Land Cover Changes in Blue Hill, Maine From 1997 to 2013

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Introduction and Motivation

Jim Fisher of Hancock County Planning Commission in Ellsworth, Maine, expressed an interest in a land cover change analysis for the town of Blue Hill, Maine, to help town officials and residents to decide whether a comprehensive plan would be pursued in the future.

The town of Blue Hill is located in Mid-Coast Maine in Hancock County and has a rich history, as well as vibrant, year-round and summer communities. Its boundaries include a wide collection of salt and fresh water coastlines, many islands, and Blue Hill Mountain.

Geographic Questions & Goals

A land cover study can show changes between conventional land uses for different periods of time. Logging, agriculture, land development and wetland boundaries, are a few of the land covers that can be studied. Analysis of these areas can help town officials and residents understand where changes are occurring and how the causes and consequences are related.

Methods:

I obtained Landsat and orthophoto images from U.S. Geological Survey. Landsat data came from Glovis and aerial images from 1997 and 2013 originated from EarthExplorer, both online. It is very important to get cloud-free images (or as cloud-free as possible), to have as little interference as possible with the analysis. The time of year of the aerials is also vital. Images taken over Maine in fall through late spring will not give enough vegetation readings to be significant.

I used ArcMap 10.2.2 to process all my data and create my maps and layers. All layers needed to be clipped to my study area, the town boundary of Blue Hill, so the layers would load and process faster. I converted each of the Landsat images to reflectance. A cloud mask was needed on the 2013 Landsat image for a few clouds in the southeast corner of the image.

I ran a normalized difference vegetation index (NDVI) for each time frame to see where vegetation was occurring. I used bands 3(red) and 4(infrared) for Landsat 5(1997) and for Landsat 8, the bands used were 4(red) and 5 (infrared). The band numbers for each satellite are different because the more recent satellites have additional bands in a slightly different order. For the NAIP orthos, the bands were 1 and 4. To calculate NDVI I used the following formula:

NDVI = (Near-Infrared Band- Red) / (Near-Infrared + Red)

This was done using a model that could be used repeatedly with other layers. I also symbolized the Landsat bands to produce a false color image that highlighted the healthy vegetation in vibrant reds.

After having completed the preprocessing of the Landsat data, the next phase was classification. In my first try at classifying, I used a model which ran an unsupervised classification on the image. In this process the computer compares colors and comes up with its own groups of values. The final result of this process was not correct and much too generalized. (go to next column)

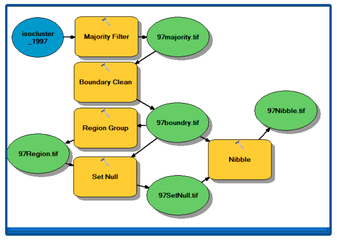
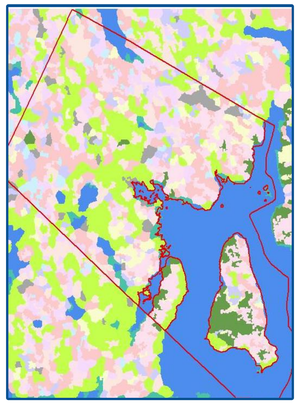
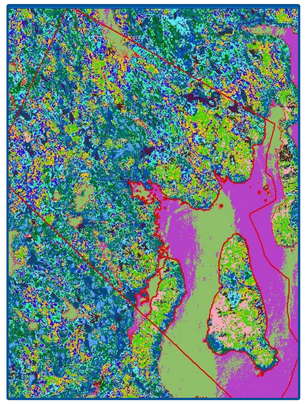


Fig.1 ArcGIS Toolbox model classifying tool with the resulting Nibble layer (Map 1, right). This tool automatically divides a Landsat aerial into categories that it "sees" as the same. The resulting map was not correct and much too generalized to work with.

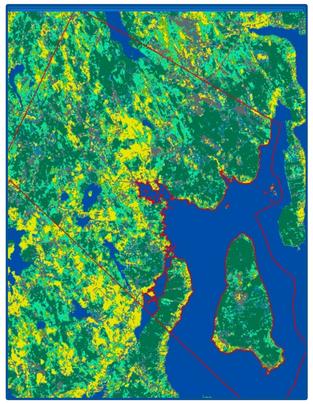


Map 1 Nibble Tool resulting layer

Unsupervised Classification Using a Model Tool



Map 2 1997 Isocluster (creating classes based on spectral signatures) classification



Map 3 1997 After isocluster classification and supervised classification (identifying and merging classes)

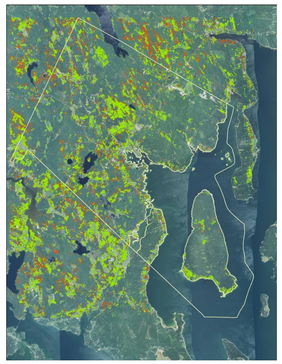
Isocluster and Supervised Classification

Map 4 1997 False color image (Landsat 5)

Map 5 2013 False color image(Landsat 8)

False Color Images Using Landsat Band Combinations

Intense reds indicate healthy vegetation



Map 6 Forest land cover changes 1997 to 2013

Map 7 Field land cover changes 1997 to 2013

Land Cover Difference Layers

Green indicates gain in acreage Orange indicates loss in acreage

Methods(cont.):

I followed this process with a supervised classification which involves identifying small patches of ground and using these as training samples. These samples give the computer an idea of what you want it to look for. After identifying several different classes of ground cover, I ran an interactive supervised classification.

The final step, change detection, calculated the changes in land cover type areas between the two time periods. I did this by entering the 1997 and 2013 seven-class layers into the Combine tool. This tool combines two or more raster layers and gives a unique output value to each unique combination of input values. The resulting layer gave a change matrix grid with 49 values.

Results

The results of these analyses are shown in Figure 1 and Map 1. Map 2 shows the many tiny areas as a result of isocluster classification and Map 3 displays the larger areas of fewer classes after performing supervised classification and merging the classes. False color images (Maps 4 and 5) were produced by symbolizing the bands of Landsat images, revealing healthy vegetation in bright red. Maps 6 and 7 show two land cover types with the most significant losses and gains. Below is the change matrix table (Table 1) which shows how much acreage moved from one category to another and how much was unchanged.

Change Matrix of Land Cover Types in Blue Hill, Maine 1997 to 2013 (in acres)

		1997							
	Cover type	Water	Bare Ground	Forest	Light Forest	Wetland	Field/Trees	Field	2013 Totals
2013	Water	23474.1	29.8	147.2	70.7	18.7	21.1	25.1	23786.7
	Bare Ground	418.5	1713.9	630.7	484.4	535.1	125.9	1138.8	5047.3
	Forest	329.6	2580.6	24552.4	8956.2	1996.6	748.1	557.1	39720.6
	Light Forest	221.3	2655.5	3258	5966.6	1193.3	2989.1	1447.5	17731.3
	Wetland	26	1431.5	354.7	440.5	560.4	369.2	1757.7	4940
	Field/Trees	11.1	1377.2	542.6	1029.4	628.7	2253.9	7081.5	12924.4
	Field	18.2	315.3	56.9	39.6	361.2	33.6	1524.9	2349.7
	1997 Totals	24498.8	10103.8	29542.5	16987.4	5294	6540.9	13532.6	106500
	no change								

Table 1 Change Matrix Table

Discussion

There was room for a great deal of error, in this analysis, as it was difficult for me to distinguish between different densities of forest. Ground-truthing would have been useful with more time. I was expecting to find less vegetation due to development and clear-cutting but my results did not reflect this. What I did see was the greening of spaces that had been cut around the time of the 1997 image. The 1997 image was taken the middle of June, when vegetation growth may not have been quite as lush as it was in the August 2013 image.

Conclusion

This analysis shows only differences between 1997 and 2013. There are more changes that may have occurred between 2013 and 2015. It is important for communities to keep an eye on environmental changes as they may indicate issues that could be addressed with future planning.

Credits and Acknowledgements

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ArcGIS 10.2.2
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Landsat 5 and Landsat 8 images, http://glovis.usgs.gov/
Landsat 8 Data Assistance, http://landsat.usgs.gov/Landsat8_Using_Product.php
Aerial Images for 1997 and 2013, http://earthexplorer.usgs.gov/
Maine town boundaries and web mapping services, http://www.maine.gov/megis/catalog/index.shtml -