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Final Draft: Research Paper

Abstract

One of the best ways to understand vegetation change are from direct ground observations that can be achieved by using and manipulating satellite imagery data in ArcMap (Scheftic et. al., 2014). We use two spatial analyses: NDVI (Normalized Difference Vegetation Indexes) and Zonal Statistics to understand vegetation changes within the Knox Preserve, Stonington, CT between 2004 and 2012. Our results showed an increase in vegetation densities within our three habitats: Grasslands, Wetlands, and Forested Areas. Increased vegetation densities throughout our Forested Areas might be a key indicator that our site is becoming dominated by certain invasive (non-native) vine and shrub species that have outcompeted the native species for land and resources. Future studies can be done to determine the percentage of invasive vine species coverage in Forested Areas and its effects on the native bird species populations.

Introduction

Human disturbances can have a direct influence on ecosystems, affecting the distributions of vegetation and animal populations found within a given area. Analyzing vegetation changes can help us to understand biodiversity reduction and habitat

degradation within certain ecosystems (Pettorelli et.al.2005). Today, one of the best ways to understand vegetation change is from direct ground observations that can be achieved by using and manipulating satellite imagery data in ArcMap (Scheftic et.al. 2014). Using orthographic satellite imagery data we hope to assess the vegetation health of the Knox Preserve, located in Stonington, CT. We use NDVI (Normalized Difference Vegetation Indexes) and Zonal Statistic spatial analyses to understand vegetation changes within our three different habitats (e.g. Grasslands, Forested Areas and Wetlands) of the Knox Preserve between the years of 2004, 2008, 2010 and 2012. Though, NDVI has become increasingly popular in ecological studies and can play a major part in understanding environmental changes within areas such as the Knox Preserve, future studies can be done to look at other factors that might have an affect on vegetation change such as salinity levels and seasonality (Scheftic et.al. 2014)

Site Description

The Knox Preserve is located in Stonington, CT and is owned by the Avalonia Land Conservancy Agency. There are three different vegetation habitats within the site, which include Forested Areas, Grasslands and Wetlands (Figure 1). The Knox Preserve is filled with invasive vine and shrub species that have dominated areas by outcompeting the native species for essential resources such as sun and water. While some work has been done to manage these invasive plant species, our focus was on spatially analyzing the four-year changes in vegetation densities within our three different habitats.

Figure 1: Site map of the Knox Preserve in Stonington, CT depicting our three different habitats (Grasslands, Forested Areas, Wetlands) and their locations within the site. (Made in ArcMap)

Methods

A collection of orthographic imagery was obtained from the Digital Coast website (http://coast.noaa.gov/digitalcoast/). This 4-banded imagery was manipulated using spatial analyses tool extensions in Arc Map 10.2.2. In order to understand vegetation changes within the four-year period we ran a spatial analysis tool extension known as NDVI (Normalized Difference Vegetation Index). This measured the differential reflection in the red (Band1) and infrared (IR) (Band 4), enabling us to monitor the density and intensity of green vegetation growth. Healthier vegetation absorbs more active radiation while unhealthy vegetation reflects most active radiation (Figure 2).

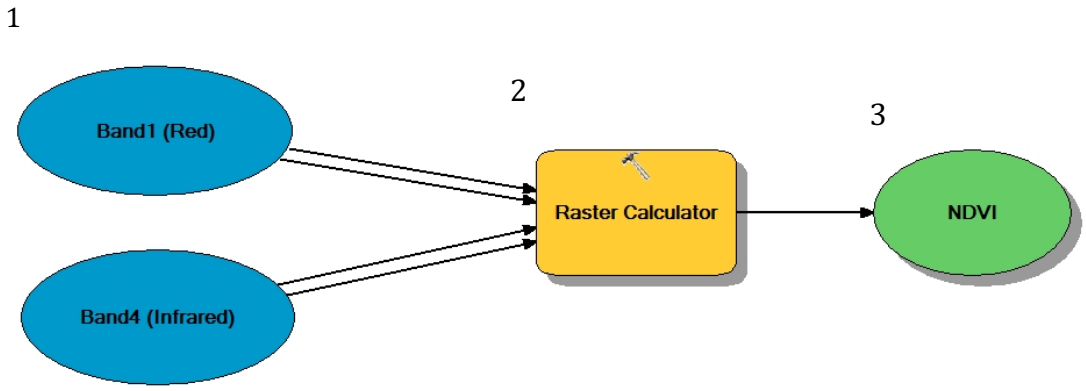

Figure 2: Model Processes of NDVI analyses done in Arc Catalog.

After running NDVI for our four year orthographic imagery, we ran a spatial analyst tool known as Zonal Statistics. Zonal statistics calculated the mean NDVI value of each raster dataset within our three distinguished zones (Forested Areas, Wetlands and Grasslands) (Figure 3).

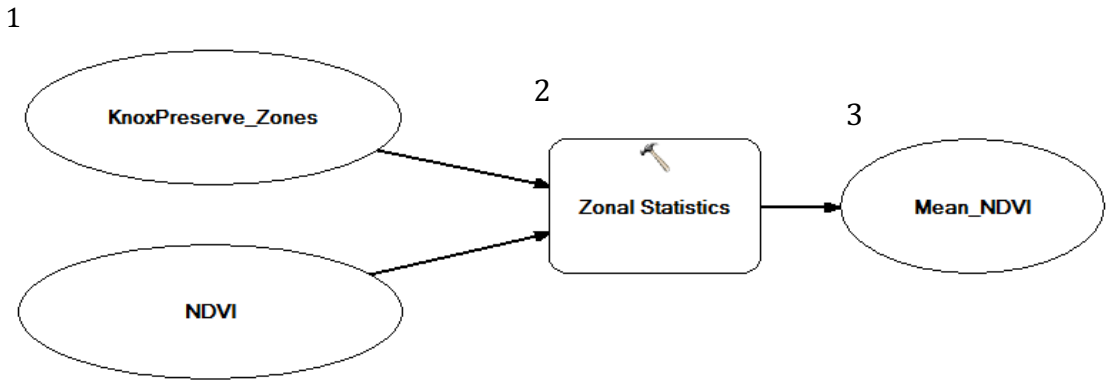

Figure 3: Model Processes of Zonal Statistics done in Arc Catalog.

Our results from the Zonal Statistics were numerically recorded in a tabular dataset that was exported from ArcMap to Excel where we formatted our tables and graphs. We then ran additional statistical analyses to see if there were any regressions and their levels of significance.

Results

Our results show an increase in NDVI (e.g. vegetation density) within our Forested Areas, Grasslands and Wetlands. There has been a significant difference between time and vegetation density within our forested areas ($p < 0.05$). However; there was no significant difference between time and vegetation density within our Grasslands and Wetlands ($p > 0.05$).

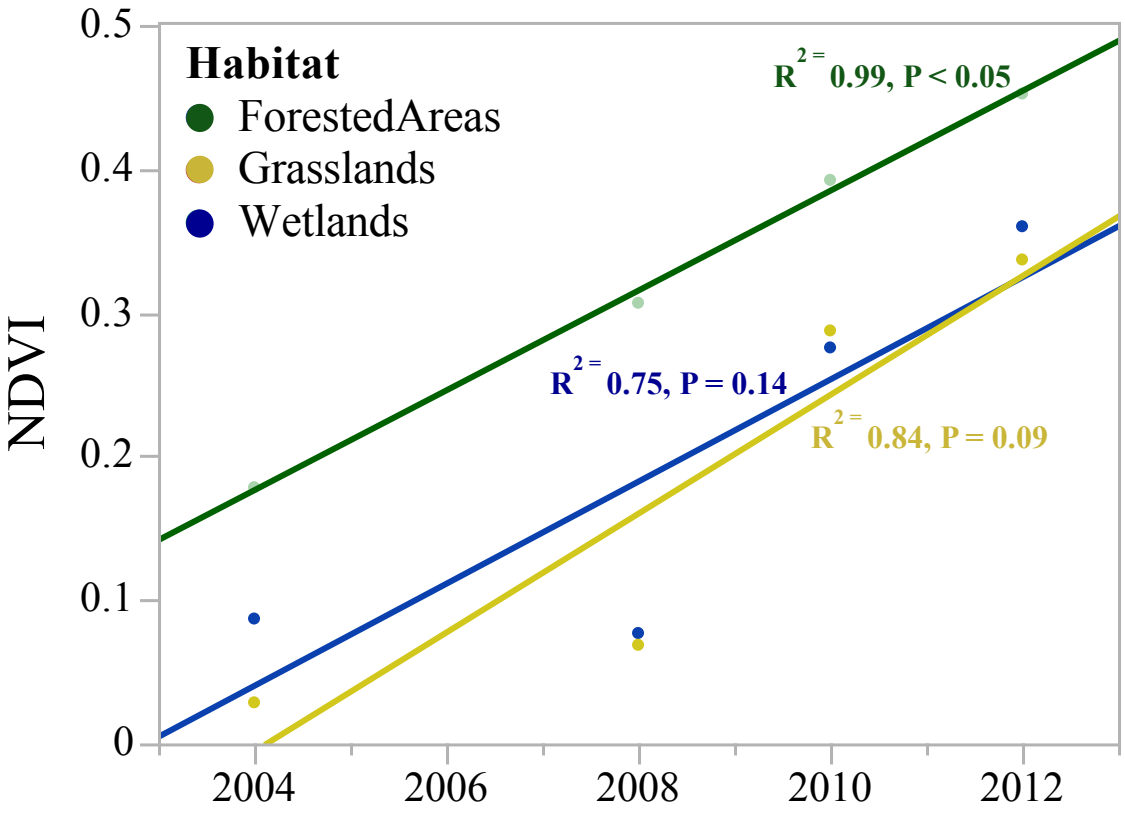

Figure 4: Collection of Mean NDVI's between 2004 and 2012 within our Forested Areas, Grasslands and Wetlands. Our results show that there has been an increase in vegetation since 2004.

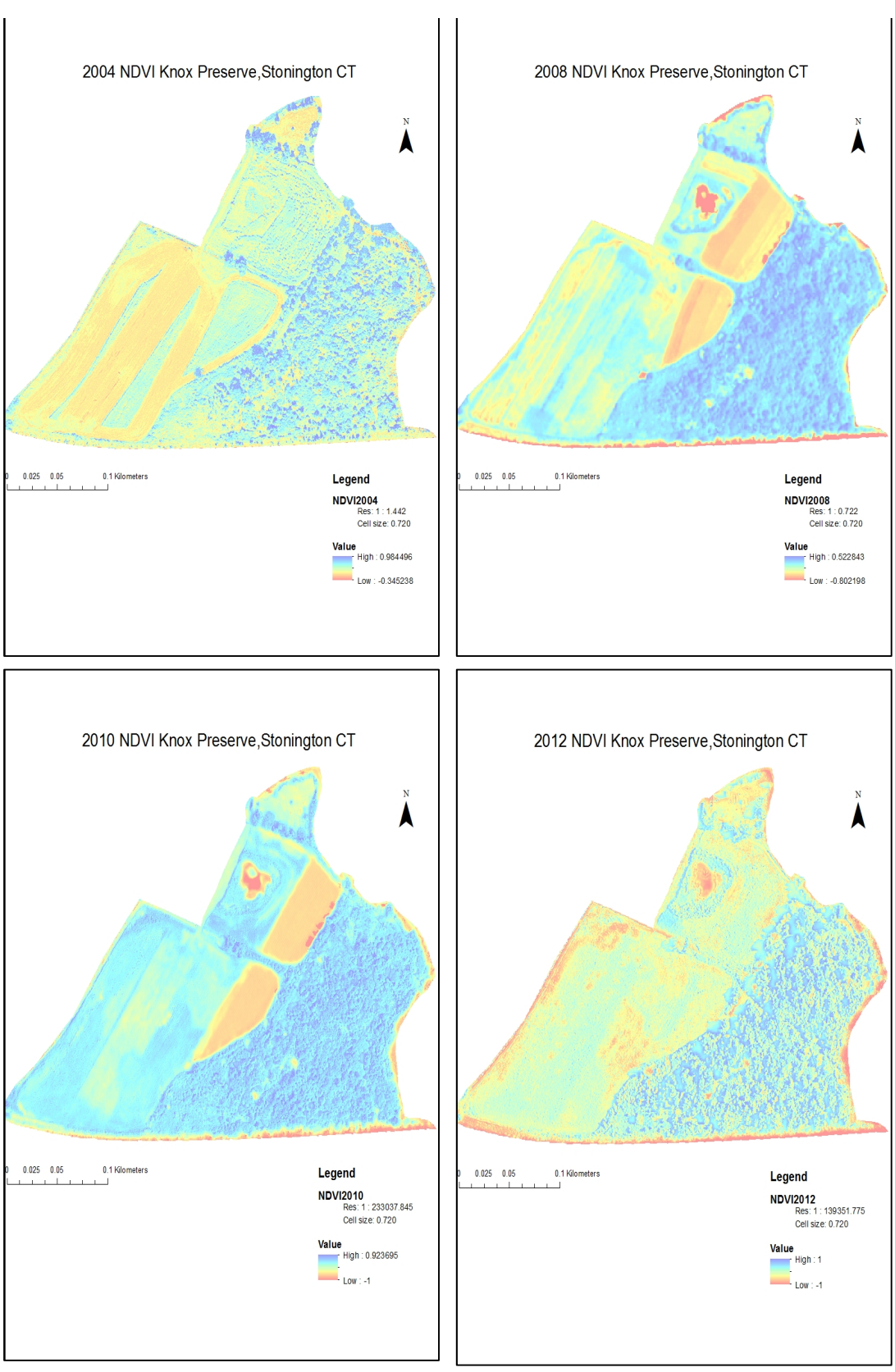

Figure 5: A collection of our four-year NDVI analyses within the Knox Preserve, Stonington CT. All maps were made in arcMaP by using the spatial raster calculator tool extension to input the following equation for NDVI: NDVI = ((IR - R)/(IR + R)

Discussion

Our results show that there has been an increase in vegetation density at the Knox Preserve between 2004 and 2012 (Figure 4). Shadows may have affected our NDVI results, as shadowed regions tend to have the same NDVI values as dense vegetation. Further analysis should focus on limiting the amount of shadows present for better results; one suggestion would be to manipulate the blue RGB band. Similar studies have incorporated NDVI and EVI (enhanced vegetation indexes) for improved measures of canopy sensitivity and measures of photosynthetic canopy cover, especially in areas that experience high levels of sensitivity (E.g. Forested Areas) (Huete et.al.2002, Chen et.al.2005, Vina el. Al. 2014). Enhanced vegetation monitoring can improve our results by minimizing the amounts of shaded areas that may have had an affect on our final mean NDVI results.

Although our results show there to be increases in vegetation between 2004 and 2012, we need to consider the fact that we sampled a relatively small amount of orthographic satellite imagery. A more accurate depiction of mean NDVI would be the result of analyzing a collection orthographic satellite imagery taken during the same time within each year. Given that NDVI is based on differential reflections the best results for our NDVI would come from orthographic imagery taken during prime growing season (e.g. early June) when vegetation is healthiest. Healthy green leaves absorb more active radiation than yellowish/brownies leaves, therefore; NDVI is also a good indicator of the health and productivity of biomass.

We expected NDVI to be lowest in our wetlands and grasslands given the fact that small plant species (e.g. grasses) are less photogenic than bigger plant species (e.g. trees). Although the grasslands have greater surface area coverage than our Forested Areas, the 2004 mowing of the grasslands may have had an influence on our NDVI analyses. Increases in vegetation within our Forested Areas may be associated with increased invasive vine and shrub coverage. Invasive species often outcompete native species for resources and dominate landscapes. Future studies can be done to determine the percentage of invasive vine species coverage in Forested Areas and if this has had an overall effect on bird species populations between 1990 – 2013.

Work Cited

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