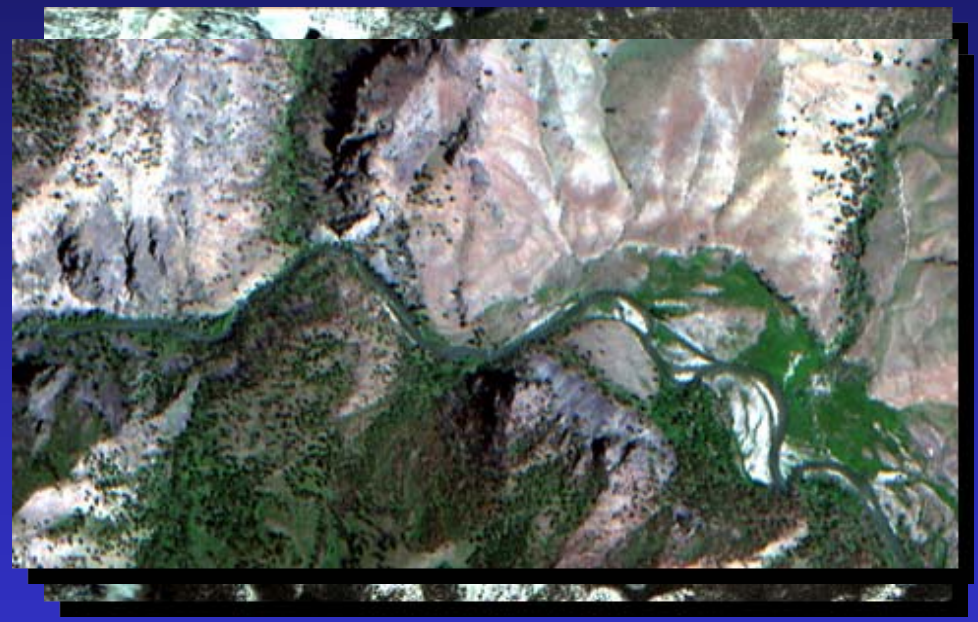
My Research

- Need to assess current population status
- Knowledge of wetland distributions is a fundamental first step
- Incorporate into future management plans


Cliff Creek
Clear Creek
Waterfall Creek
Big Creek
Bighorn Crags
N
W
E
S
0 5 10 20 30 40
Kilometers
0 2.5 5 10 15 20
Miles

My Research

- Multiscale Assessment (Spectral/Spatial)
- ADAR Multispectral, HyMap Hyperspectral, Landsat 7 ETM+
- Evaluate Cost of Imagery, Time of Processing, Accuracy Assessment

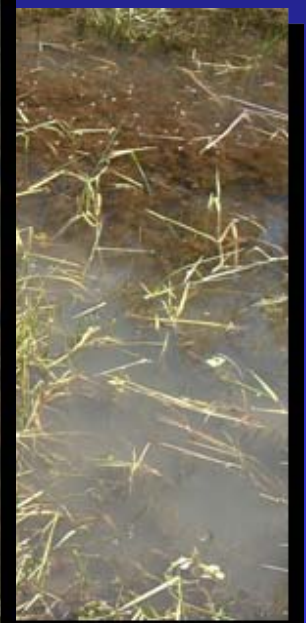


Big Creek Area

- Amphibian presence is associated with backwater channels and pools and emergent vegetation

Mapping Shallow Water Sediment

- Identified a submerged sediment endmember and mapped distribution

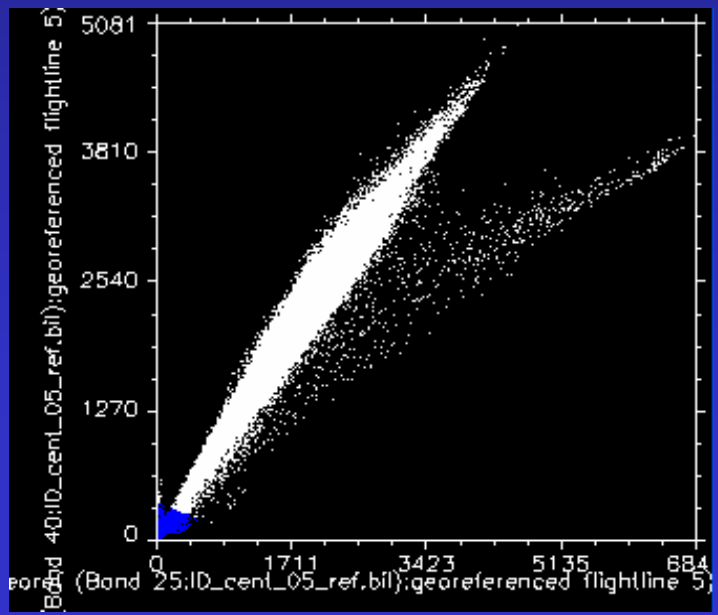


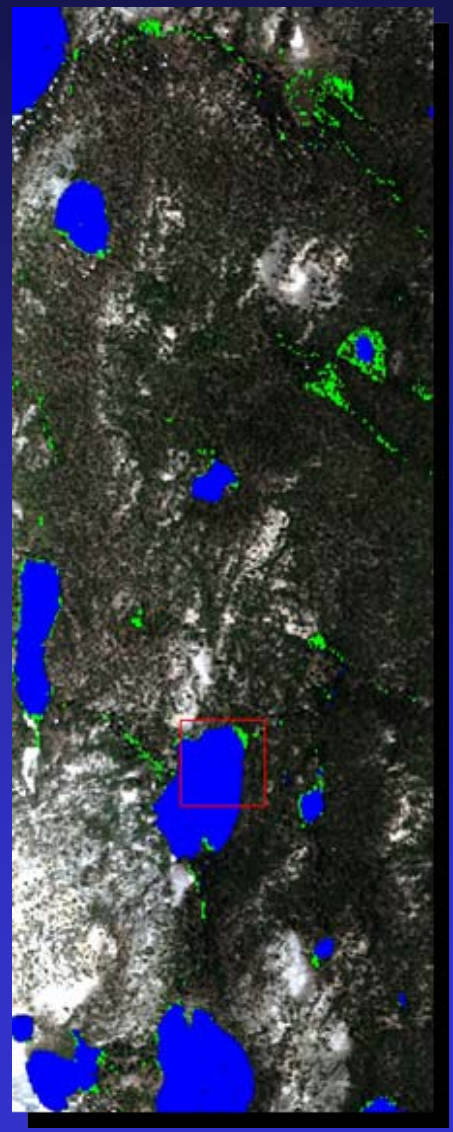
Mapping Moist Vegetation

- Identified regions where vegetation shows larger absorption of leaf water

Bighorn Crags Area

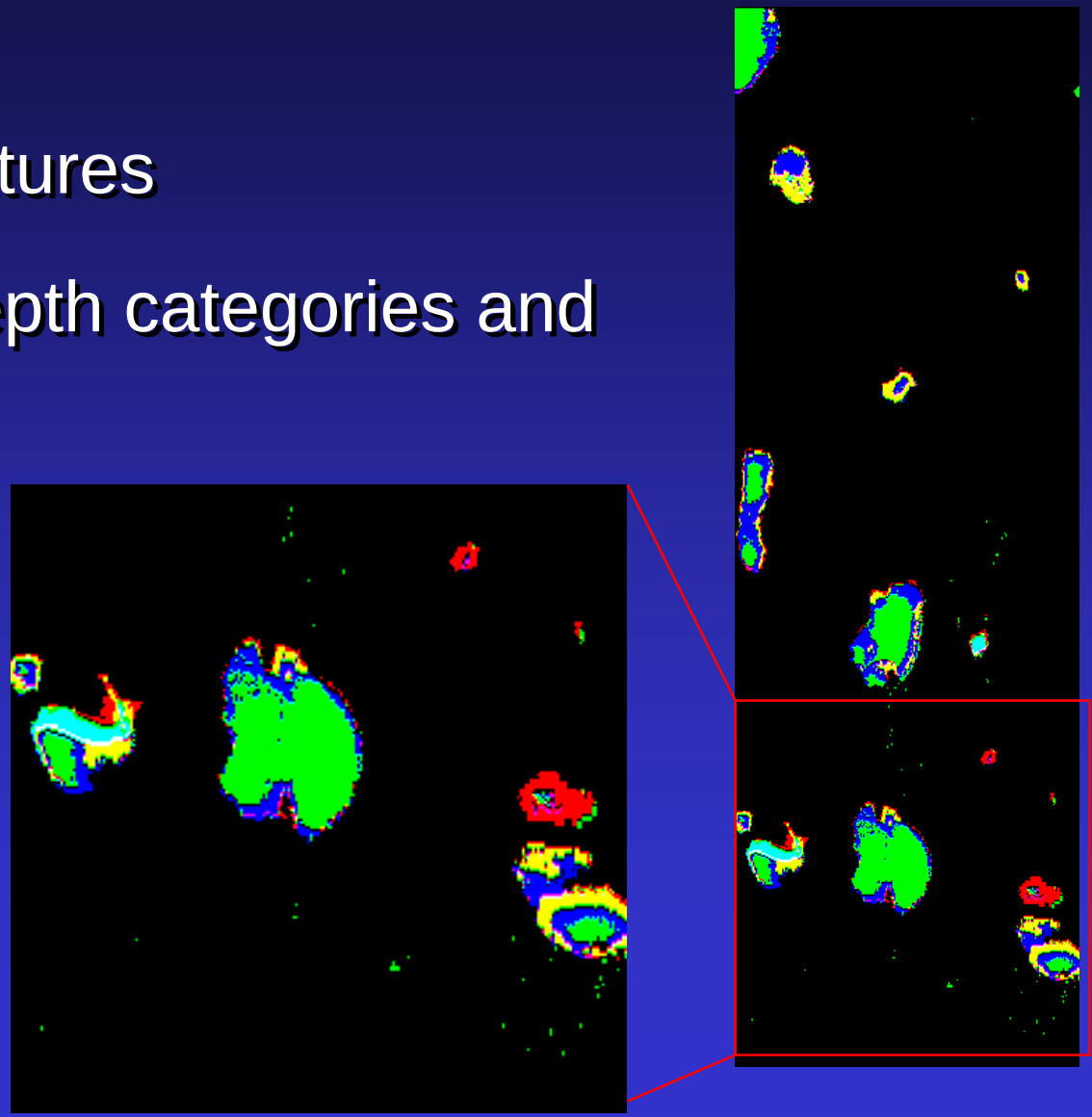
- Amphibian presence is associated with emergent sedges
- 2-D scatterplot using NIR bands to identify standing water





Lake Depth and Composition

- Mask Water Features
- Classify three depth categories and substrate



Summary

- Preliminary results suggest that hyperspectral data can successfully map amphibian habitat
- Hyperspectral data may distinguish breeding, foraging, and overwintering habitat (in some landscapes)
- Potentially important method for wetland habitat mapping and conservation