Detecting Defoliation

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Motivation

My topic of interest is the detection of insect-induced tree defoliation of Eastern Ontario Forests.

According to "***The Intelligencer***", "it was the worst Gypsy moth caterpillar outbreak in Eastern Ontario in 30 years (Baldwin, 2020)" and I witnessed it first hand. Several trees on our cottage property were defoliated.

With this summer's outbreak, the vast number of egg masses that are now in Eastern Ontario will in turn lead to defoliation of the trees next year.

Cycle of a gypsy moth from caterpillar to moth to laying egg sacks.

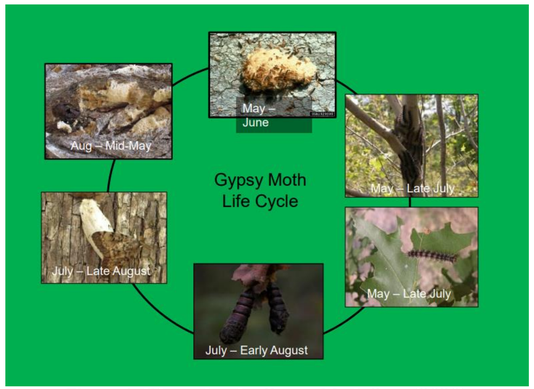

Figure 1. life cycle of a Gypsy Moth Scarr(2020)

Insect-induced tree defoliation can lead to ecosystems being disrupted and forests being completely stripped of their healthy vegetation, leaving them more susceptible to diseases. Remote sensing data, along with surveys, can be used to map the distribution of invasive species. These maps are used in order to protect forests. They help with early detection and focus control efforts to be used against invasive species (EOSDIS, 2020)."

For these reasons I was interested in studying this topic.

Objective

My project seeks to confirm the occurrence of insect- induced tree defoliation. My project will compare forest foliage from the early summer/late spring to the foliage of late summer, i.e. over the course of possible peak outbreak periods.

For my geographic focus, I chose specific satellite images from June/July and August to observe the difference between the forest's foliage before and after the caterpillars feed and turn into moths. The scope of my project includes areas of confirmed defoliation. These include a study area in Eastern United States and another reported by Ontario's Ministry of Natural Resources and Forestry.

Fig. 2 image of damaged trees Scarr(2020)

Supporting Material

For this project I used imagery from EO Browser with filters/Band combination and Moisture Stress index. I used EO Browser to get my imagery for the Eastern Ontario study area. These selections are suitable for my question because EO browser gives a wide range of satellite images with filters for agriculture. It allows for easy identification of the disturbances in the foliage using the Moisture Stress index, showing changes in moisture. I have also used reference images from the articles I have used to support my project.

Investigative Method

I confirmed the occurrence of defoliation caused by forest insects, such as Gypsy moths, through the use of satellite images. I used satellite images that clearly highlights a difference between the trees with lost foliage and trees with full foliage. I selected images from the months June and August, a change from my original proposal of May and August, due to the availability of satellite images. With respect to time; I used images from midday, to capture the clearest images of the forests. I applied the Moisture Stress Index, for investigating vegetation, while the study article used false colour. I drew my conclusions from visual interpretations of my satellite images as well as information and images from articles. I used the images for a qualitative comparison, of the study areas, before and after the caterpillars feed on the trees.

Results

The first images I will talk about are in Fig 3., taken from the article by Townsend. These images show foliage changes at the location of Savage River in western Maryland, US. These images use Landsat false color composite with the SWIR and NIR bands. With these images we can see the huge differences between the colors of the not defoliated image (top) and the defoliated image (bottom). As evident from the images, we can see that the spike of purple, in image B, indicates a significant amount of defoliation. In image B, the changes in vegetation and the purple color, demonstrates the lack of vegetation whereas the green color shows areas with vegetation. The drastic changes from A to B demonstrates that defoliation was detected using remote sensing and can be seen using False color images. The article stating knowledge, of gypsy moth outbreaks in the study area, proves to some extent that these insects caused the defoliation, in the area.

Next are the images I obtained from EO browser using the satellite Sentinel 2(Fig 4). These images are taken from Frontenac County, CA north of Kingston. This study area was reported by the Ministry of Natural Resources and Forestry, in *"Forest Health Conditions in Ontario 2019",* for having a gypsy moth outbreak. I used the NDMI filter on my images as it is useful in detecting moisture levels on the surface. From these images we can clearly see a difference in moisture content between early summer and late summer and that the moisture content changes drastically. This change from a mixture of dark blues, indicating high moisture, to light blues, indicating low moisture, shows a significant loss in moisture over the summer. This can be inferred as a loss of foliage over the summer due to the loss of leaves but could also be something else that caused the loss of moisture in the area. Knowing that there was a gypsy moth outbreak in this area the year this image was taken, we can infer that the loss in moisture could be from insect-induced tree defoliation over the summer months.

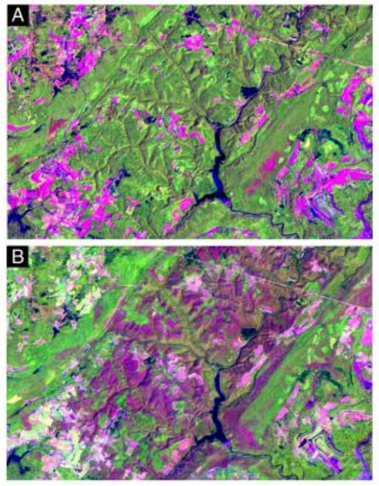

Fig. 2. False color images of the Savage River area for 7 July 2001 (top, not defoliated) and 25 August 2007 (bottom, defoliated). Band combination is Landsat channels 5, 4, and 3 in RGB. Study area is 28 km wide.

Fig 3. explained in image taken from Townsend(2012)

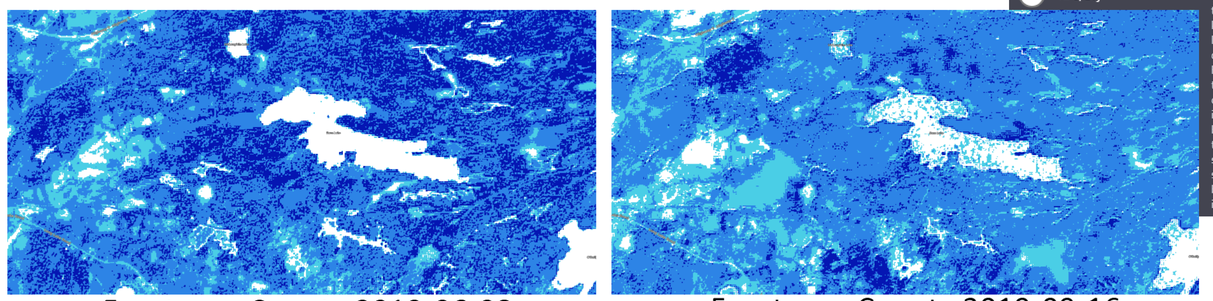

Figure 4. Map of Bass Lake of Frontenac County taken from EO Browser. Lake in the center of the map is approximately 2.1 km wide

Conclusion

The findings of my project have shown me that defoliation can be detected by using remote sensing. Using only the Moisture Stress Index images of Frontenac County I was able to show the occurrence of defoliation.

Detecting defoliation caused by insects can help with the control and monitoring of forest health.

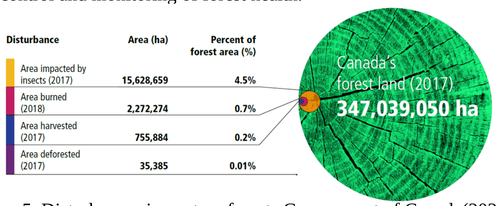

Figure 5. Disturbances impact on forests Government of Canada(2020)

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