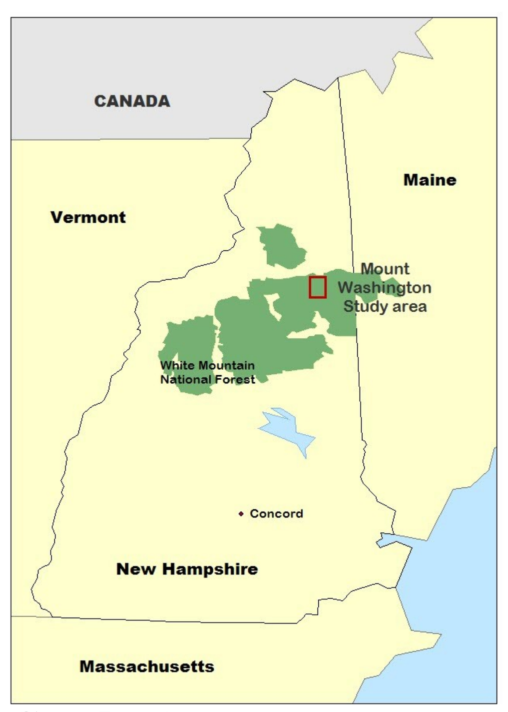
Tracking Advance of the Tree Line on the New Hampshire Presidential Ridge

Introduction



Study Area

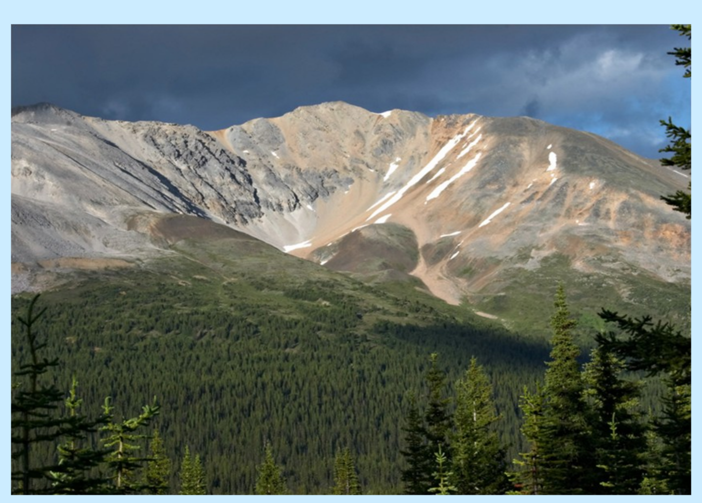
Remote sensing change detection technology was can track the effects of climate change on alpine ecosystems. This study focuses on changes in the tree line of the Presidential ridge in the White Mountains of New Hampshire.

What is the tree line?

The tree line is the point at which trees can no longer grow, due to inhospitable climate. At a certain elevation, which varies by geographical region, trees cannot survive the conditions and rocky soil is exposed. This rocky zone above the tree line is known as the alpine tundra. As global climate increase, the tree line advances to areas of higher elevation.

Why is tree line important?

Tree line shift is an effective way to measure climate change. Further, tree line has great biological significance.



Many species of plant and animal can only survive in specialized environmental niches, such as the alpine tundra. A large-scale advance of the tree line will likely result in the severe endangerment and possible extinction of many species.

How can the tree line be studied?

Most commonly, a Normalized Difference Vegetative Index (NDVI) is used to analyze changes in the tree line. However, a supervised classification may be able to provide more accurate results. In this analysis, both of these methods of land classification will be used to track changes in vegetation. By using two methods, the overall reliability of the results may be assessed. Further, the two methods will be compared on their effectiveness to evaluate changes in the tree line.

Question

Has the tree line advanced on the Presidential Ridge?
Which classification method best tracks tree line migration?

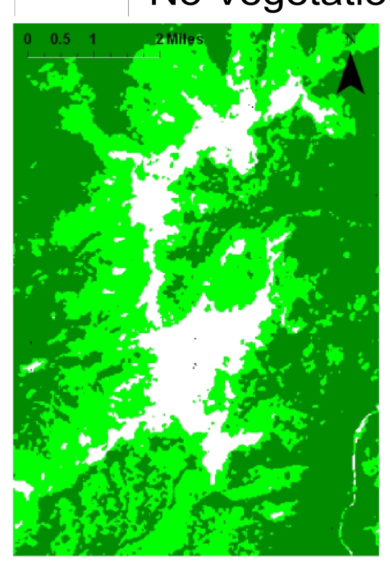
1986 Image

2004 Image

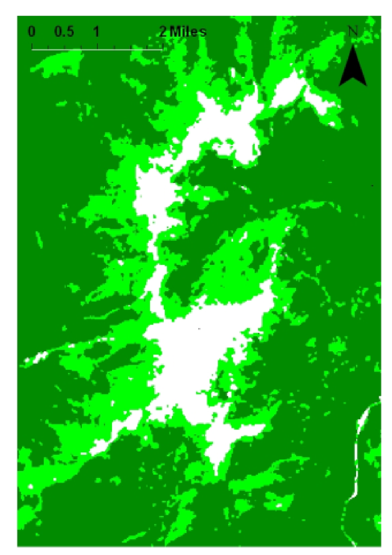
All analyses performed in this project were based on the above images. These images were taken by Landsat 4-5 TM in the month of August.

Legend

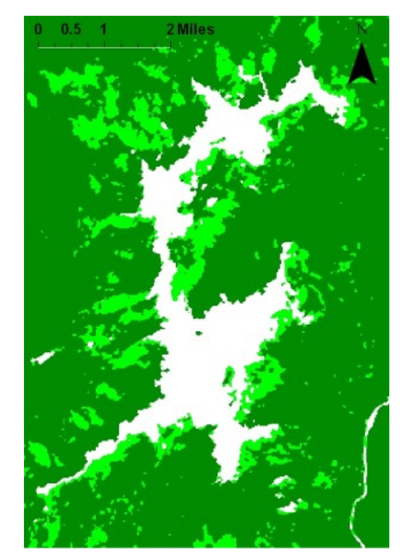
- Heavy Vegetation
- Light Vegetation
- No Vegetation



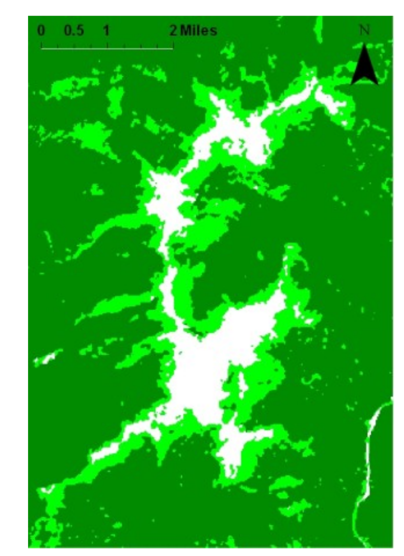
1986 NDVI



2004 NDVI



1986 MLC



2004 MLC

NDVI Change Detection

Classification	% Change	Sq. Mi. Change
Heavy Vegetation	42.1	8
Light Vegetation	-37	-6.4
No Vegetation	-21.1	-1.3

NDVI Binary Change Detection

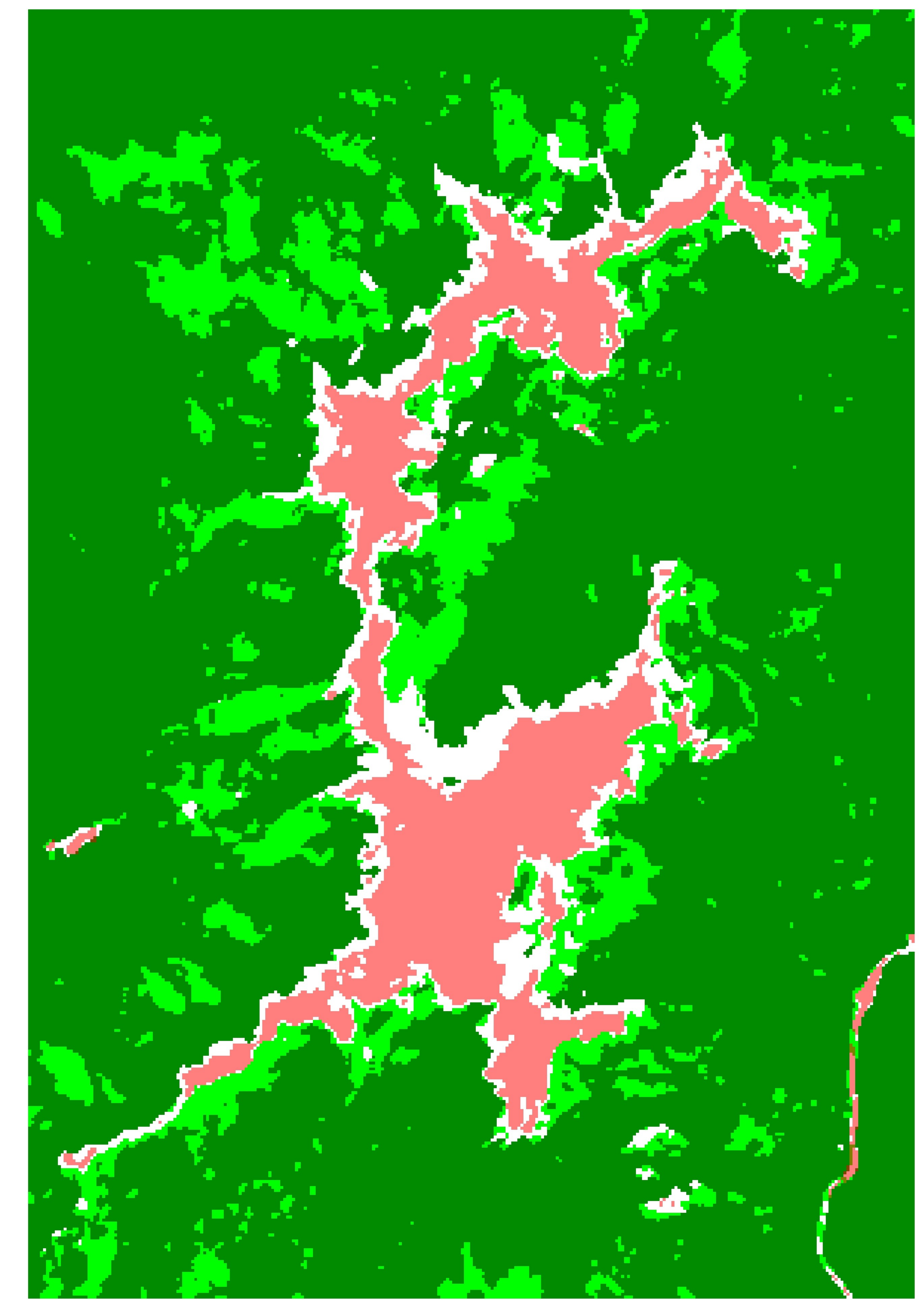
Classification	% Change	Sq. Mi. Change
Vegetation	4.4	1.6
No Vegetation	-21.1	-1.3

MLC Change Detection

Classification	% Change	Sq. Mi. Change
Heavy Vegetation	3.5	1.1
Light Vegetation	17.7	1.29
No Vegetation	-37.6	-2.39

MLC Binary Change Detection

Classification	% Change	Sq. Mi. Change
Vegetation	6.1	2.39
No Vegetation	-37.4	-2.39



1986 classification overlaid with 2004 alpine tundra

Legend

- 2004 No Vegetation
- 1986 No Vegetation
- 1986 Light Vegetation
- 1986 Heavy Vegetation

Methods

To track the advance of the tree line, data from August 1986 was compared with data from August 2004.

Data Processing

The Landsat TM 4-5 data were obtained from the USGS. After being downloaded, the layers were stacked and then clipped to the size of the study area. For the NDVI analysis, data were converted into reflectance.

Classification

1. Maximum Likelihood classification. This supervised classification was done by creating three categories of land cover: heavy vegetation, light vegetation, and no vegetation. For each category, training sites consisting of 8 polygons and over 200 points were created. The classification was run using ENVI.
2. NDVI classification. This unsupervised classification compares the reflectance of the red band and the near infrared band. After NDVI classification, three classes based on the NDVI value of each pixel were created:
-1 to 0.49: No vegetation
0.49 to 0.65: Light vegetation
0.65 to 1.00: Heavy Vegetation

Post Classification

Once the images were classified, the data were compared using the change detection function of ENVI. First, comparison of the two dates was conducted using all three land classes. Next, the light and heavy vegetation classes were combined and a further binary change detection analysis was done to compare areas with vegetation to areas without vegetation. In this way, the results of the MLC and the NDVI classification methods may be directly compared despite differences in the classification criteria.

Results

The NDVI data show that the amount of heavy vegetation is increasing, while the areas of light vegetation and no vegetation are decreasing. The MLC data show that areas of both heavy and light vegetation are increasing, while areas of no vegetation are decreasing. The accuracy of the MLC classification was greater than the accuracy of the NDVI classification.

Accuracy of Classification Method

Classification Method	1986	2004
NDVI	77%	71%
NDVI Binary	93%	96%
MLC	98%	95%
MLC Binary	100%	100%

Conclusion

Regardless of classification method, the tree line is advancing. More work is needed to determine if this shift is caused by climate change or normal climate fluctuations. By comparing the NDVI and the MLC methods, we see improved classification accuracy with the supervised technique.

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Intro to Remote Sensing
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Data: Landsat 4-5 TM, from USGS

Tufts