

# Final Project: Detecting Impervious Surfaces

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GEOG 883: Remote Sensing Image  
Analysis and Applications, Spring 2011

# Project Overview

- Problem Description
- Study Area
- Data Documentation
- Analysis Documentation
- Results
- References

# Problem Description

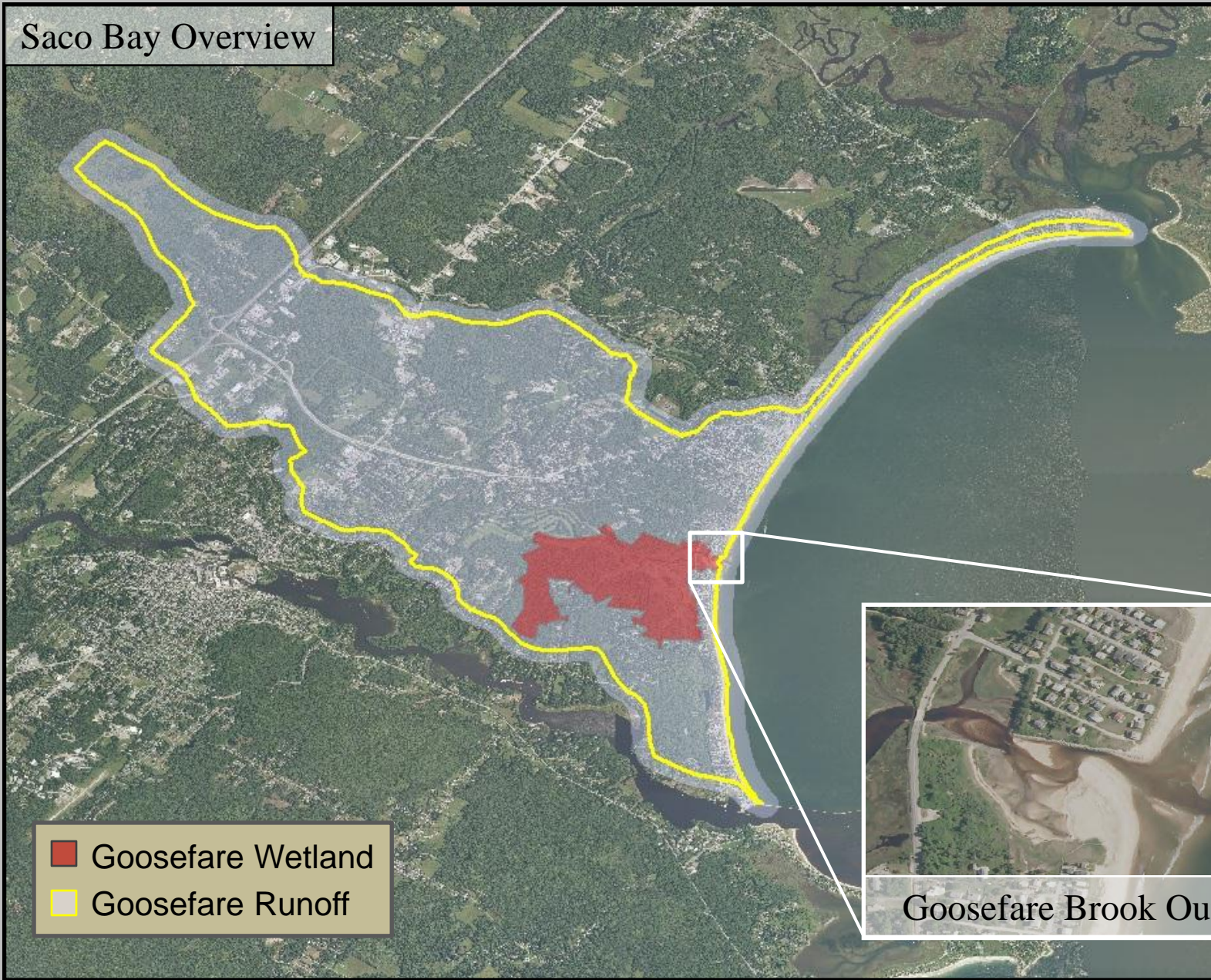
In addition to a beautiful and jagged coastline, the state of Maine is home to an abundance of wetlands, which make up nearly 25% of the land area. The EPA defines wetlands as “an area that is regularly saturated by surface water or groundwater and is characterized by a prevalence of vegetation that is adapted for life in saturated soil conditions.” These wetlands perform many functions, from recreational activities, such as hiking and canoeing to serving as natural wastewater purification systems. There is an important connection between the health of the wetlands and the surrounding land use. Impervious surfaces (e.g., roads, houses, parking lots) increase the amount of polluted runoff that flows into wetlands. Using remote sensing data and techniques, this project will attempt to acquire data over the Goosefare Brook wetland, classify the impervious surfaces, and calculate the overall percentage of impervious surfaces contained within the wetland.

# Study Area

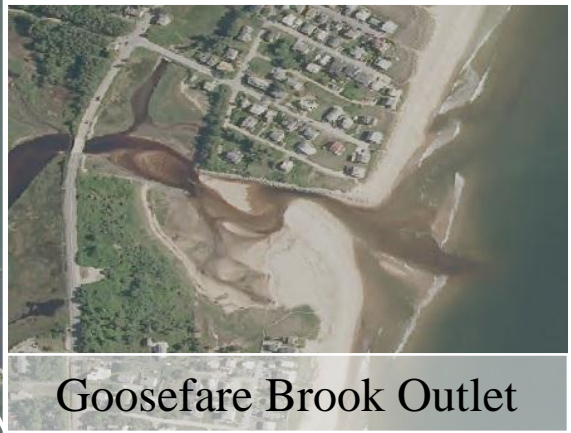
- Saco Bay, Maine



# Saco Bay Overview



- Goosefare Wetland
- Goosefare Runoff



# Data Documentation

- Data Acquisition
  - Landsat Multispectral Imagery
    - [USGS New Earth Explorer](#)
  - Maine Orthorectified Imagery
    - [Maine GeoPortal Library WMS](#)
  - Maine Wetland Shapefiles
    - [USDA Geospatial Data Gateway](#)



# Data Documentation

- Landsat Multispectral Imagery
  - LE70120302001289EDC00 acquired on October 16, 2001. Metadata available [here](#).
  - **Sensor and Platform:** Landsat Enhanced Thematic Mapper Plus (ETM+) on Landsat 7
  - **Coordinate System:** WGS\_1984\_UTM\_zone\_19N
  - **Resolution:** 30 meters, 6 bands, 8 bit
  - **File Format:** geotif

# Data Documentation

- Landsat Multispectral Imagery



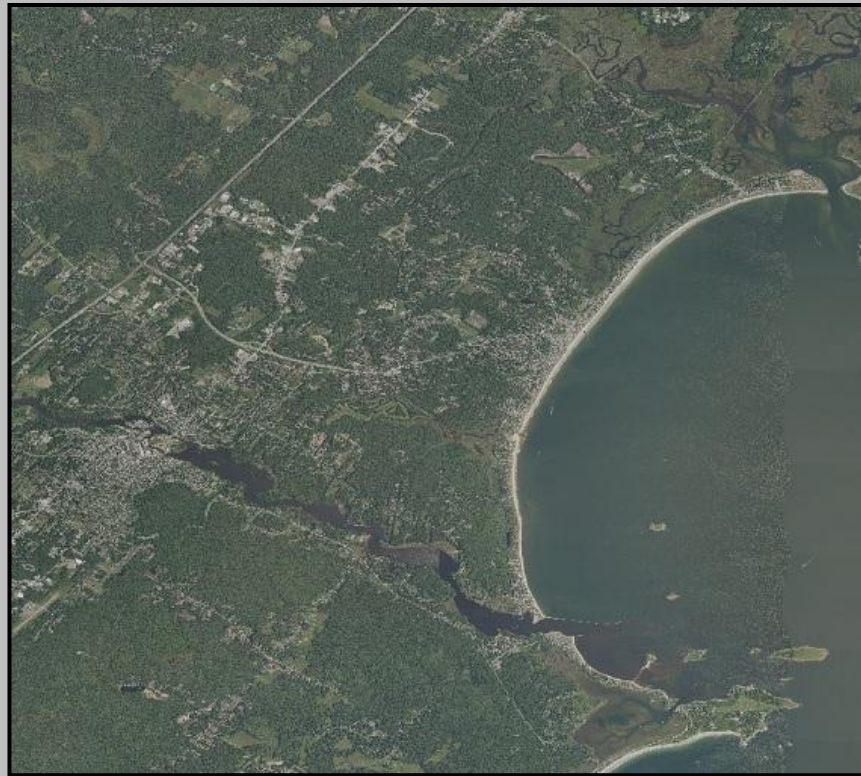


# Data Documentation

- Maine Orthorectified Imagery
  - State of Maine aerial orthophotos provided by the State of Maine, Maine Office of GIS and Maine GeoLibrary Board.
    - **Sensor and Platform:** Varies by layer
    - **Coordinate System:** GCS\_WGS\_1984
    - **Resolution:** Varies by layer
    - **File Format:** WMS delivered PNG24

# Data Documentation

- Maine Orthorectified Imagery

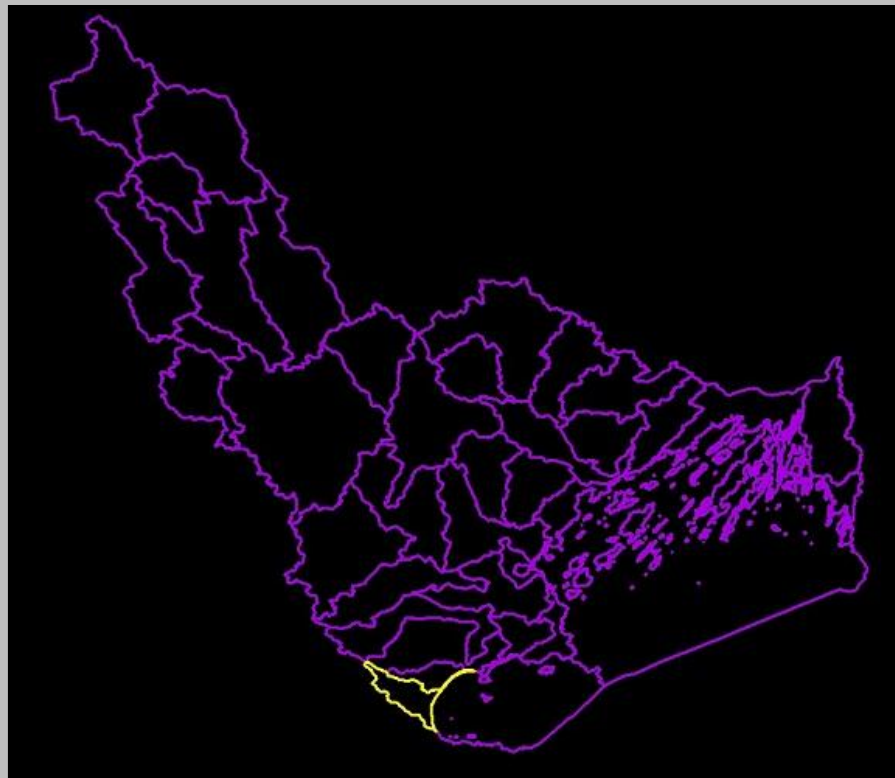


# Data Documentation

- Maine Wetland Shapefiles
  - 12 Digit Watershed Boundary Dataset 1:24,000 (AK 1:63,360). Metadata available [here](#).
    - **Sensor and Platform:** Not Applicable
    - **Coordinate System:** NAD\_1983\_UTM\_Zone\_19N
    - **Resolution:** Not Applicable
    - **File Format:** vector - shp

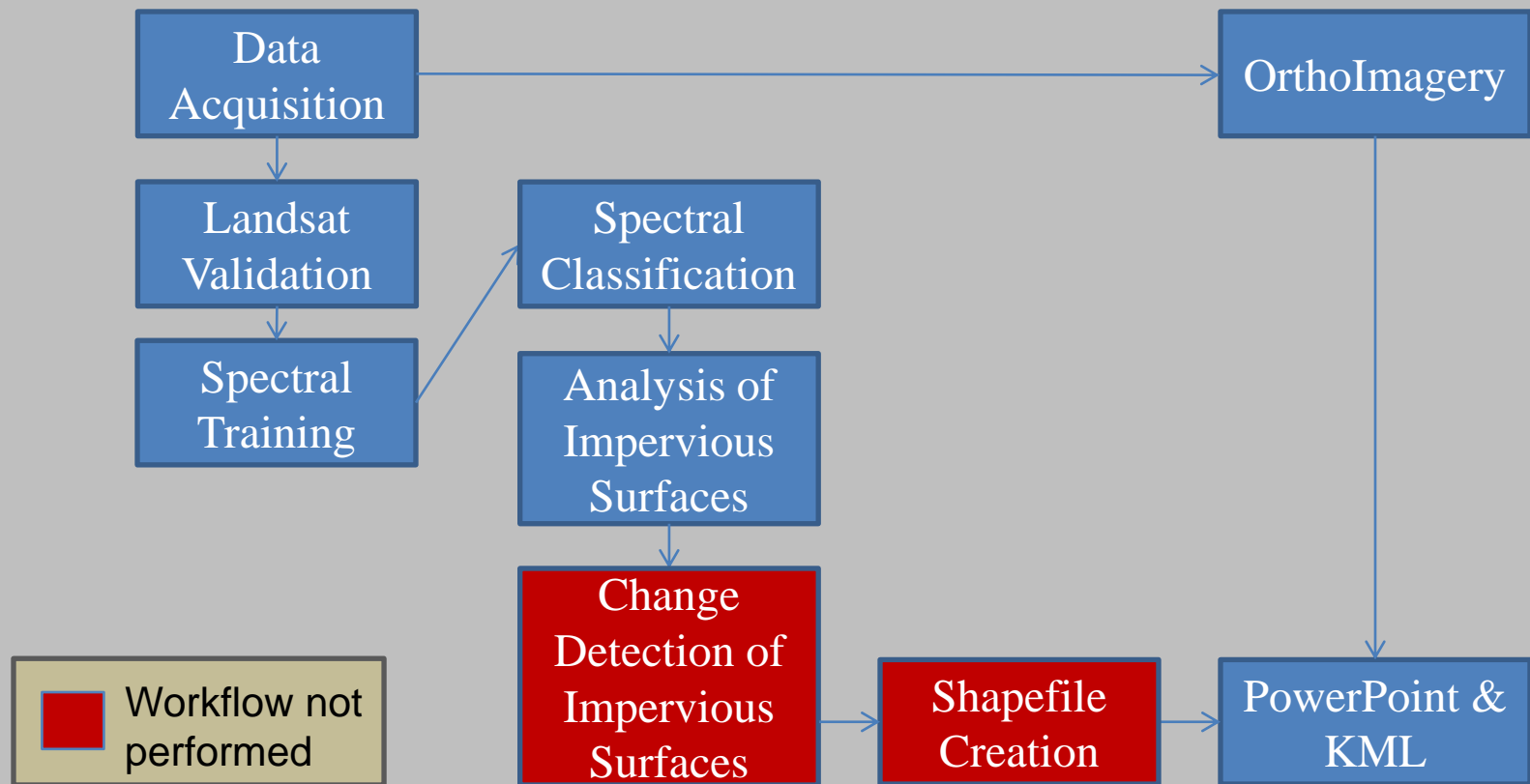
# Data Documentation

- Maine Wetland Shapefiles



# Analysis Documentation

- Proposed Workflow



# Analysis Documentation

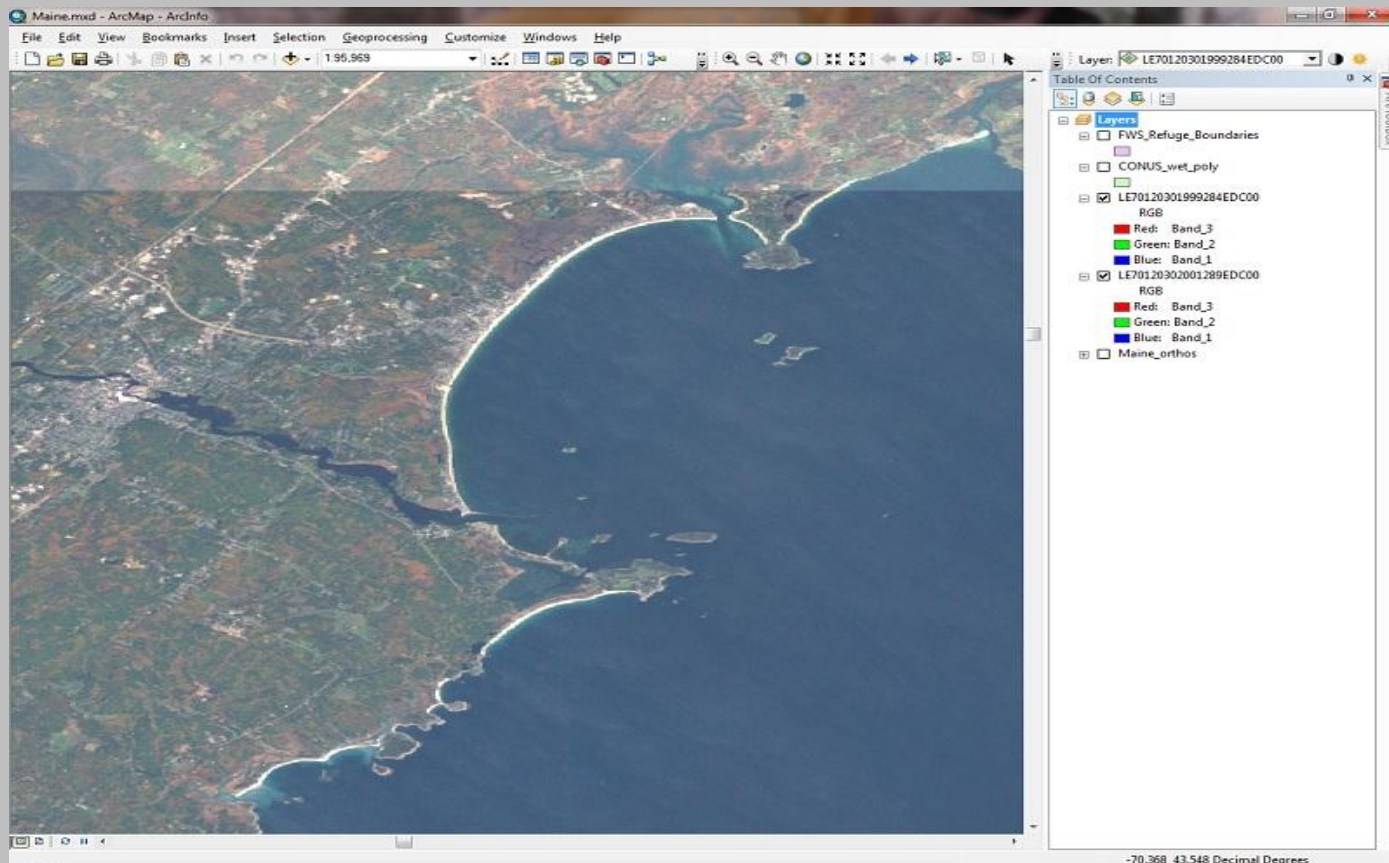
- Data Acquisition
  - Data set acquisition went smoothly
  - After downloading Landsat imagery, decided against doing Change Detection since the ETM+ striping was bad in the study area
  - Orthoimagery obtained by using a WMS service to avoid downloading large imagery files. Added WMS Server to ArcMap 10.0 (Build 2800)
  - Wetland shapefiles were the hardest to track down

# Analysis Documentation

- Data Validation
  - Landsat data was overlaid with both orthoimagery and additional Landsat data to make sure it was correctly georeferenced
  - Used the Swipe Tool from ArcMap's Effects Toolbar to check how pixels matched both North-South and East-West roads

# Analysis Documentation

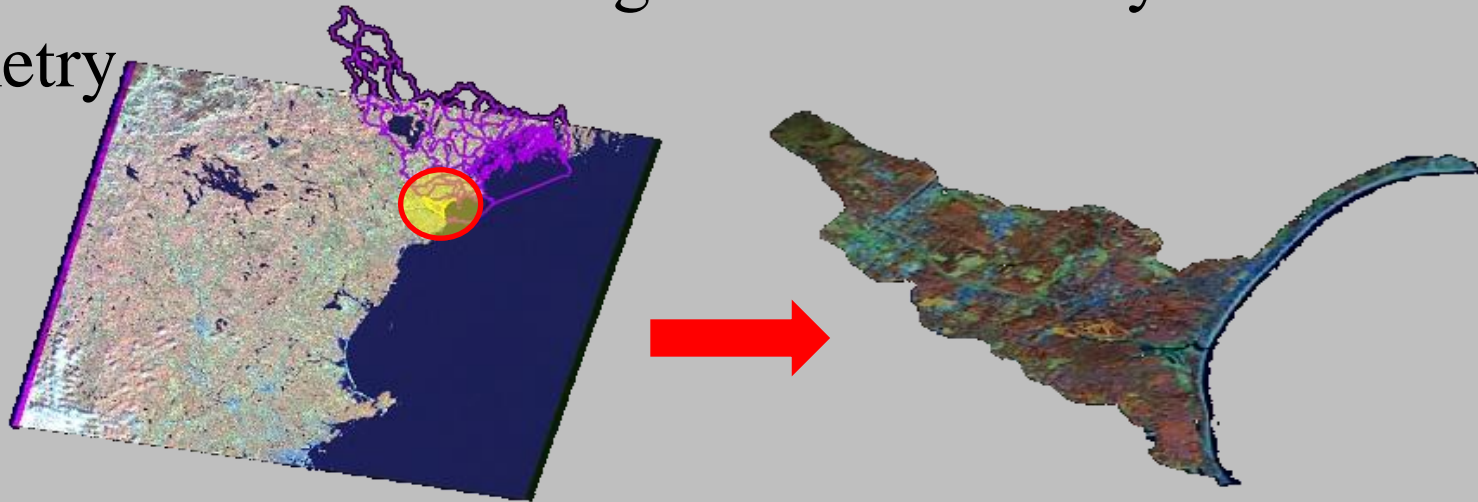
- Data Validation





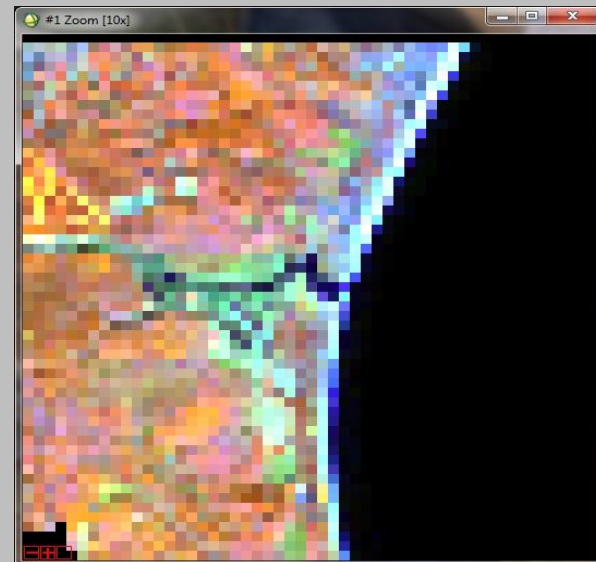
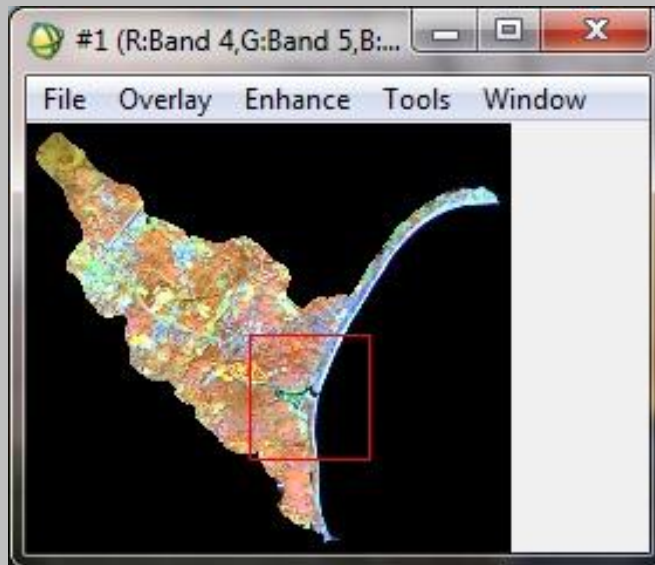
# Analysis Documentation

- Analysis of Impervious Surfaces
  - Loaded data into ArcMap 10.0 for data validation
  - Exported Goosefare Brook's (GFB) wetland feature from the larger wetland boundary shapefile
  - Clipped Landsat data using GFB's boundary geometry



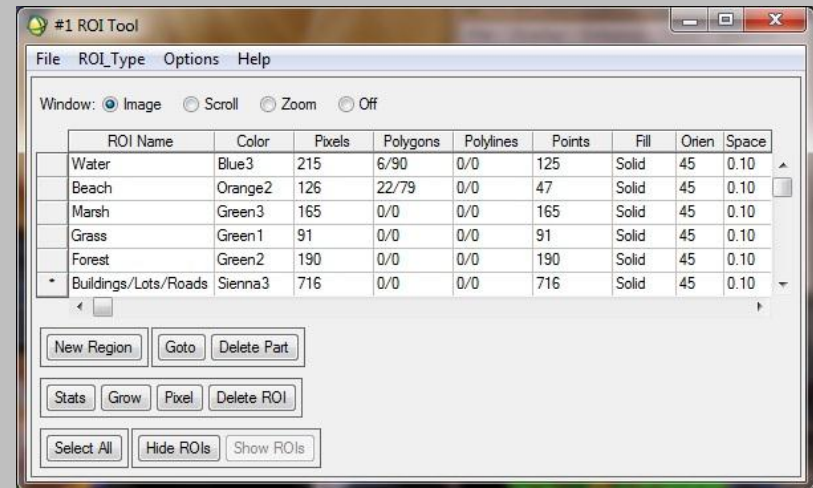
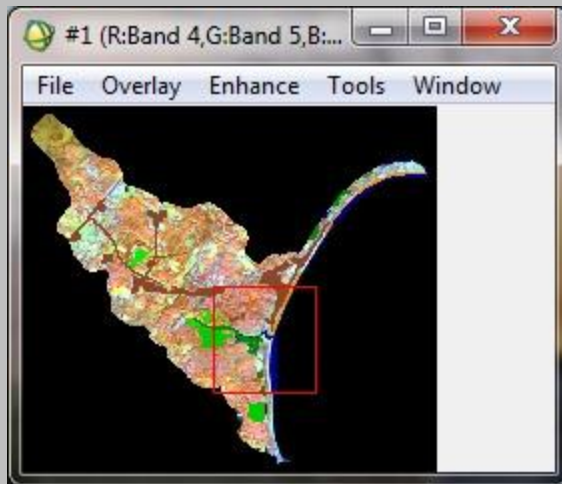
# Analysis Documentation

- Analysis of Impervious Surfaces
  - Loaded clipped Landsat data into ENVI 4.8  
*File > Open External File > Landsat > GeoTiff with Metadata*
  - Displayed data in RGB using Bands 4, 5, 3



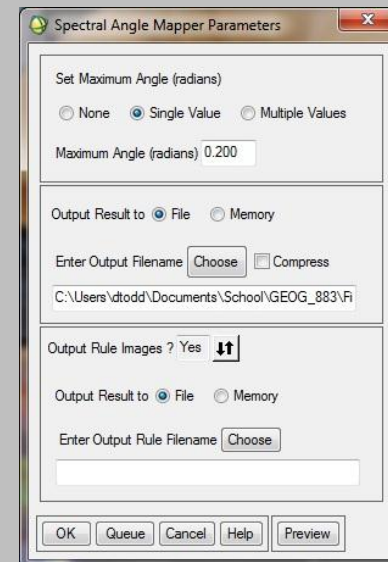
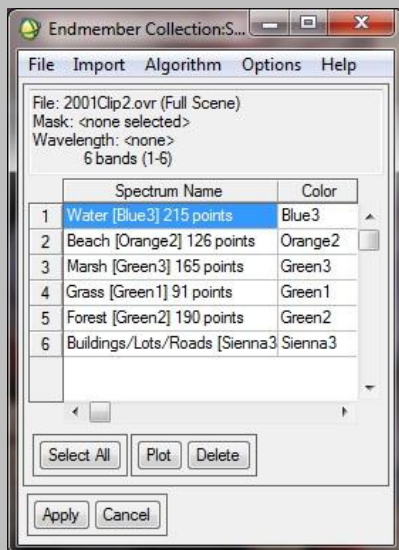
# Analysis Documentation

- Analysis of Impervious Surfaces
    - Defined Regions of Interest (ROI) for classification training using a mixture of pixel and rectangle selection to define Water, Beach, Marsh, Grass, Forest, and Buildings/Lots/Roads
- Basic Tools > Regions of Interest > ROI Tool*



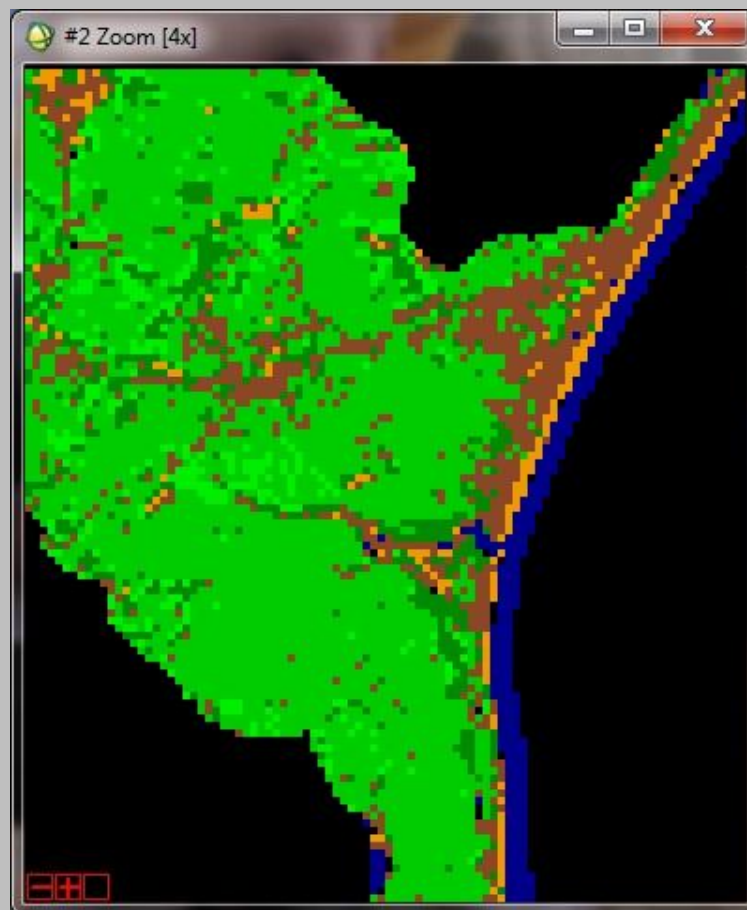
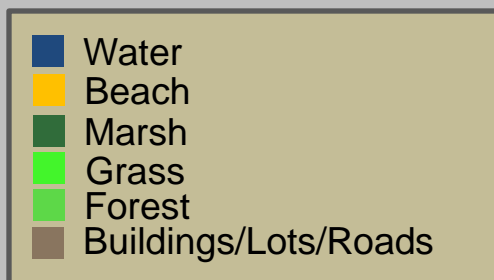
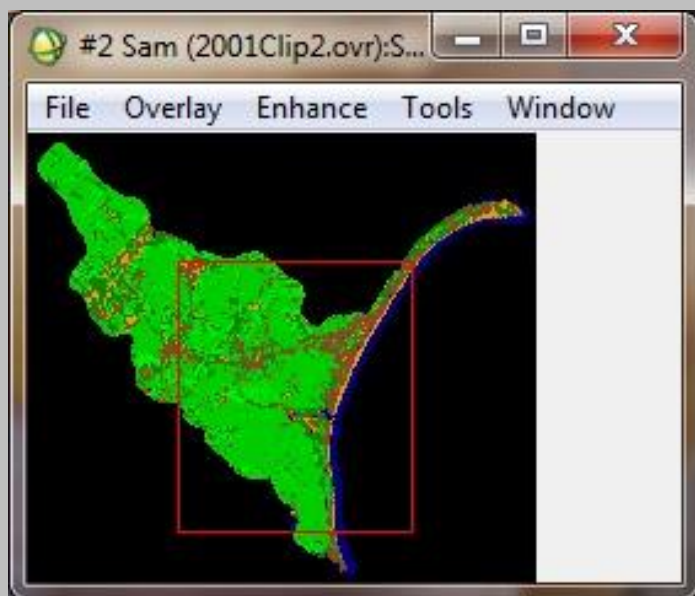
# Analysis Documentation

- Analysis of Impervious Surfaces
    - Classified the rest of the pixels using Spectral Angle Mapper (SAM) by importing the ROIs and using a Maximum Angle of 0.200
- Classification > Supervised > Spectral Angle Mapper*



# Results

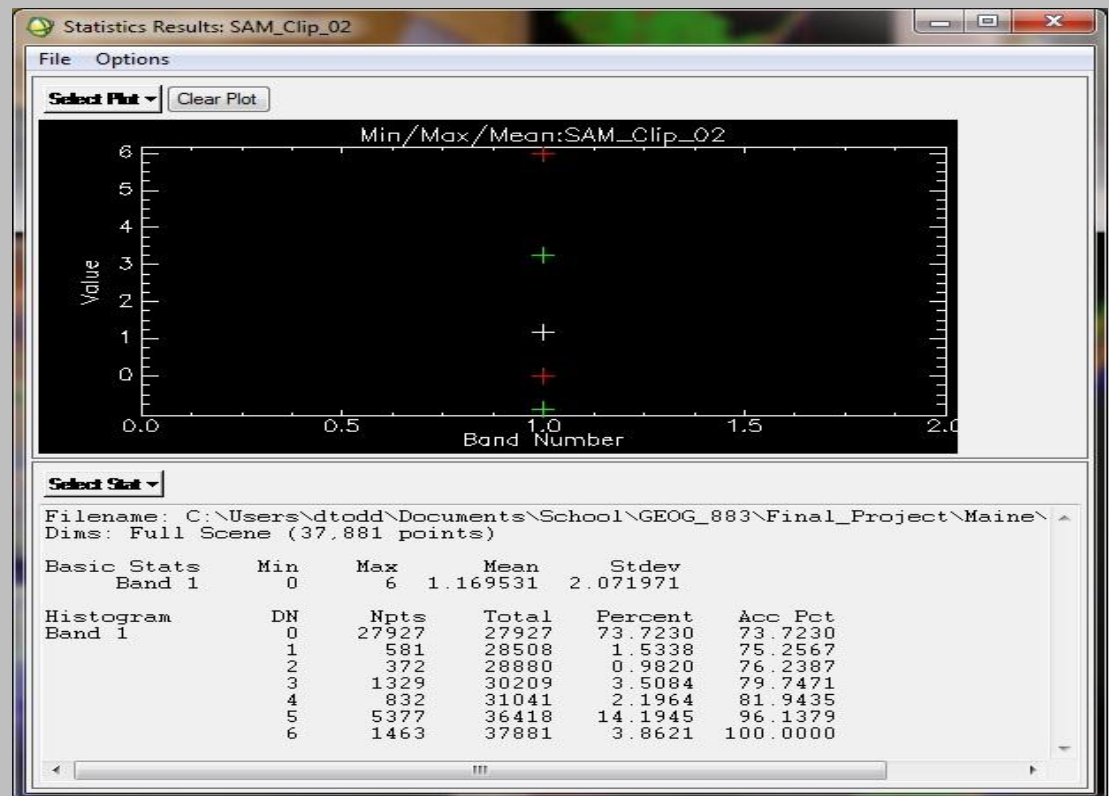
- SAM Classification method was successful at classifying the remaining pixels



# Results

- Quick stats on the SAM data layer reveals information on each grouping of pixels. Since the image was clipped, Unclassified (0) pixels make up ~73%. Subtracting the unclassified pixels from the total and recalculating will give the proper results.

- (1) Water = 5.84%
- (2) Beach = 3.74%
- (3) Marsh = 13.36%
- (4) Grass = 8.35%
- (5) Forest = 54.02%
- (6) Buildings,  
Lots,  
Roads = 14.69%



# Results

- Summary
  - Supervised classification of Landsat data is a viable method for determining land use
  - Determined that Impervious Surfaces cover ~**15%** of the area that surrounds the Goosefare Brook's wetlands
  - DEP has stated to support Class B aquatic life, the Goosefare Brook watershed needs to have the characteristics of a watershed with **9%** impervious surfaces, which is an almost **40%** reduction
  - Results were easy to produce in KML format for public consumption.
  - Pitfalls
    - Large Data – decided against downloading orthoimagery due to size
    - Unable to Link orthoimagery and Landsat data to be 100% sure that the pixel used for training was indeed correct
    - Defining ROIs to train the classification of pixels is a lengthy process, hence deciding against the change detection portion
    - If you clip down a Landsat image, be sure it has a Spatial Reference when you bring it into ENVI – if it does not, you will be unable to align it properly in ArcMap or Google Earth

# References

- Maine Impervious Cover, Total Maximum Daily Load (TMDL) for Aquatic Life-Impaired Waters - Preliminary Draft, March 2011, FB Environmental Associates, Inc.