# Mangrove Conservation in Southern Florida

*An Analysis of Changes in the Mangrove Ecosystem from 1988 to 2003*

## Research Objective

Mangroves are threatened by disturbances in water composition and quality due to human development, and are vital to local ecosystems and coastline storm protection. This research seeks to examine whether recent conservation efforts have had any positive effects on the mangrove ecosystem, using images of the mangroves from 1988 and 2003. Classification and post-classification comparison change detection were used to analyze the change in mangroves by area and percentage, as well as the change in mangrove height and health.

## Results/Conclusions

There is evidence of mangrove erosion along the coastline, a decrease in healthy vegetation, and expansion of mangroves into historically freshwater areas due to saltwater encroachment. In total, mangrove area decreased by 5.2%, or roughly 27.5 sq km. While this rate of decline is not as severe as mangrove loss in other tropical areas, it still indicates that conservation efforts must be strengthened to prevent further mangrove loss along the western coastline of southern Florida. It is particularly important to restore the drainage relationship between Lake Okeechobee and the Everglades that was destroyed by human development.

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## Background

The mangrove ecosystem of southern Florida is part of the Everglades, a subtropical wetland. Southern Florida has been developed extensively for urban and agricultural purposes, which destroyed roughly half of the Everglades since the 1800s. Attention has only been paid to its conservation since the 1970s, with growing national interest in environmentalism.

The Everglades were once a large freshwater drainage system, originating in Lake Okeechobee to the north. With urban and agricultural development, fresh water has been diverted away from the Everglades and disrupted this system. Phosphorus and nitrogen pollution from agricultural areas have severely reduced the water quality of the Everglades.

Although mangroves cover a geographically small area, their critical position between land and sea makes them far more important than their size might suggest. Mangroves serve as shelter and nurseries for crustaceans, fish, and birds. They also protect the coastline during storms by trapping sediment and absorbing wave energy.

## Methodology

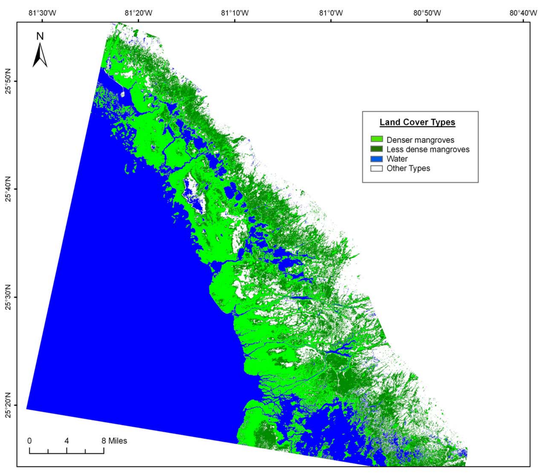
### *Preprocessing*

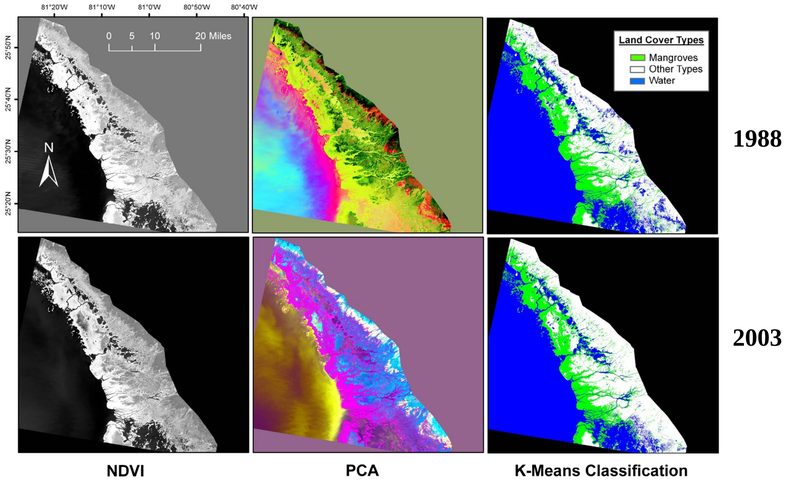
Images of southern Florida were obtained through USGS Earth Explorer. A Landsat TM image from March 15, 1988 and a Landsat SLC image from February 13, 2003 were used. After layer stacking, mangrove areas in the southwestern part of each image were clipped with an ROI mask. A Normalized Difference Vegetation Index (NDVI) was used, with Band 3 as the red and Band 4 as the near-infrared, to compare the change in vegetation in the two areas. An unsupervised K-means classification of the enhanced 2003 image was able to distinguish between taller, denser mangroves and shorter, less dense mangroves.

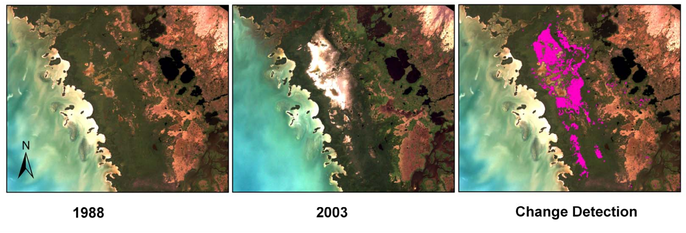
A first attempt at land cover classification was made without image enhancement, using unsupervised K-means classification, specifying 10 classes and 12 iterations, and merged into 4 final classes: water, mangroves, coastal salt marsh, and coastal prairie. These results were somewhat successful, but not sufficiently accurate at distinguishing the non-mangrove land cover. Principal Component Analysis (PCA) was used with the MNF method in order to reduce noise and enhance the mangrove features.

### *Classification/Change Detection*

The first three MNF bands of each image were used to run an unsupervised K-means classification with the same number of classes and iterations. The classes were merged down to 3, rather than 4, because the limitation of publicly available reference maps made it difficult to distinguish between non-mangrove land cover types. A post-classification comparison change detection quantified the change in mangrove, water, and other land cover types. Finally, a confusion matrix was generated to measure the accuracy of the classifications, using ground truth ROIs from the original masked images. The matrix reported 94.2% accuracy for the 1988 image and 99.5% accuracy for the 2003 image, with 100% accuracy for the mangrove class for both images.

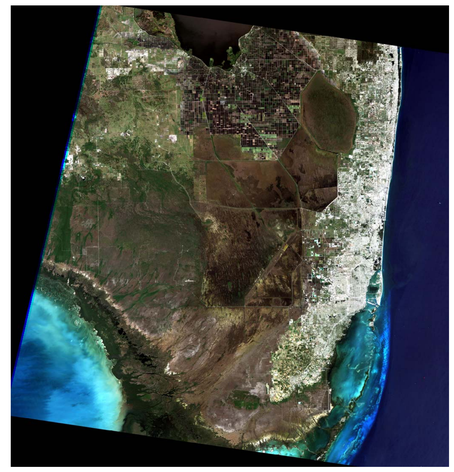


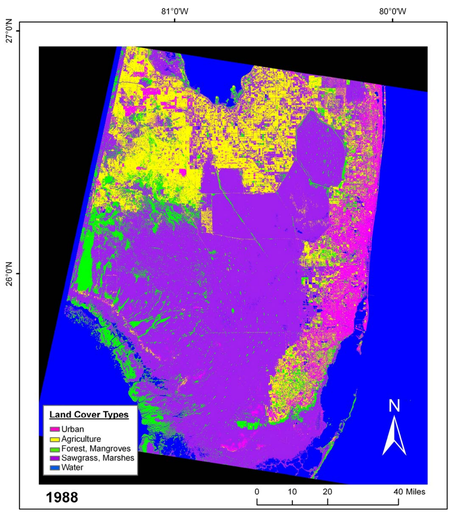




| Land Cover Types | Change (%) | Area Change ($km^2$) |
|---|---|---|
| Water | -2.2 | 37.2 |
| Other Types | 6.85 | 64.73 |
| Mangroves | -5.21 | 27.53 |

## South Florida Land Cover (1988)






## Suggestions for Improvement

The lower spatial and spectral resolution of the Landsat images made it difficult to distinguish between certain types of land cover. It was impossible to classify land cover for the 2003 image of southern Florida, or to distinguish non-mangrove land cover types from one another with confidence. This information would have enhanced the quality of analysis.

It would also have been useful to include an image from the 1970s in the comparison in order to better chronicle how rates of mangrove loss have changed in accordance with conservation efforts. Unfortunately, high-quality satellite images from the 1970s are difficult to find.