Impact of Bark Beetles on the Health of California's Forests

Grand Valley State University
Geography and Sustainable Planning Department

By: Dylan Postma and Matt Lyle
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Faculty Mentor: Dr. Kin Ma

Introduction

The bark beetle is a small insect that feeds off the bark of injured or sick trees. Due to recent droughts in the western United States, food supply has been abundant and widespread for the bark beetle (USDA, 2015). In recent years, bark beetles have actually killed more trees than wildfires. In 2015, it was reported that bark beetles were the culprit in killing over 29 million trees in the State of California alone, inevitably increasing the risk and severity of wildfires, which is already quite high.

Our research study focuses on forested areas of California and the bark beetles that now inhabit these areas from 2010 to 2016. Specifically, we analyzed areas where bark beetles have had the most significant impact on forest health such as the south-central Sierra Nevada region.

Primary points of entry for non-native bark beetles are seaports and airports, both of which are characteristic of California, because these places import goods from all over the world (Rassati et al., 2016). Bark beetle outbreaks have led to the widespread loss of older, high-elevation whitebark pines and other types of conifers in recent years (Bentz et al., 2010). Rapid, large-scale tree mortality events can have long-term impacts on the structure and health of local ecosystems and its community.

Furthermore, bark beetles don't tend to rely on climate all that much, yet they are highly specific when it comes to finding a host species. They prefer conifer trees but they have also been found in certain hardwood species.

Objectives

The primary goal of our project is to explore how rising numbers of bark beetles have impacted the overall health of various hardwood and conifer tree species in California. We wanted to investigate how bark beetles have affected the health of California's forests during a recent time period, which, for our study, was from 2010 to 2016. In order to do so, we first gathered and analyzed both tree mortality and bark beetle data from the years 2010, 2013, and 2016. After retrieving the required data, we were then able to analyze various trends in data to determine which areas of California have been most severely impacted by bark beetles in the recent past. By doing so, we were then able to make predictions as to how these areas might be affected in the future if drought, bark beetle, and tree mortality trends continue.

Data

For our study, we generated Vegetation Health Index (VHI) maps for the State of California for 2010, 2013 (see **Figure 1**), and 2016 (see **Figure 2**) from the first week of June. By generating these maps, we were then able to analyze which areas of California had the healthiest vegetation as well as areas with less healthy vegetation.

In addition, we also generated a mosaicked image of the south-central Sierra Nevada region (see **Figure 3**) based on several Landsat 7 *.img* files for the year 2016.

Figure 1. Map displaying the health of vegetation in the State of California for 2013.

Figure 2. Map displaying the health of vegetation in the State of California for 2016.

Figure 3. Mosaicked image displaying extent of vegetation in the south-central Sierra Nevada region for 2016.

Results

After generating VHI maps for 2010, 2013, and 2016, we then created two VHI change maps, one for 2010 to 2013 and one for 2013 to 2016. From 2010 to 2013, it seems as though the health of California's vegetation did not change very drastically in either the positive or negative direction, but from 2013 to 2016 (see **Figure 4**), it seemed as though this trend reversed as most of California's vegetation became significantly less healthy, presumably, in part, because of bark beetles.

Furthermore, after generating point density maps for IDRAs (see **Figure 5**) as well as HHTMAs (see **Figure 6**), we were able to see how both were, in general, most densely concentrated in the Sierra Nevada region as well as portions of northern California and near Joshua Tree National Park.

Figure 4. Map showing change in VHI values for the State of California from 2013 to 2016

Figure 5. Point density map displaying various concentration levels of IDRAs from 1997 to 2015.

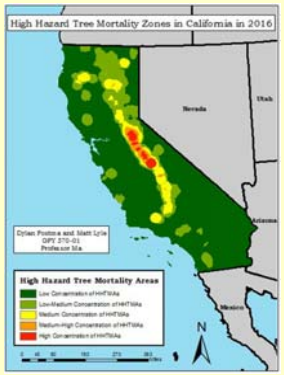

Figure 6. Point density map showing various concentration levels of HHTMAs in 2016.

Methodology

In order to analyze the health of California's forests, we first downloaded Vegetation Health Index (VHI) datasets (in GeoTIFF format) from NOAA's Star Center for Satellite Applications and Research website for the years 2010, 2013, and 2016. We then imported the global VHI datasets into ArcMap and clipped the layer to show only VHI values within the State of California.

In order to investigate changes in forested areas of California over our study period, we utilized the created VHIs for each year and input them in the Raster Calculator in ArcMap by subtracting one year from another. We were then able to generate two maps showing vegetation change from 2010 to 2013 and again from 2013 to 2016.

Although there is an overall lack of bark beetle data currently available, we were able to generalize bark beetle data by analyzing insect disease data. In order to generate point density maps showing various concentration levels for Insect Disease Risk Areas (IDRAs), in addition to High Hazard Tree Mortality Areas (HHTMAs), we downloaded polygon feature datasets. Then, we converted the polygon features to point features using the Feature to Point tool. We then created two point density maps using the Point Density tool that showed various concentration levels of IDRAs and HHTMAs.

In order to further analyze forest health for our study period, we obtained Landsat 7 images (in *.img* format) from the USGS Earth Explorer website for the predominant study area (south-central Sierra Nevada region) for 2013 and 2016. Images were then mosaicked together in ERDAS Imagine.

Conclusion

After conducting our research study, it appears as though bark beetles (as generalized by the IDRAs in **Figure 5**) have negatively impacted the health of California's forests from 2010 to 2016 to a large extent. As apparent in **Figures 5** and **6**, forested areas in the Sierra Nevada region were the most severely impacted areas in California in terms of both insect disease and tree mortality. However, confounding variables such as forest fires, changes in climate, and drought may have also played a role in the widespread degradation of California's forests. In the future, bark beetles will likely continue to wreak havoc on California's forests, resulting in large expanses of dead trees, which will serve as fuel for future forest fires.

References

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