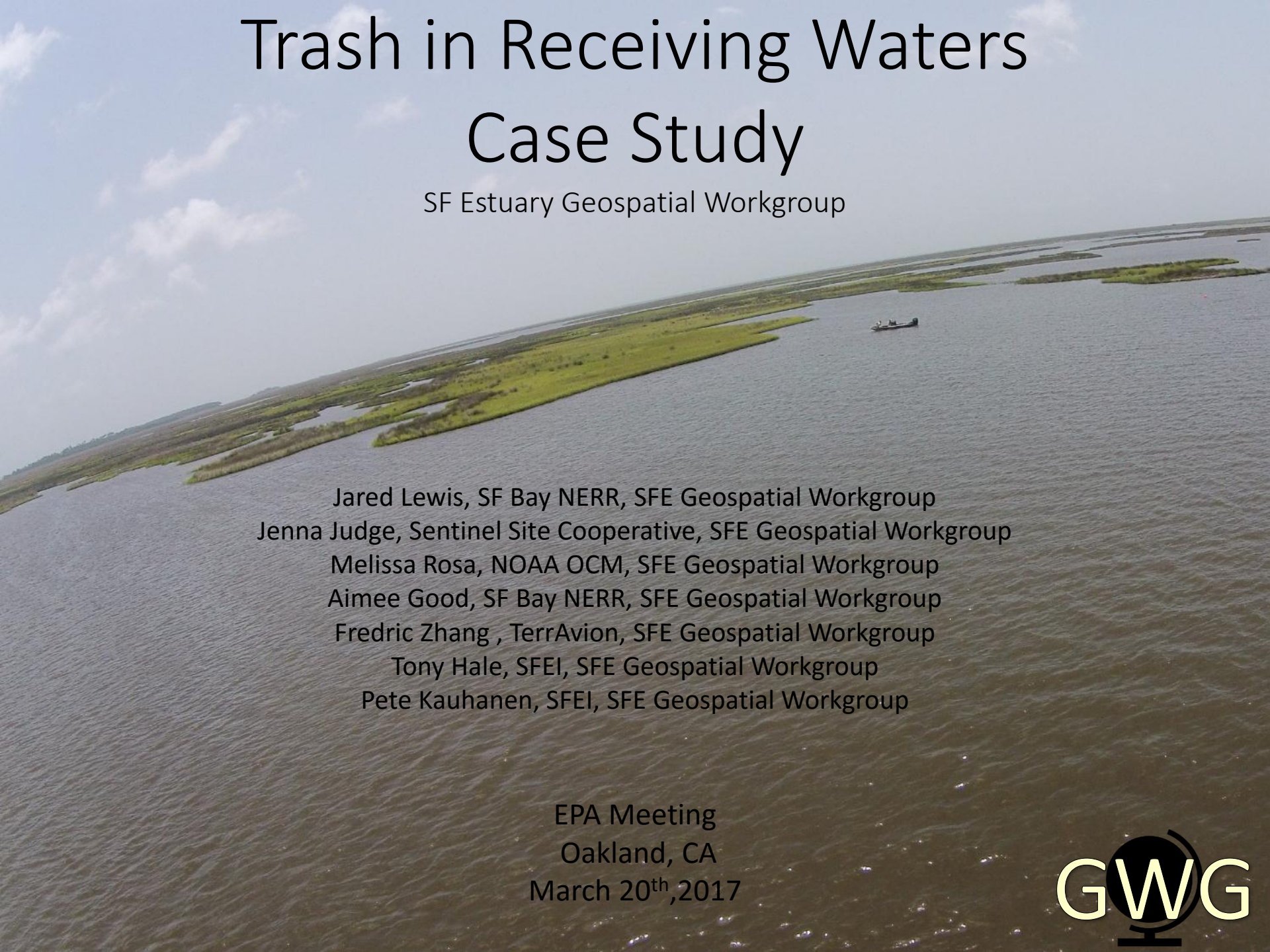
Trash in Receiving Waters Case Study

SF Estuary Geospatial Workgroup



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Jenna Judge, Sentinel Site Cooperative, SFE Geospatial Workgroup
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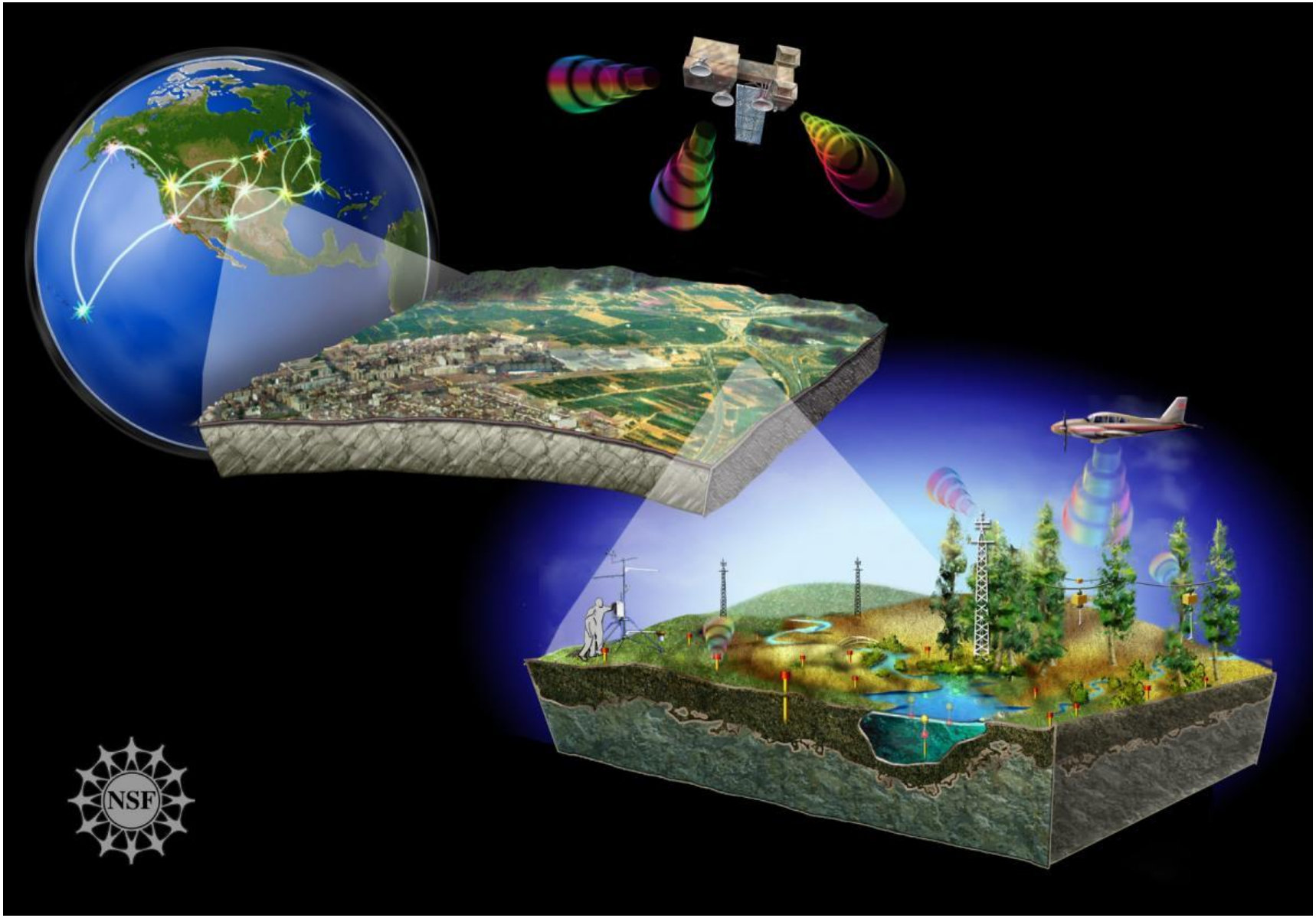
EPA Meeting
Oakland, CA
March 20th,2017

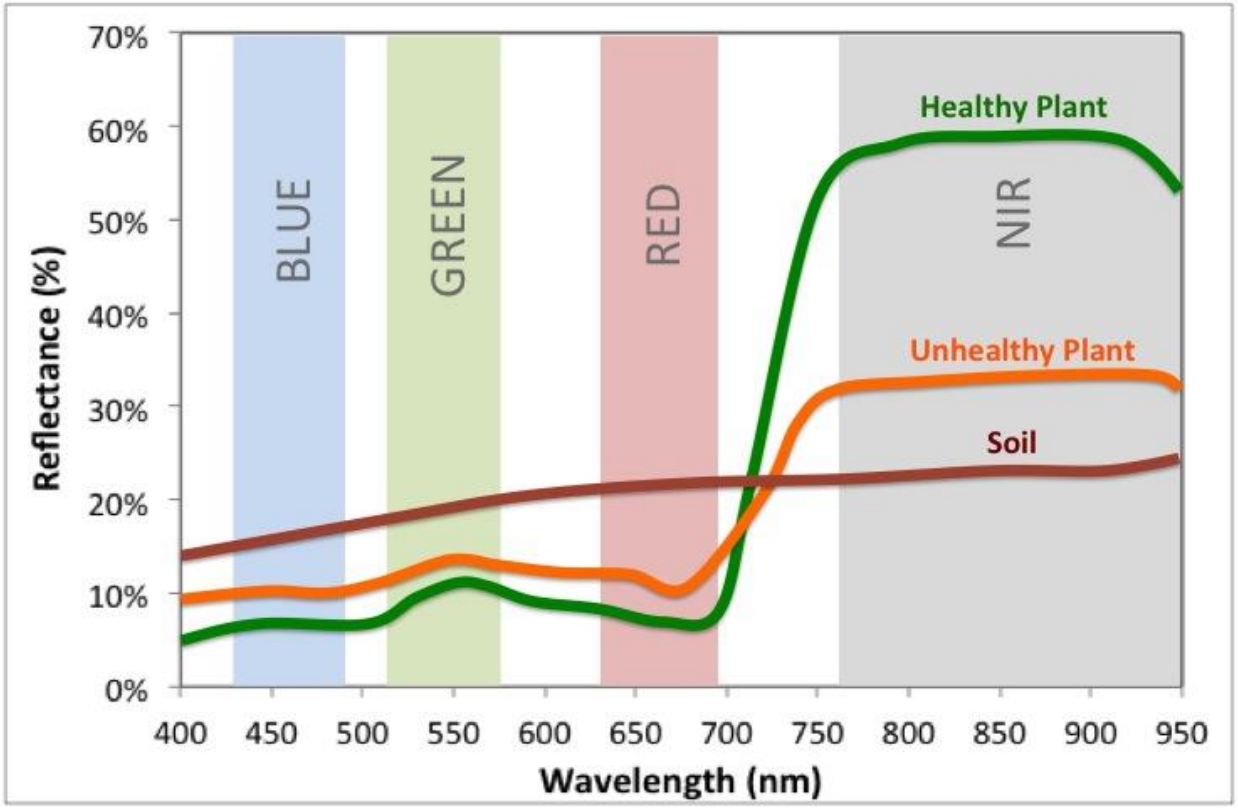
GWG

What is Remote Sensing?

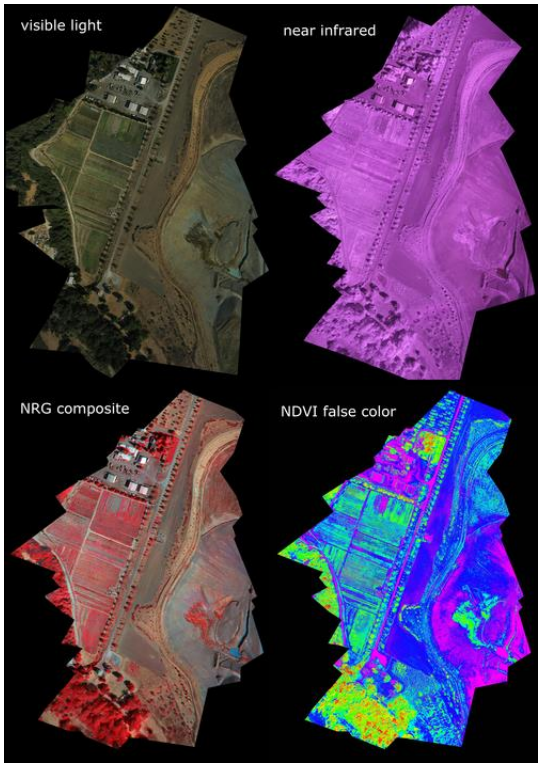
"Remote sensing is the **science of obtaining information** about objects or areas from a distance, typically from aircraft or satellites." (NOAA 2016)


NSF

Spectral Signal

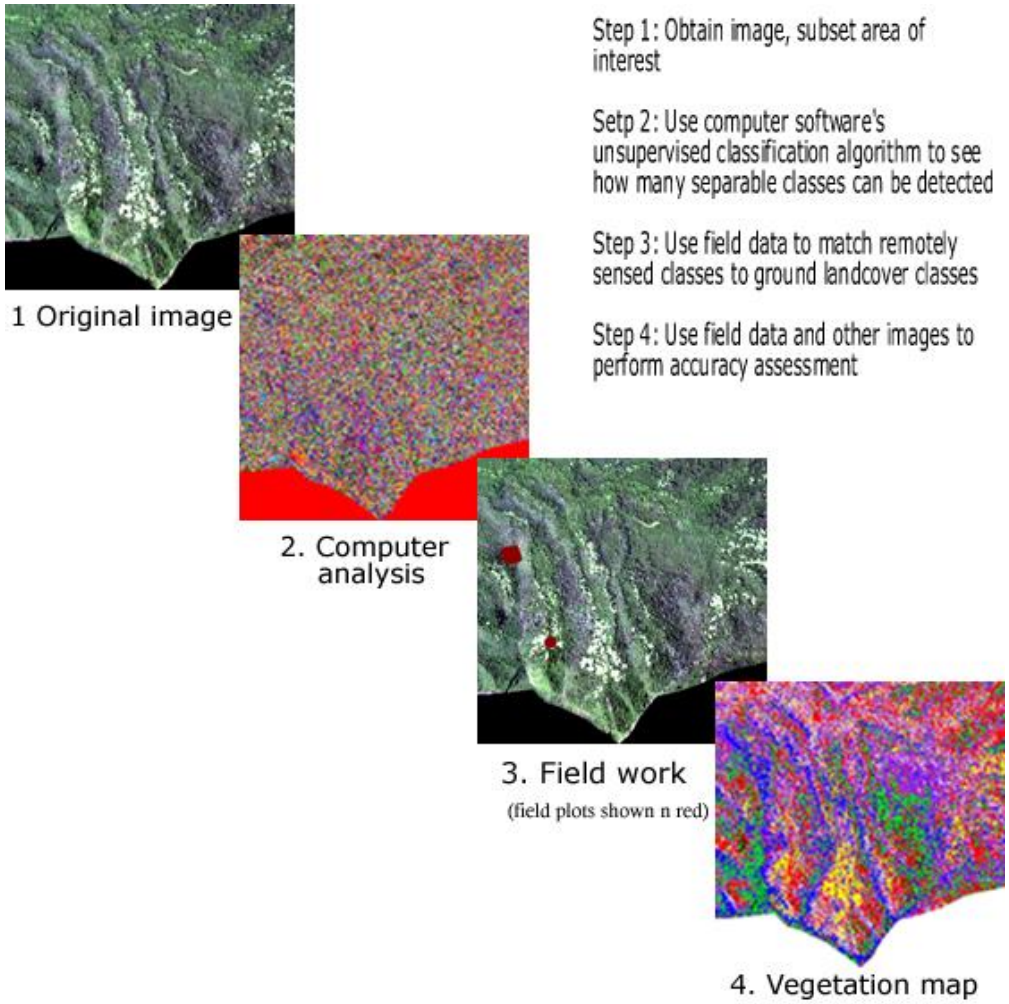


Extracting Information



- Different spectral bands and combinations provide different information
- Spectral data can be manipulated and analyzed in many different ways

Image Classification



Step 1: Obtain image, subset area of interest

Setp 2: Use computer software's unsupervised classification algorithm to see how many separable classes can be detected

Step 3: Use field data to match remotely sensed classes to ground landcover classes

Step 4: Use field data and other images to perform accuracy assessment

Case Study Overview

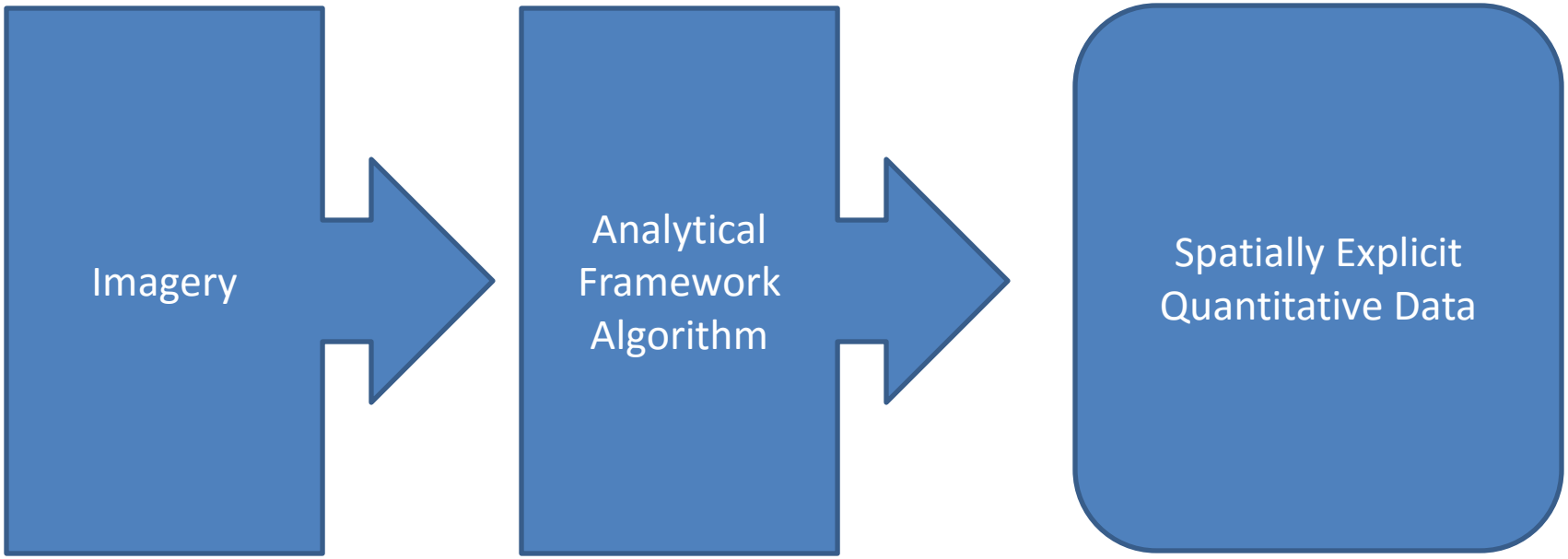
- Test the efficacy of multispectral aerial imaging for trash detection
- Evaluate spatial resolution constraints
- Evaluate automated classification routine (PCA)
- Evaluate spectral response and differentiation, using various band and sensor configurations
- Address outcomes of previous research
- Report back

Detection Challenges and Needs

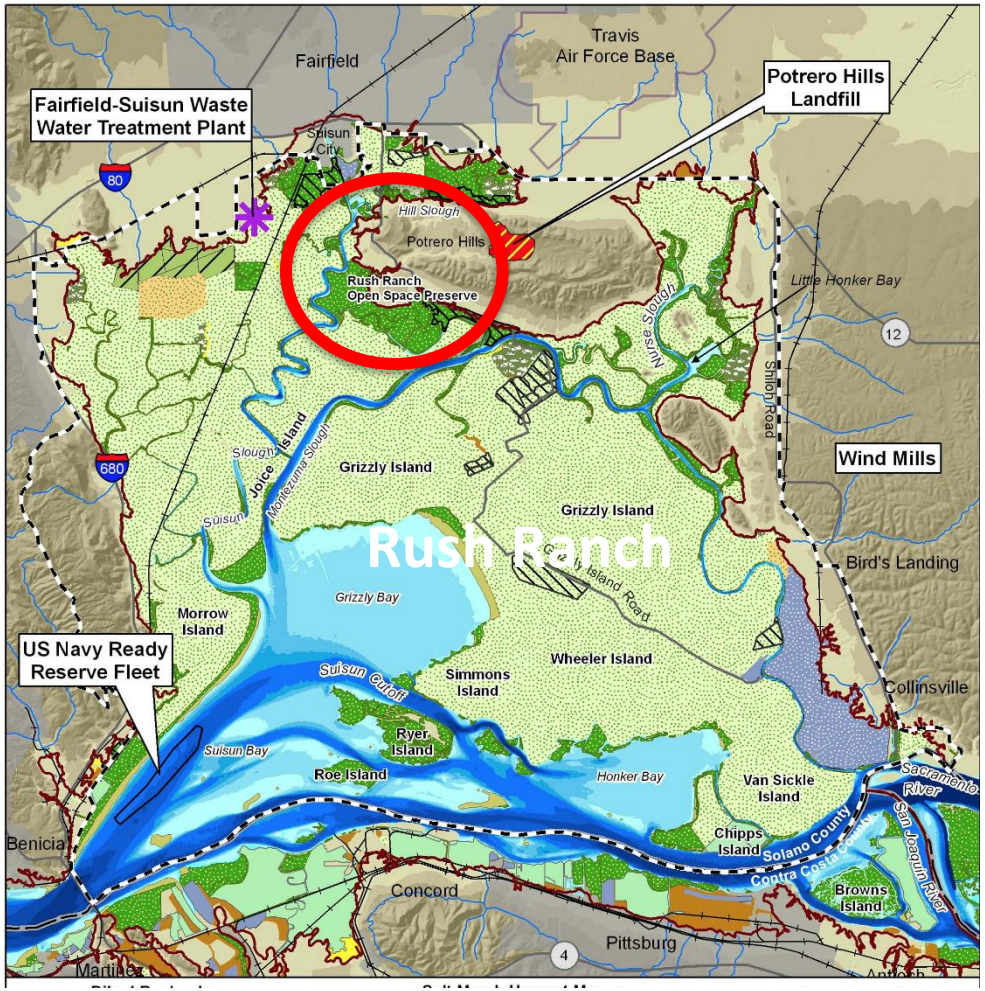
1. **Encounter Rate**
– Debris concentration is often unpredictable and variable
2. **Debris Size**
– Most debris is relatively small (<1m in long dimension, often <0.3m)
3. **Debris Visibility**
– Debris often awash or partially sub surface, reducing target size. Many platforms and sensors are weather dependent.
4. **Detection v. Identification**
– Noting the presence of "something" versus identifying what the anomaly is
– Challenge increases as resolution decreases
5. **Resolution v. Coverage**
– Trade off between detail of imagery versus coverage of imagery
– Post processing is often labor intensive

Source: NOAA Remote Sensing Workshop – Honolulu - January 19th, 2017
http://iprc.soest.hawaii.edu/NASA_WS_MD2016/pdf/Murphy2016.pdf

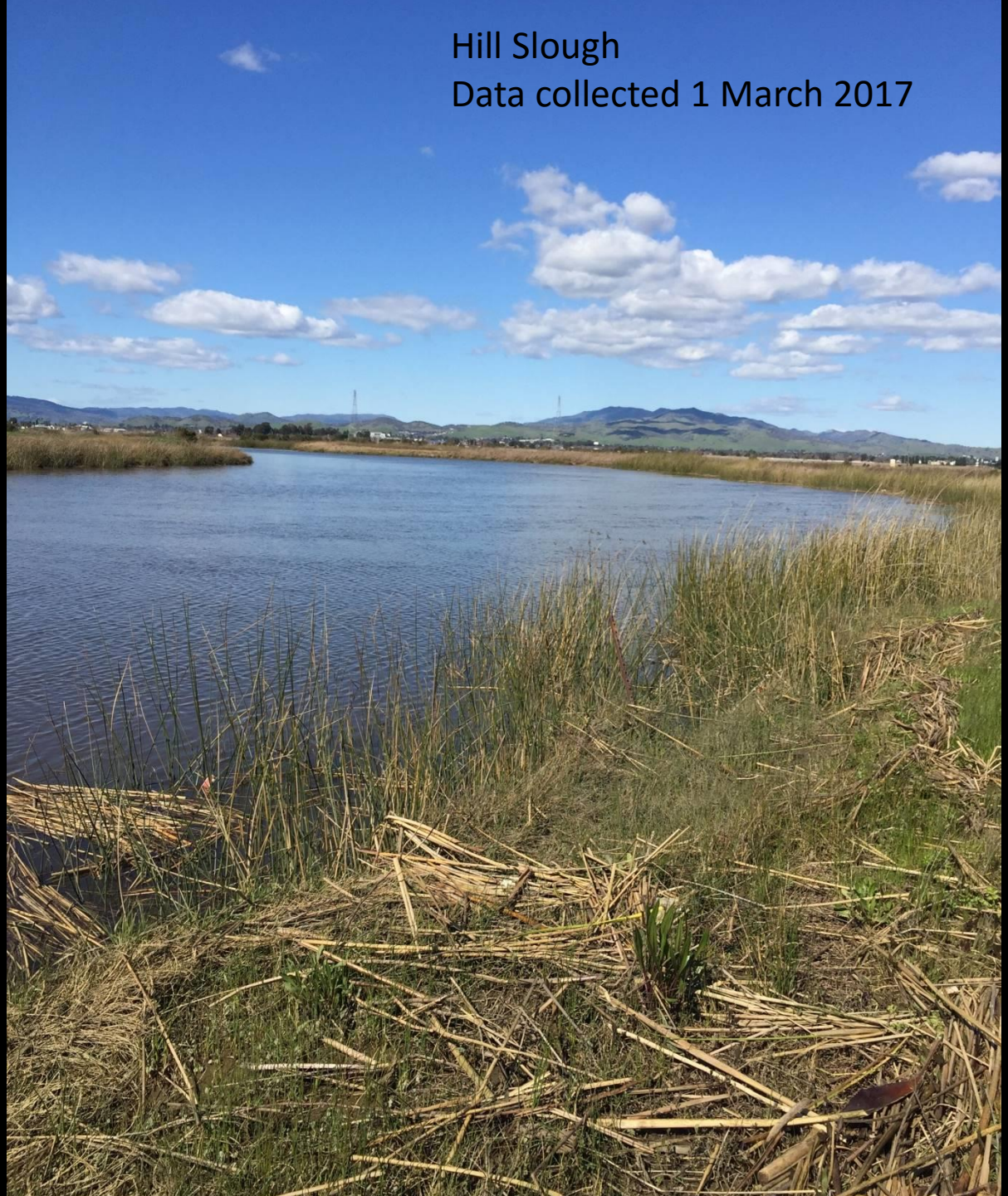
Conceptual Model



Rush Ranch
National Estuarine Research Reserve
Solano County




GARBAGE

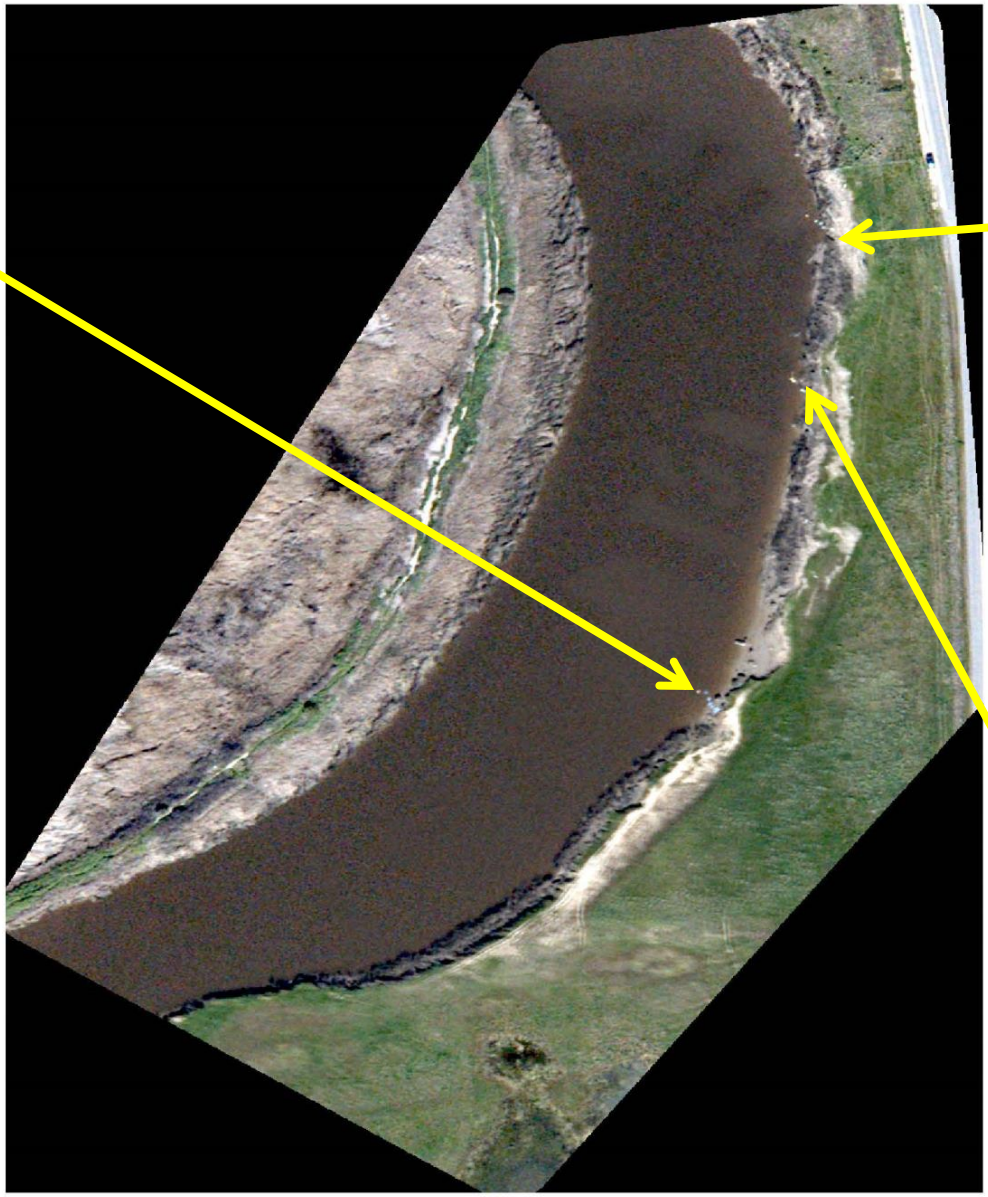

Hill Slough
Data collected 1 March 2017


Hill Slough
Trash Transects

Aerial Image of Study Area
~ 10 acres

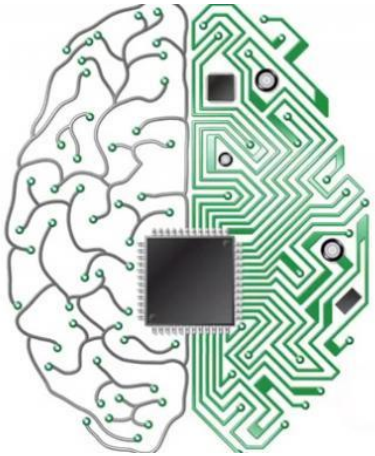
1200 ft.

Trash Transects

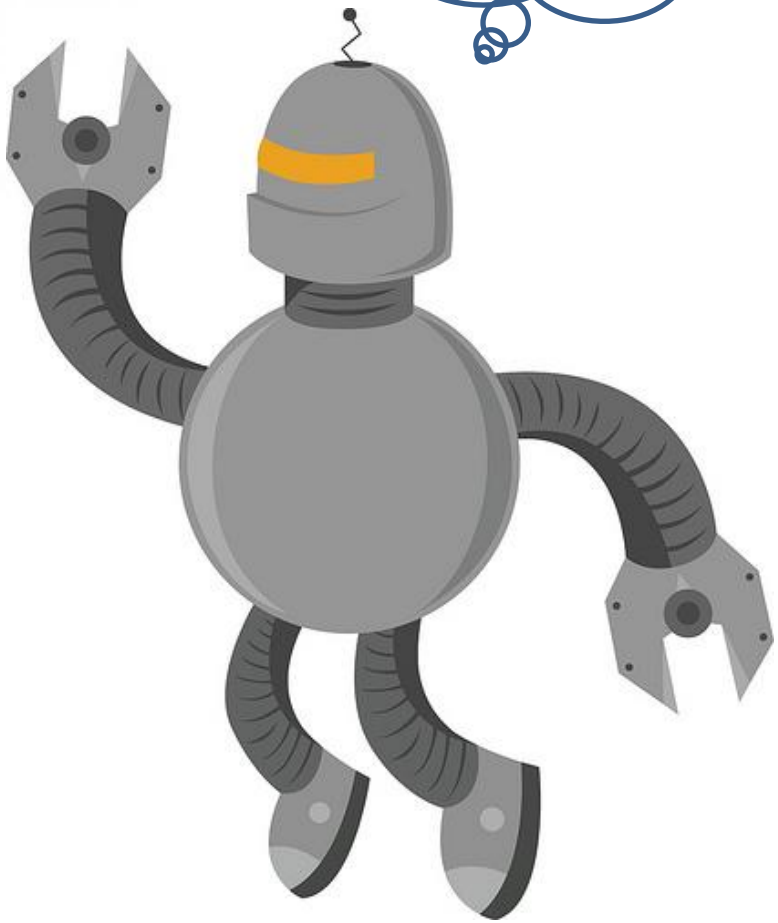


Upland and In-channel Trash

Automation, Machine Learning



$$X^2 = \sum \frac{(o-e)^2}{e}$$



Principal Component Analysis

Principal components analysis is a procedure for identifying a smaller number of uncorrelated variables, called "principal components", from a large set of data. The goal of principal components analysis is to explain the maximum amount of variance with the fewest number of principal components. Principal components analysis is commonly used in the social sciences, market research, and other industries that use large data sets.

Principal components analysis is commonly used as one step in a series of analyses. You can use principal components analysis to reduce the number of variables and avoid multicollinearity, or when you have too many predictors relative to the number of observations.

Source: www. http://minitab.com

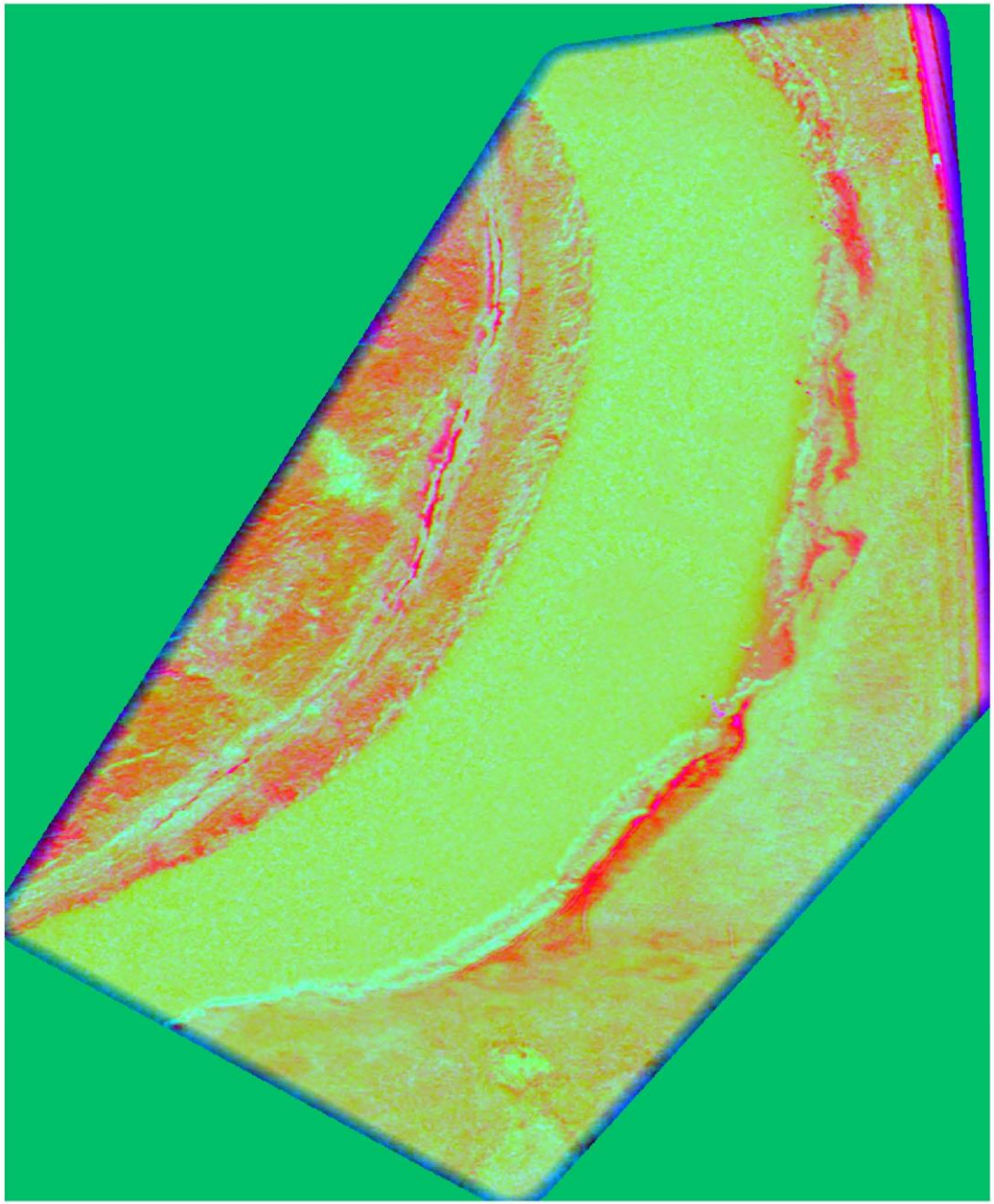
Example

A consumer products company wants to analyze customer responses to several characteristics of a new shampoo: color, smell, texture, cleanliness, shine, volume, amount needed to lather, and price. They perform a principal components analysis to determine whether they can form a smaller number of uncorrelated variables that are easier to interpret and analyze. The results identify the following patterns:

- Color, smell, and texture form a "Shampoo quality" component.
- Cleanliness, shine, and volume form an "Effect on hair" component.
- Amount needed to lather and price form a "Value" component.

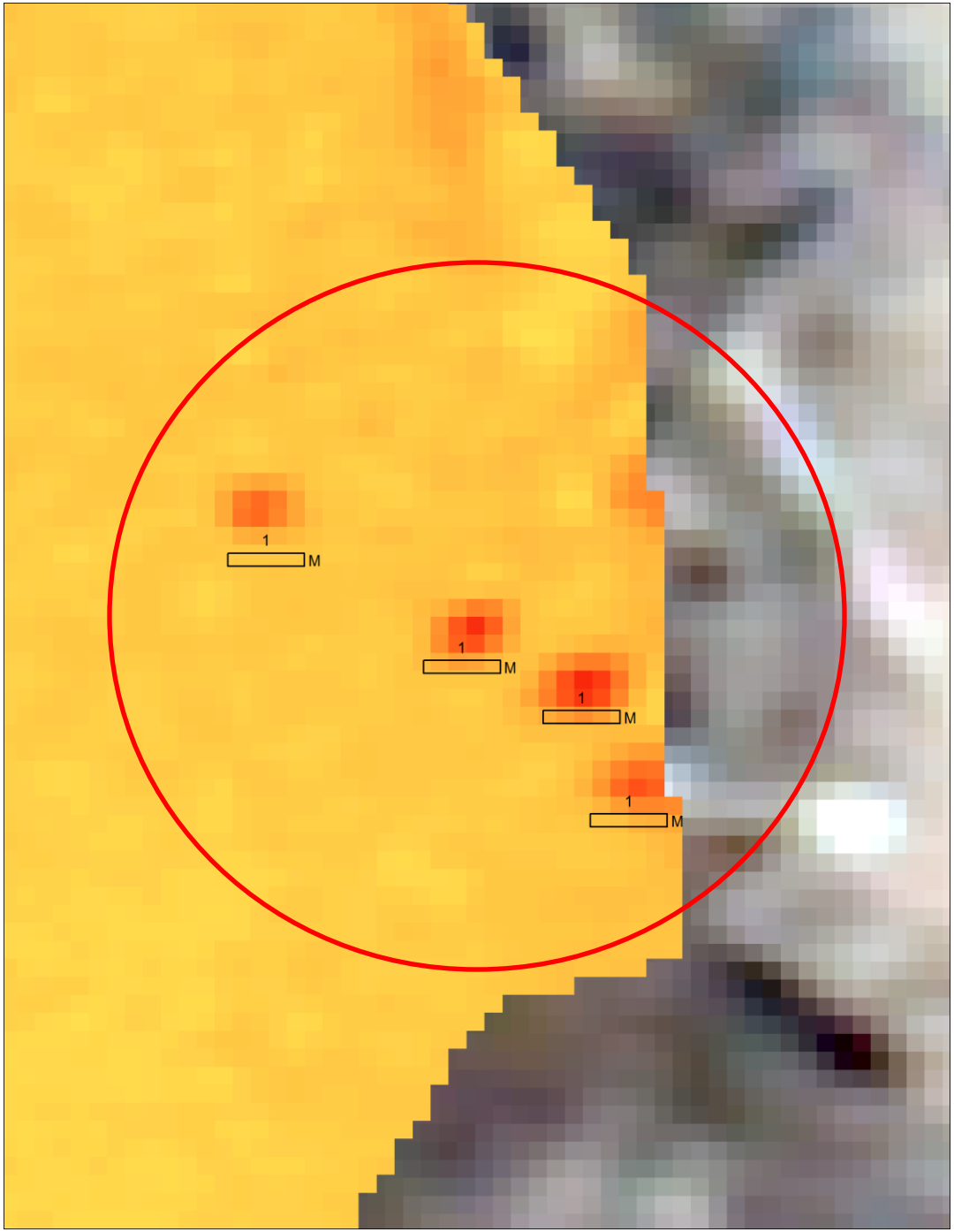
Source: www. http://minitab.com

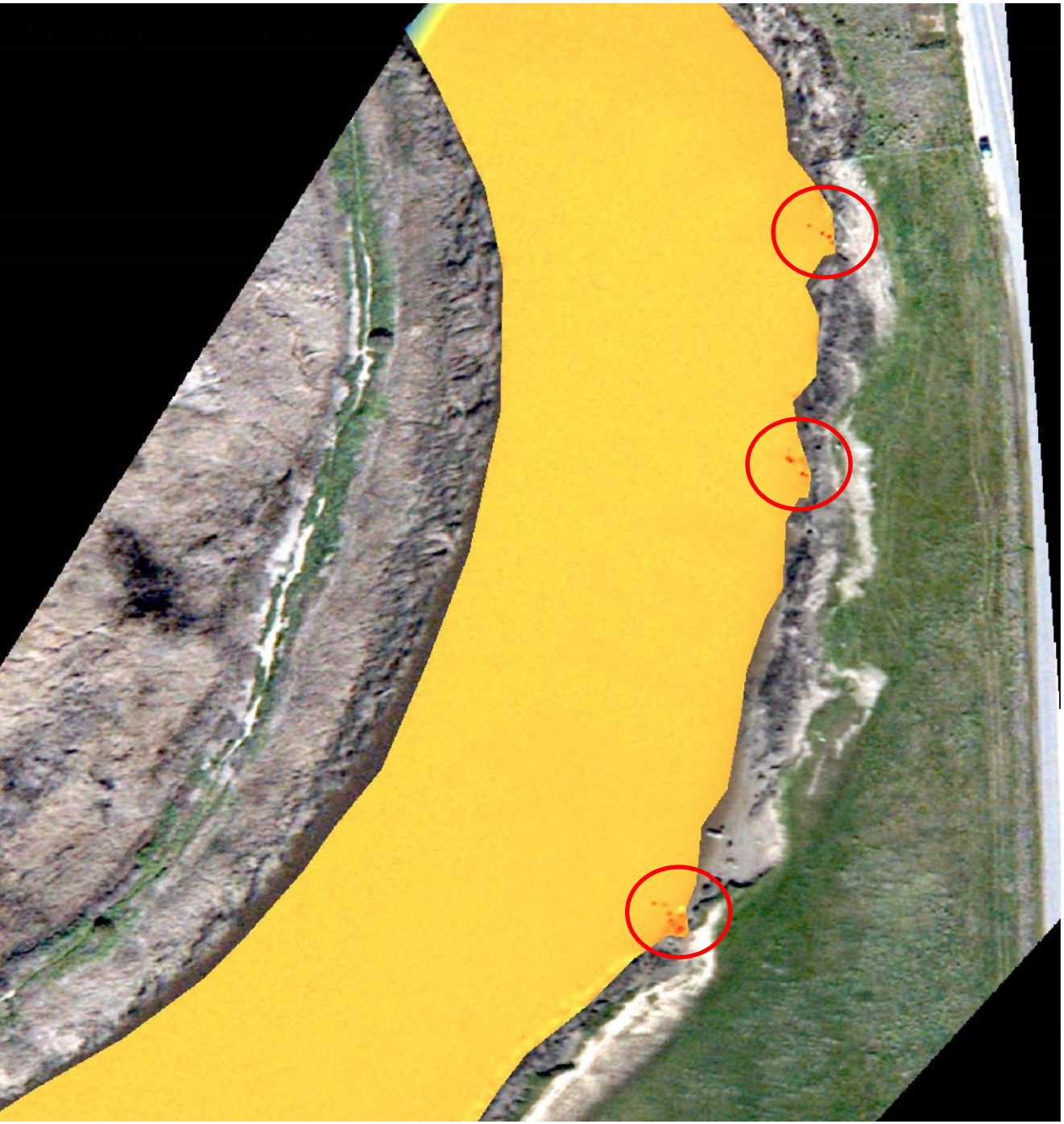
Principal Component Analysis



PCA Mask & Re-Class # 2

PCA Clip Zoom

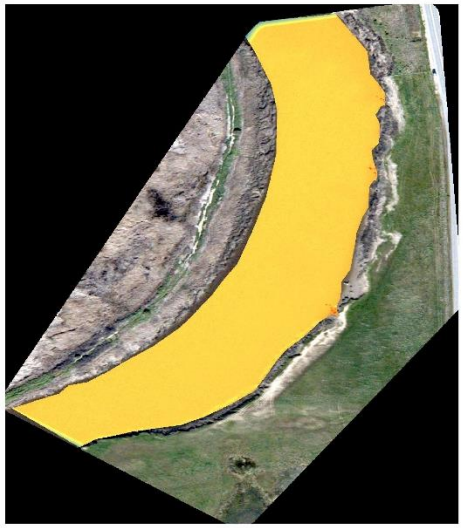




PCA Clip Detection

Total of Trash Transects

Counting Trash



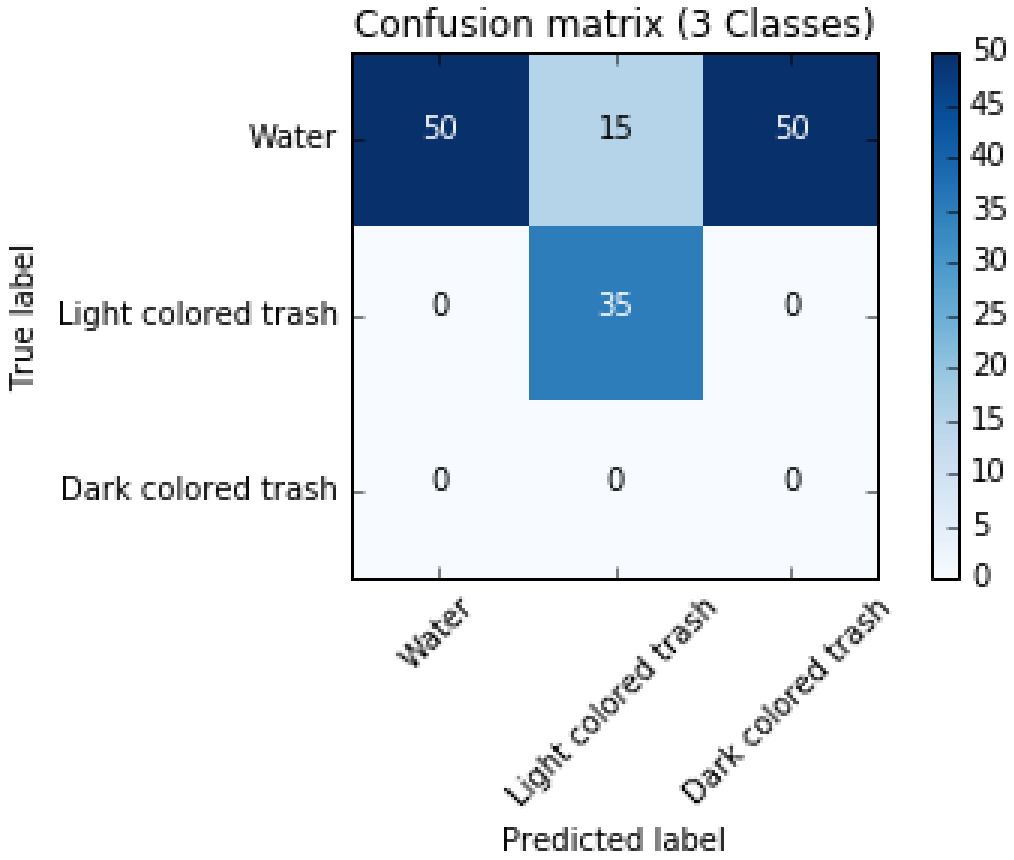
= 217,800 Total Pixels
(40,469m^2)

= 86 Trash Covered Pixels
Detected (~ 8 m^2)

Detection Rate

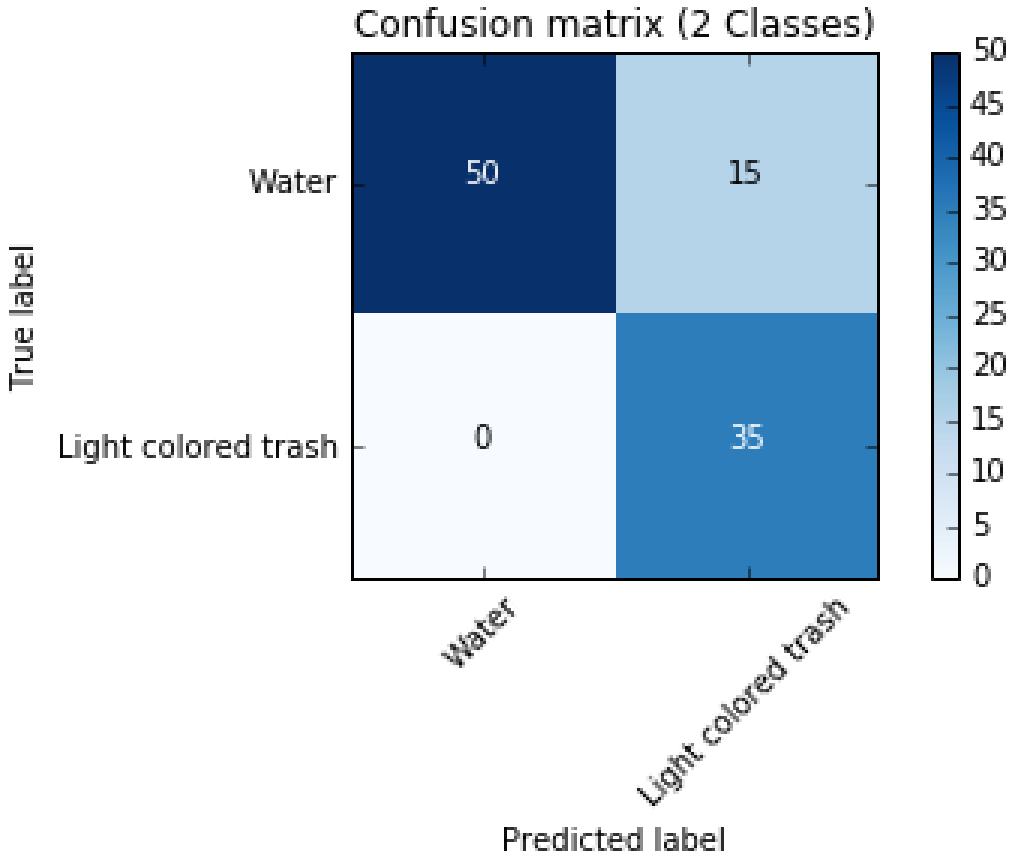
44%

Accuracy Assessment 3 Classes



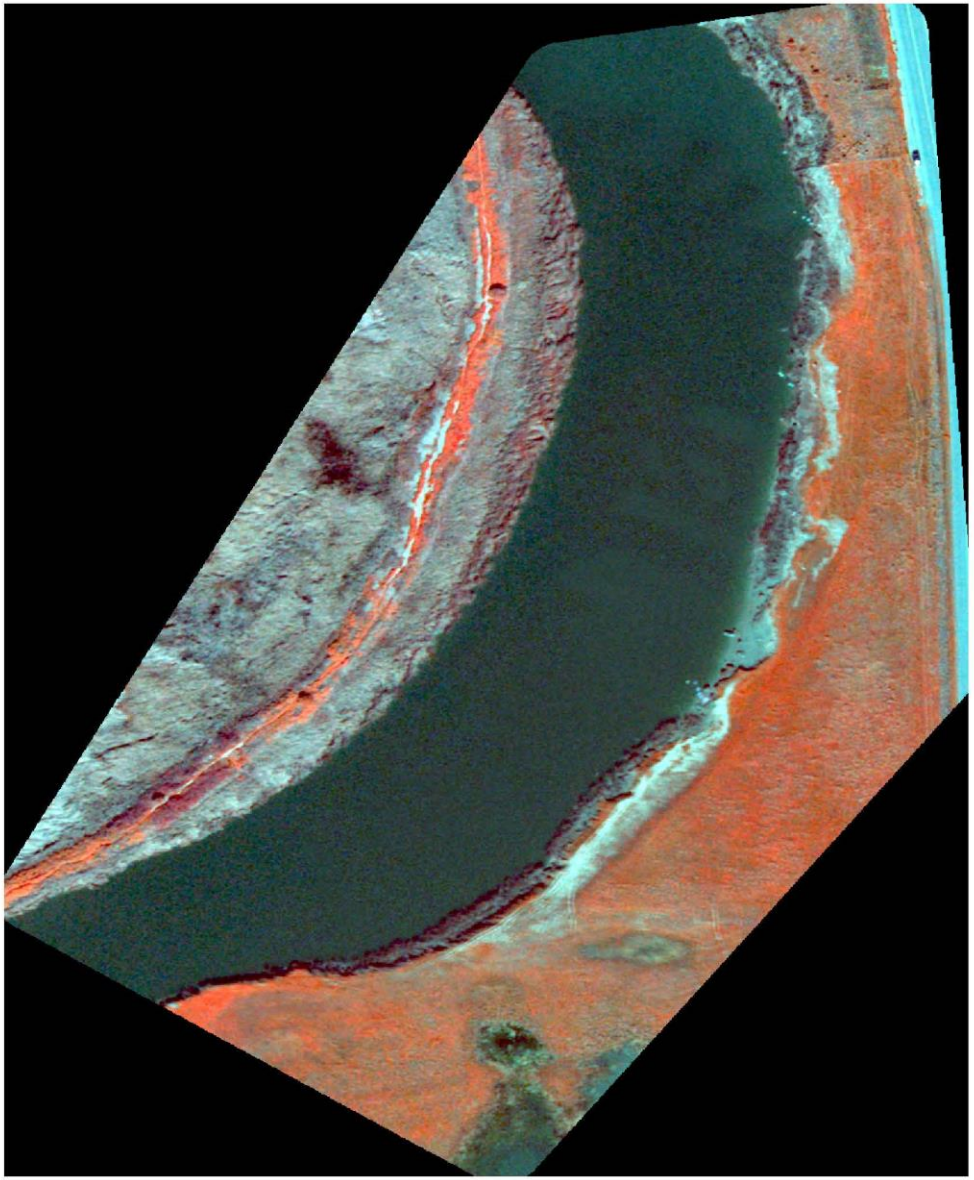
Kappa score = .3499

Accuracy Assessment 2 Classes



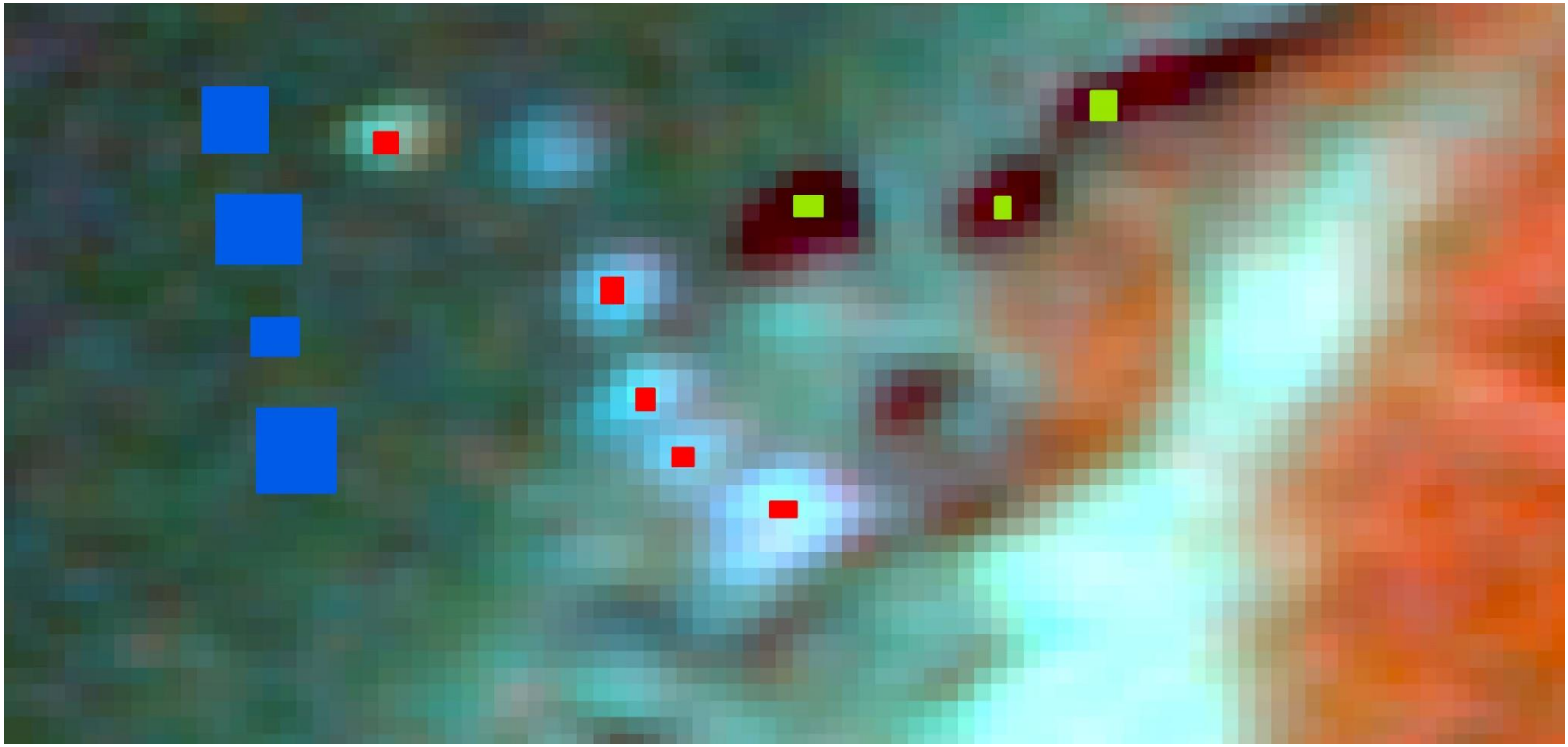
Kappa score = .6999

Near Infrared (NIR) Image

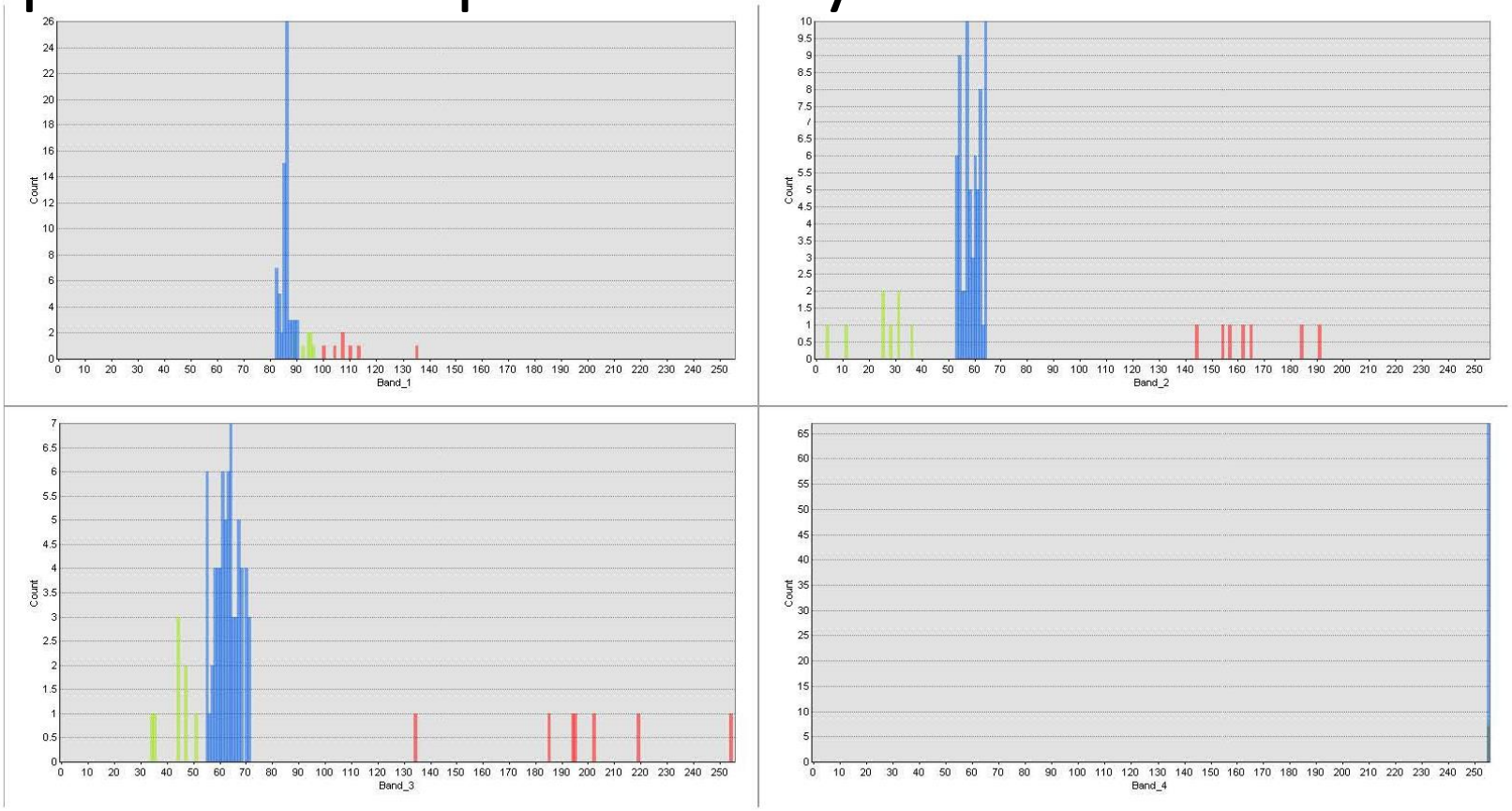


NIR Imagery Zoom x 60

NIR Spectral Sample

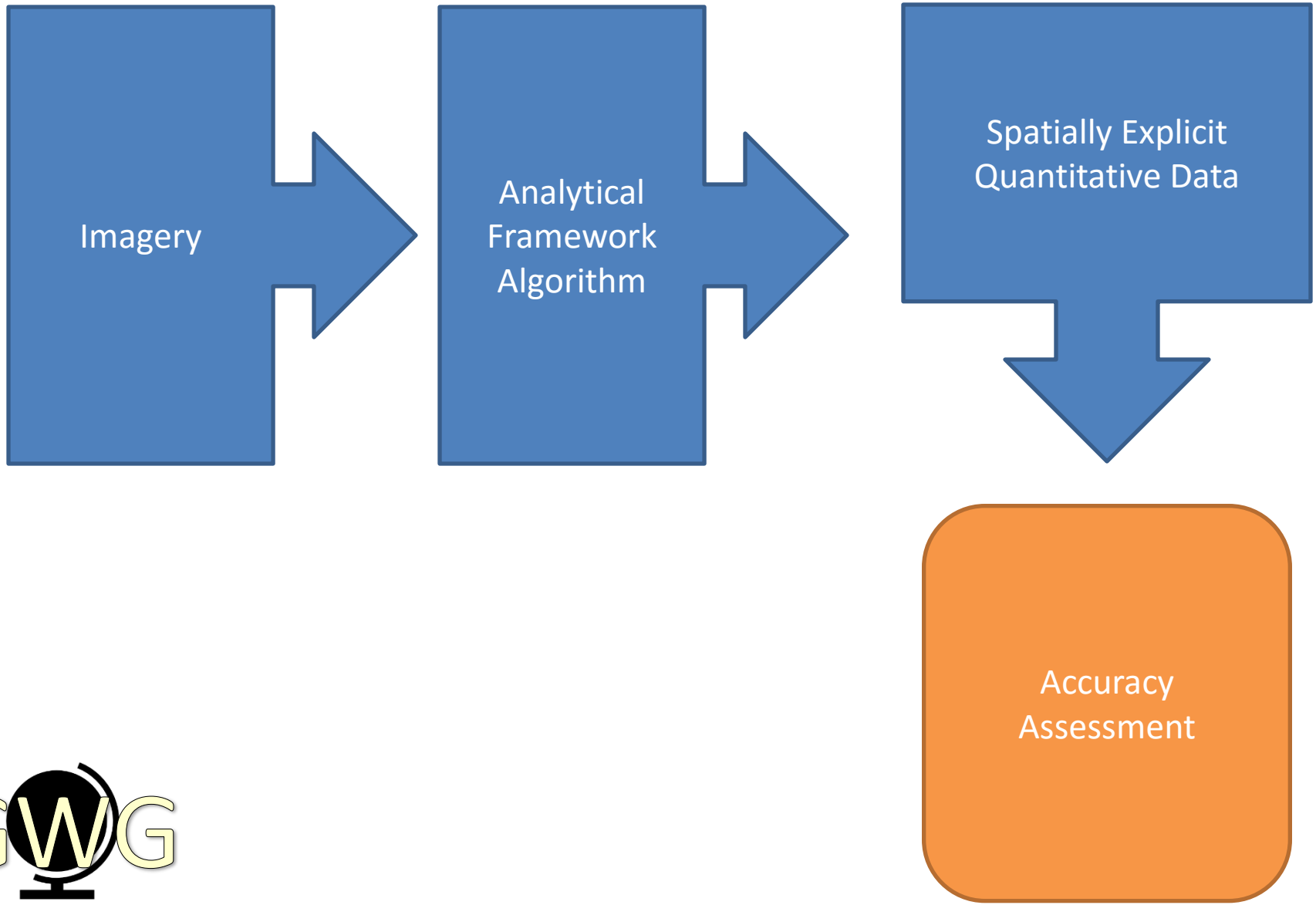


Spectral Separability



Water Vegetation Trash

Analytical Model



Summary

1. **Encounter Rate**
   - Latency of imaging is flexible with manned aircraft

2. **Debris Size**
   - 18 cm pixel resolution is likely sufficient for most detection purposes.

3. **Debris Visibility**
   - Color, size, and type of debris influences visibility (e.g. black trash bags were not detectable with NIR or RGB.
   -Additional spectral bands/sensors (such as SWIR) may be required to increase detection accuracy.

4. **Detection v. Identification**
   - Detection was possible, ID???
   - Higher resolution is possible and could increase ability for ID.
5. **Resolution v. Coverage**
   - Aerial imaging overcomes some of the tradeoffs associated with satellite and UAS.
   - Post processing is simplified through commercial imagery platforms (e.g.TerrAvion).

Questions?

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