

# Estimating and Mapping Chlorophyll *a* Concentrations in the San Joaquin River using Landsat Imagery

Edmund Yu

American River College

# Study Questions

- Could Landsat 5 TM imagery be used to accurately estimate chlorophyll *a* (chl *a*) concentrations on the San Joaquin River and thus, supplement the mandated water quality programs in that region?

# Outline

- Why do we care about chl a?
- Why use Landsat 5 TM imagery?
- Study Area
- Workflow Overview
- Results
- Implications

# Why do we care about chl *a*?

- It is a proxy for phytoplankton and is important for photosynthesis.
- Phytoplankton are an important food source for zooplankton, invertebrates and some species of fish.
- Some phytoplankton species (i.e., blue-green algae) could produce toxic blooms.
- It is an indicator of water quality.

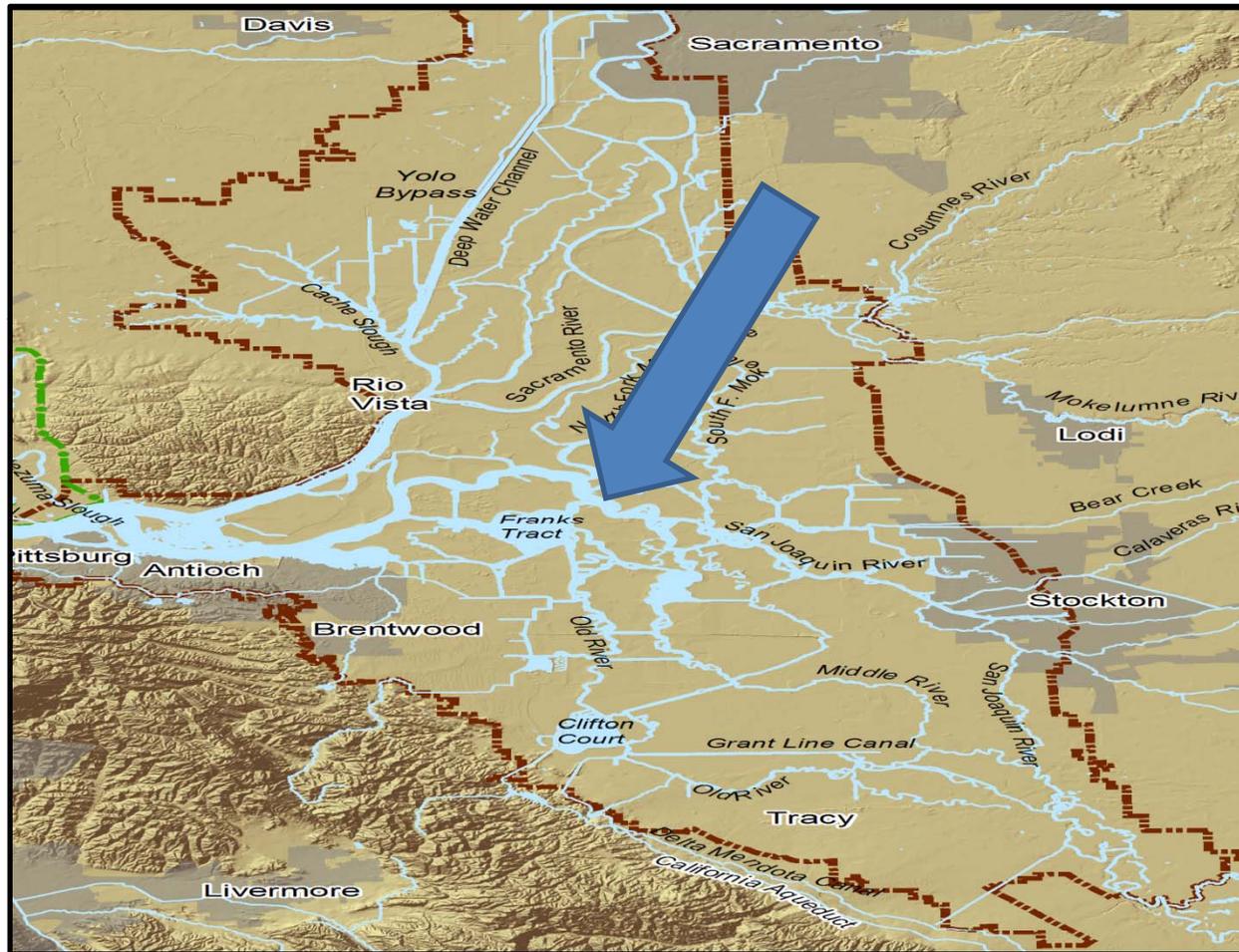
Why use Landsat 5 TM  
imagery?

It is cheap

and

readily available for use

# Study Area: The San Joaquin River



Map from DWR

**Workflow**

**Overview**

# Step 1: Obtain a Landsat 5 Image from July 29, 2010 at the Earth Explorer Website

<http://earthexplorer.usgs.gov/>

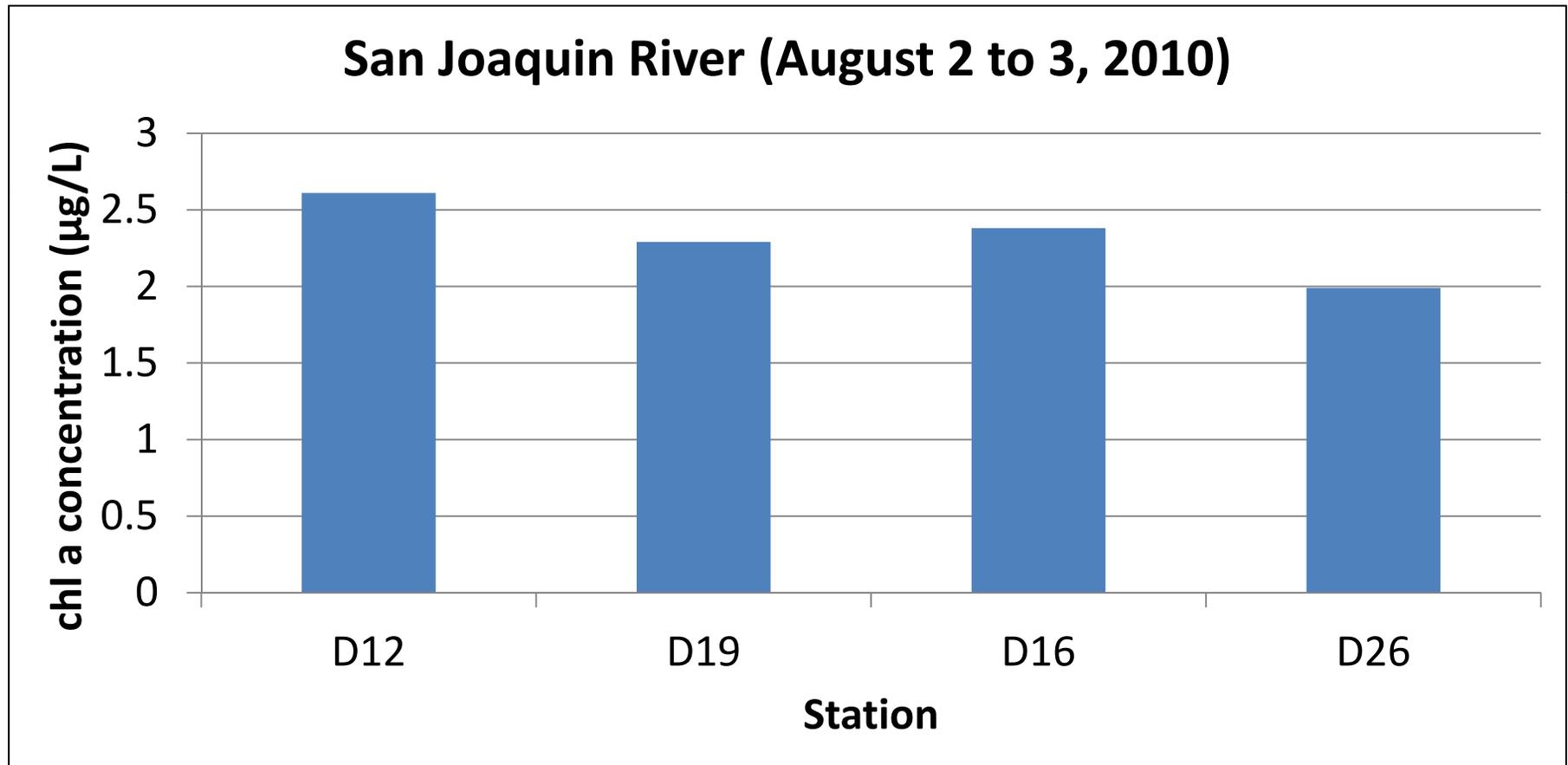
The screenshot displays the USGS Earth Explorer website. At the top left is the USGS logo with the tagline "science for a changing world". To the right are links for "USGS Home", "Contact USGS", and "Search USGS". Below the logo is the "EarthExplorer" header. A navigation bar includes "Home" and links for "Login", "Register", "Feedback", and "Help".

The main content area is divided into two sections. On the left, under the "Search Criteria" tab, there is a section titled "1. Enter Search Criteria" with the instruction: "To narrow your search area: type in an address or place name, enter coordinates or click the map to define your search area (for advanced map tools, view the [help documentation](#)), and/or choose a date range." Below this are four search method tabs: "Address/Place", "Path/Row", "Feature", and "Circle". The "Address/Place" tab is active, showing an empty text input field and "Show" and "Clear" buttons. Below that are "Coordinates" tabs for "Shapefile" and "KML", and a sub-section with "Degree/Minute/Second" and "Decimal" options. A message at the bottom of this section states "No coordinates selected."

On the right, the "Search Criteria Summary (Show)" section features a "Clear Criteria" button and a map. The map shows a satellite view of Canada and surrounding regions, with various geographical features labeled such as "Northwestern Passages", "Hudson Bay", and "Gulf of St. Lawrence". Map navigation tools like a compass, a person icon, and a vertical scale are visible on the left side of the map. Above the map are tabs for "(coordinates)", "Options", "Overlays", "Map", and "Satellite".

Step 2: Obtain discrete chl *a* samples from the San Joaquin River from the Bay-Delta Monitoring and Analysis Website:

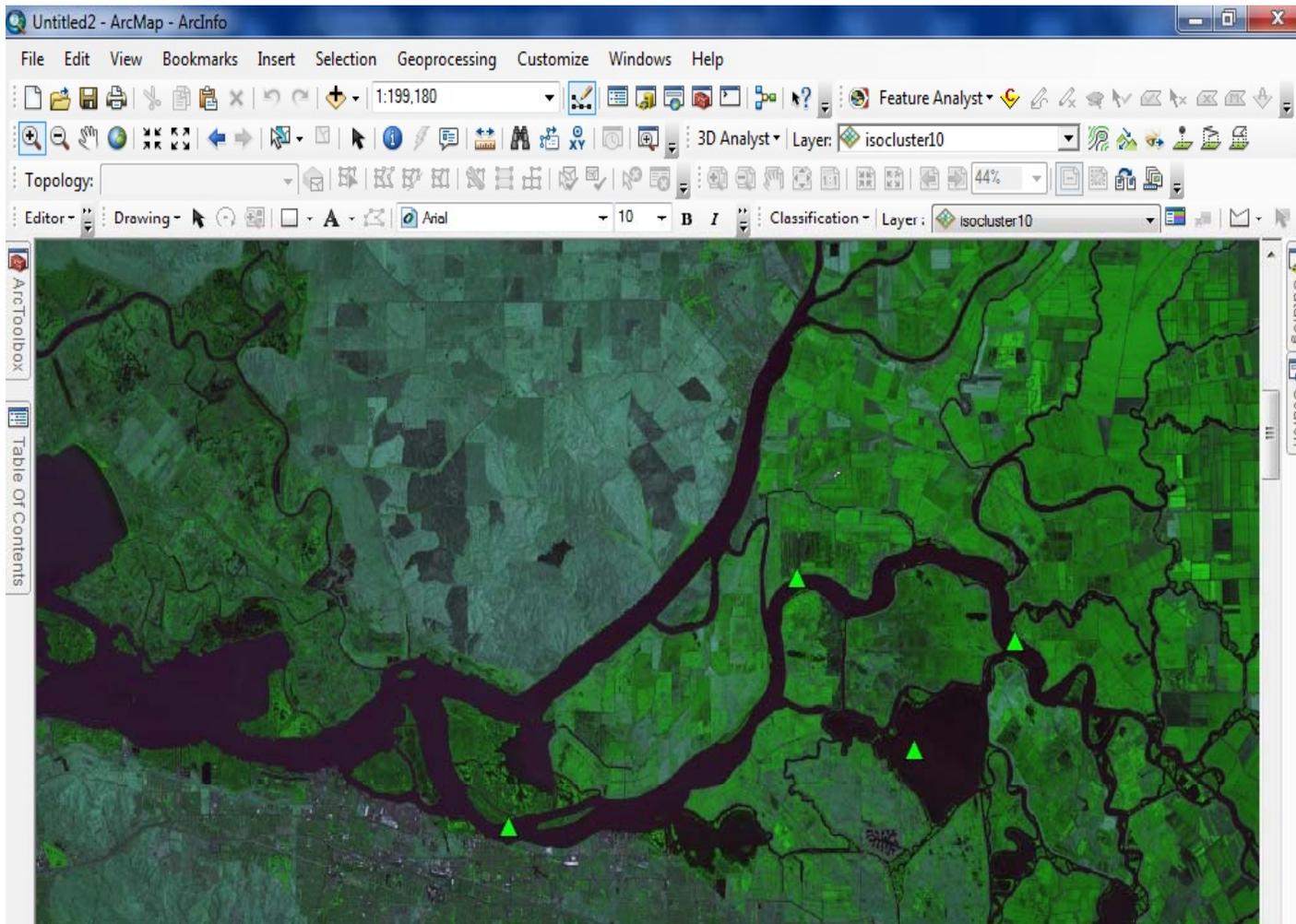
<http://www.water.ca.gov/bdma/meta/>



**Match up GPS coordinates for each station from the metadata on website and create shapefiles for the stations**

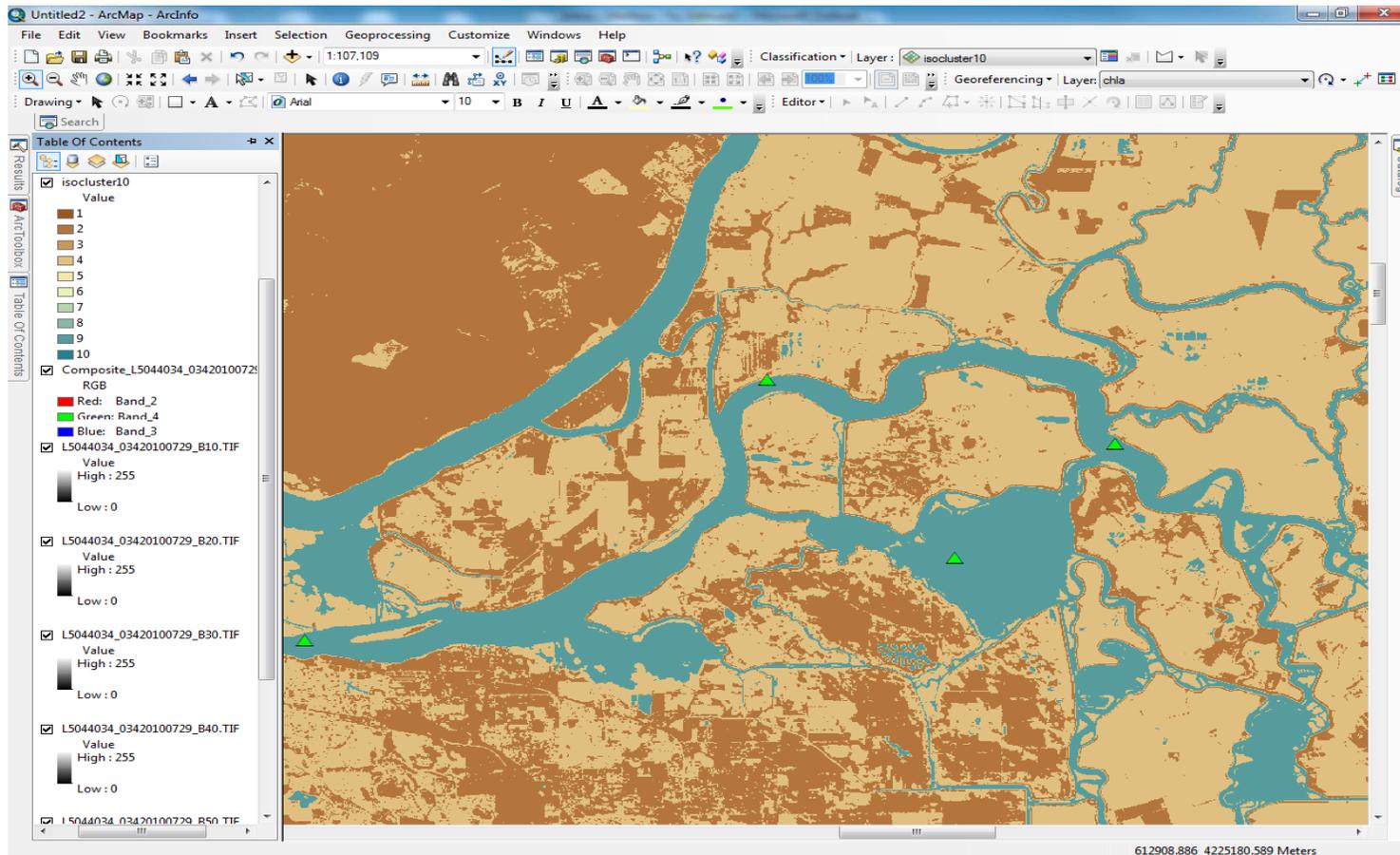
Step 4: Load Landsat files and discrete chl  $a$  data into ArcMap and apply appropriate coordinate system.

Step 5: Composite Landsat files using Image Analysis



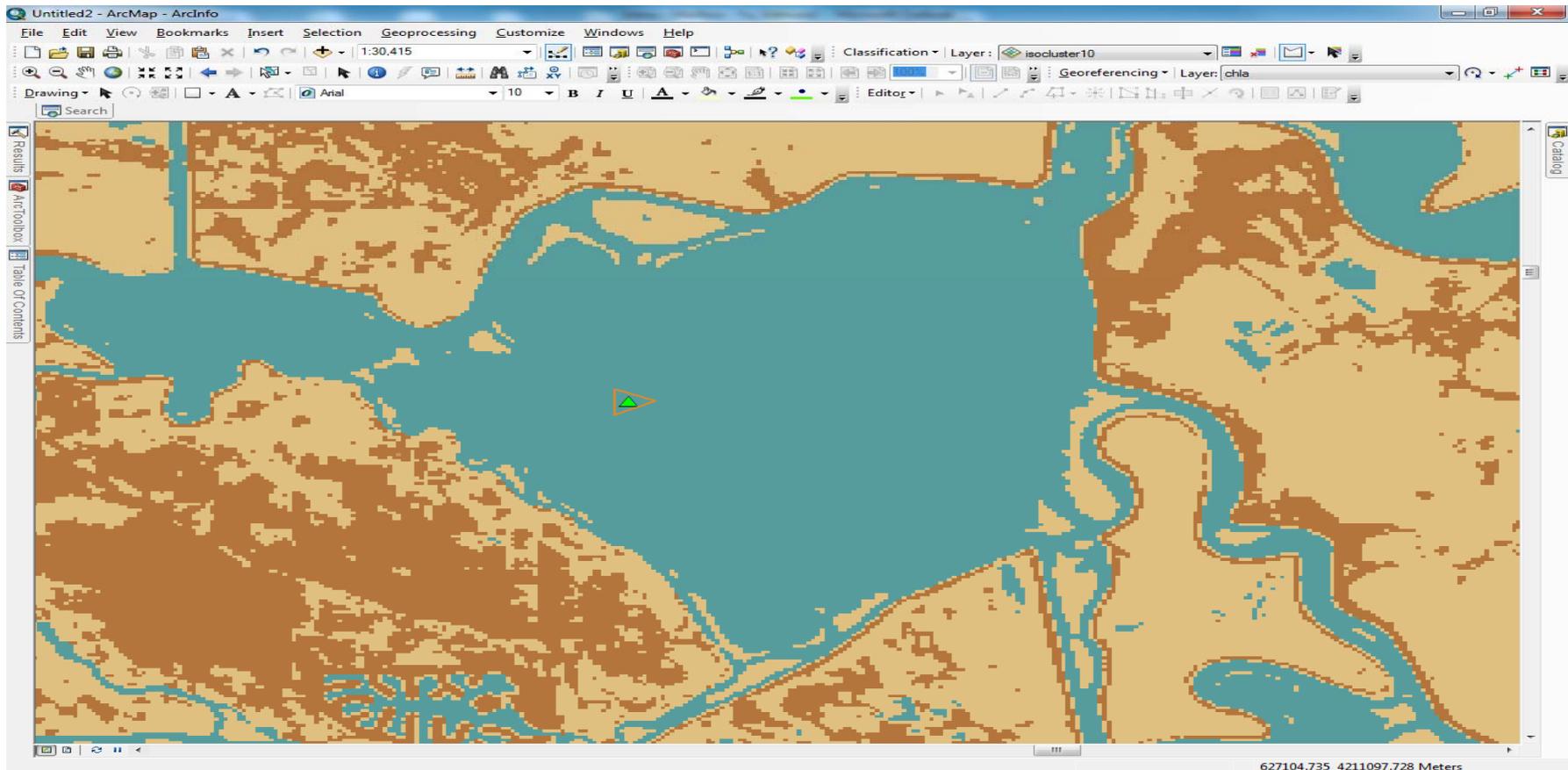
**Triangles represent the discrete sampling locations.**

Step 6: Run an unsupervised 10 class classification on the composite Landsat image to assist with identifying the river



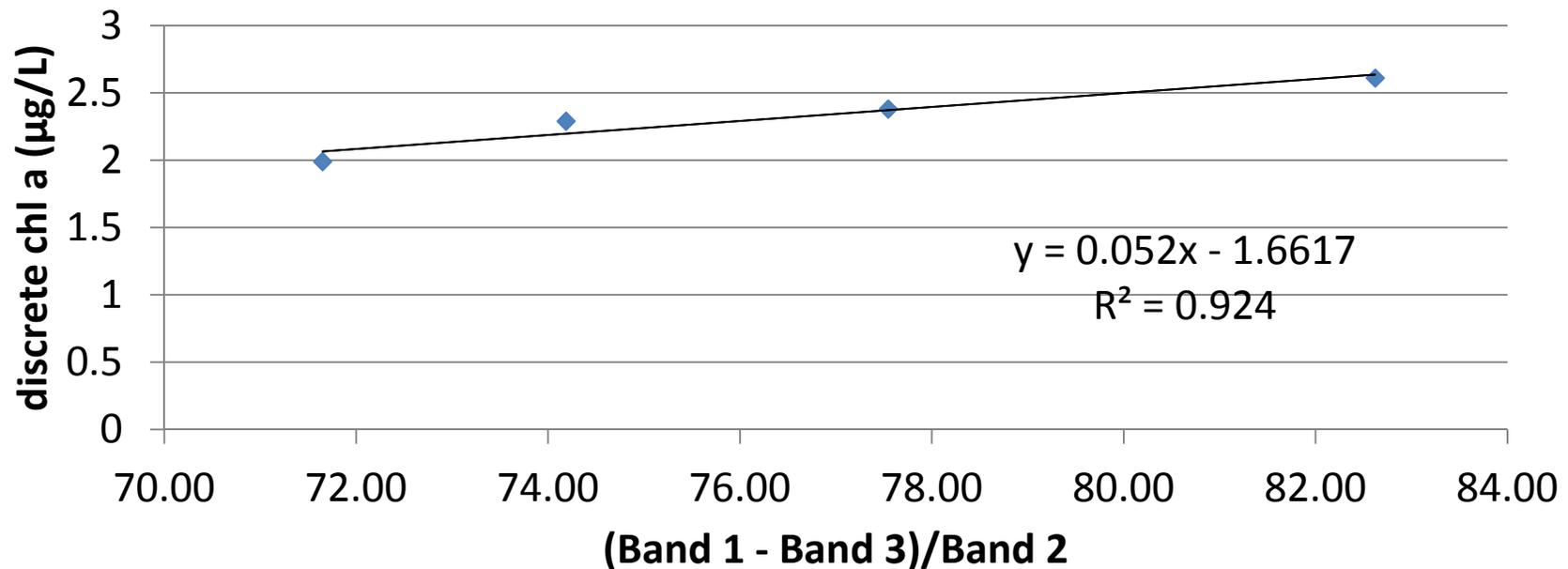
**Class 9 is an appropriate classification for water**

# Step 7: Create training sites based on discrete sampling stations to determine spectral signatures.

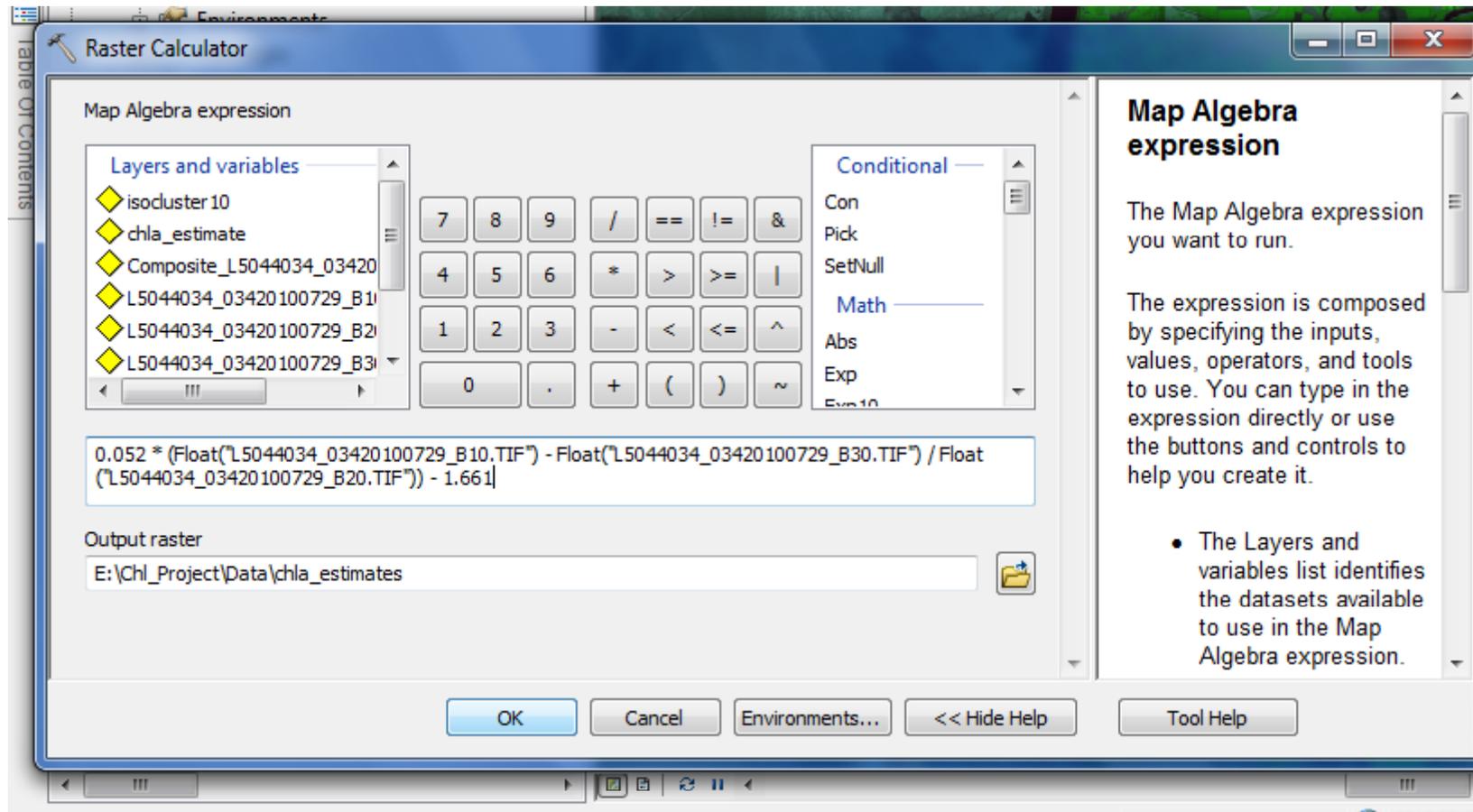


Step 8: Extract spectral signatures from training sites and look for the strongest correlation between the band ratios and discrete chl *a* samples.

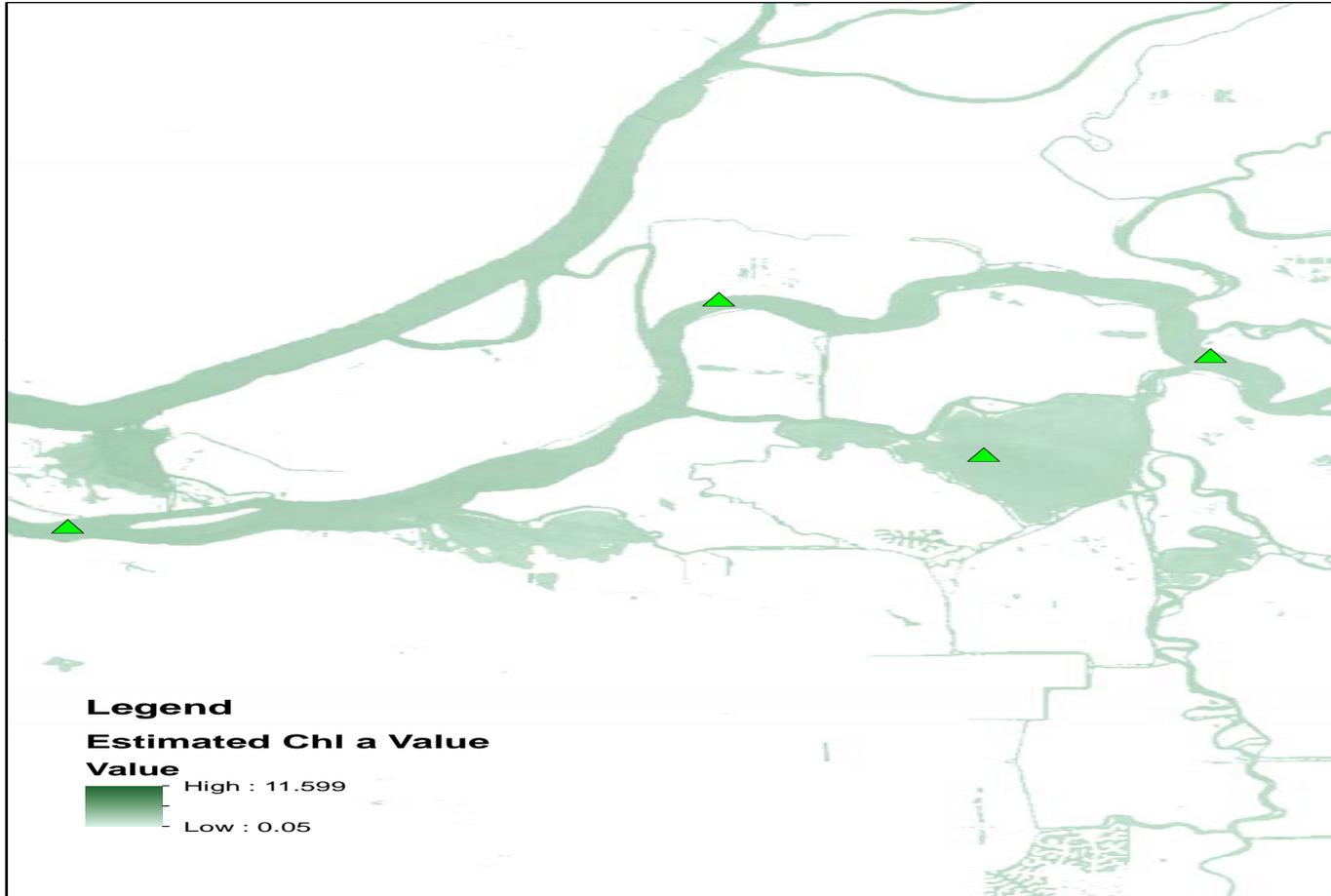
Example: Strongest Correlation



# Step 9: Use algorithm from regression equation to estimate chl *a* with raster calculator

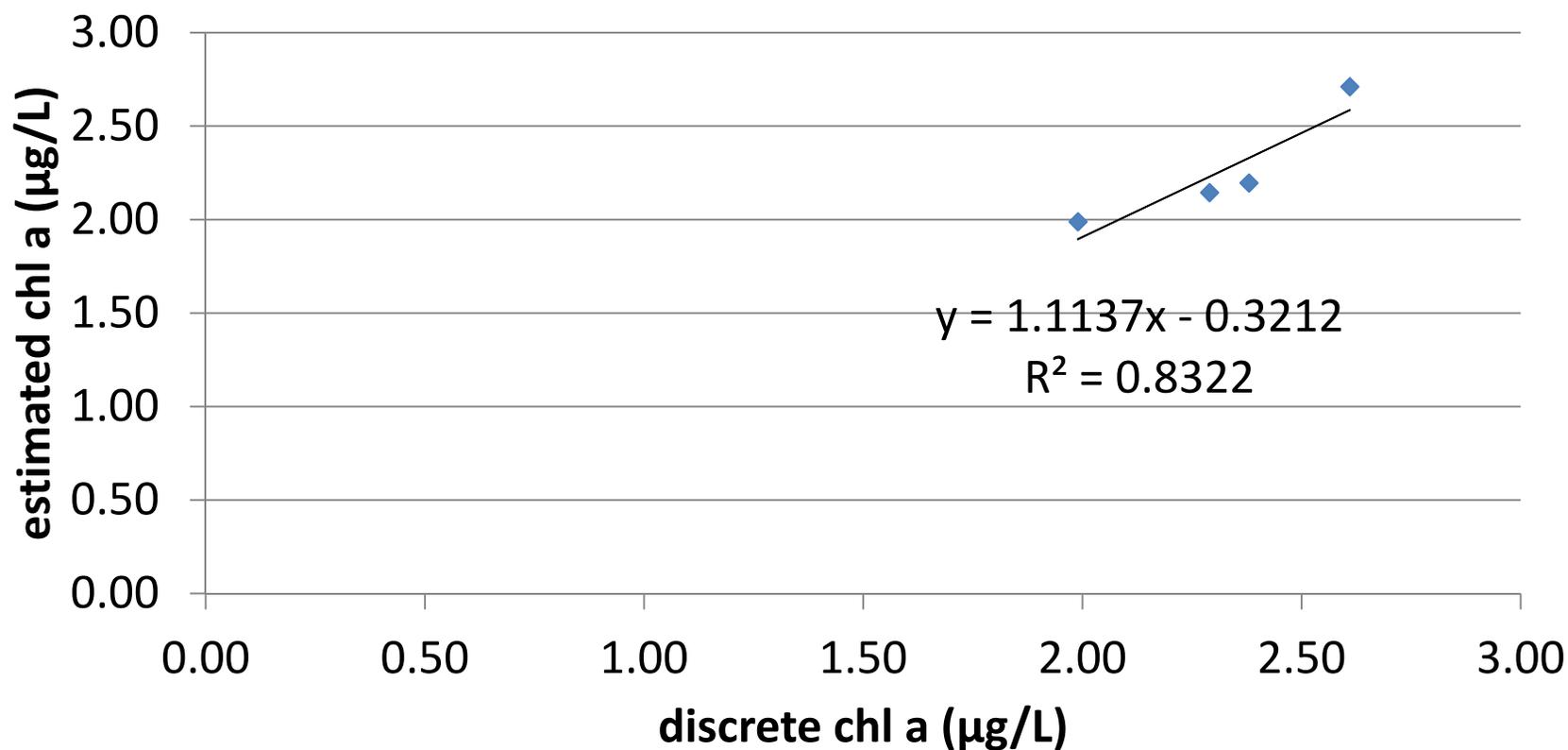


# Results from algorithm



Not a whole lot of variation

## How accurate are the calculated estimates when compared to the discrete values?



Correlation is fairly high. However, the calculated estimates are slightly higher than the discrete values. In addition, chl *a* concentrations were fairly low during this time period. These results may not apply during higher chl *a* concentrations.

# Implications

- Using Landsat 5 TM imagery could potentially supplement discrete monitoring by providing better spatial coverage.
- These results are preliminary and should be used for discussion purposes only. No strong conclusions could be made from the project.
  - There were many limitations with this study design, such as not using an atmospheric correction on the Landsat image and the limited number of discrete samples (i.e., 4) used for the regression.
- Further research needs to be done on the best algorithm to use for the San Joaquin River.

# Acknowledgements

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