Mapping Wildfire Patterns Using Satellite Imagery: Yellowstone vs. Olympic National Parks

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Olympic National Park

How did the Delabarre Fire negatively impact vegetation health and density in Olympic National Park on August 28, 2023?

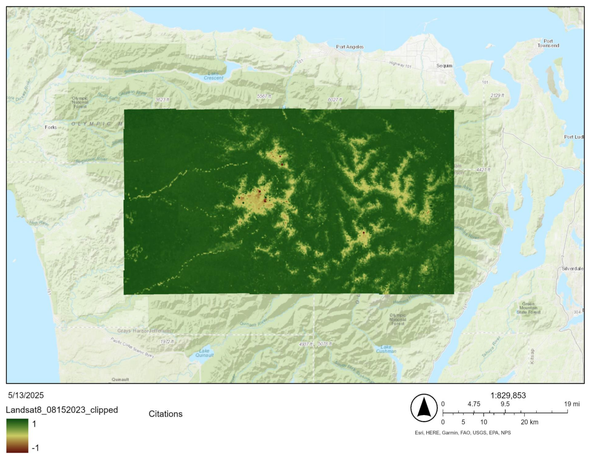
While large-scale fires are less common in the Olympic Peninsula, recent studies have noted that there is a rise in fire activity in the Pacific Northwest from hotter and drier conditions[3].

Methods

- Selected Landsat 8 images August 17 for pre-fire and September 18 for post-fire
- Analyzed them using surface reflectance.
- Applied the NDVI for both the pre- and post-fire using ArcGIS Online.
- Calculated the NBR for the post-fire to see how the areas that were affected from the fire.
- I used the Tools feature to get the Zonal Statistics to get the data for the fire area in the form of a table to use to see what data can be used to match my hypotheses.

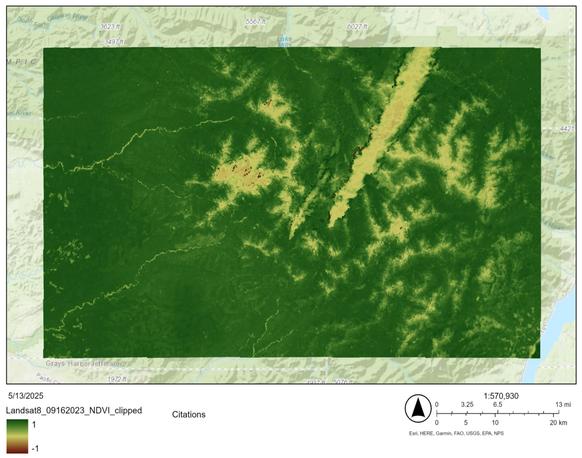
Olympic National Park, Port Angeles, WA

Aug 17, 2023 - Landsat 8 - NDVI



Landsat 8 image from August 17, 2023, with the center being Olympic National Park, Port Angeles, Washington. Center of the image is at 47.820872, -123.604725. This image is shown with the Normalized Difference Vegetation Index, showing the area prior to the 2023 Delabarre Fire in Olympic National Park. High NDVI = healthy vegetation and density; low NDVI = low vegetation health

Sept 18, 2023 - Landsat 8 - NDVI



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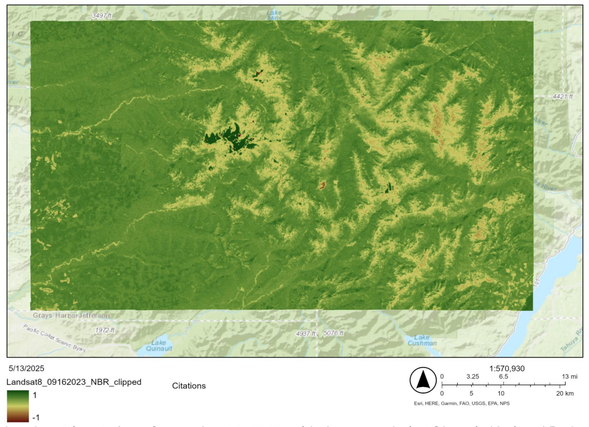
Analysis

- NDVI Key Observation:
  - Before - NDVI:
    - Mean: 0.690
    - Median: 0.539
    - Standard Dev: 0.329
  - After - NDVI:
    - Mean: 0.022
    - Median: 0.019
    - Standard Dev: 0.009
  - After – NBR:
    - Mean: 0.0217
    - Median: 0.019
    - Standard Dev: 0.0086
- Results:
  - This suggests a substantial decline in vegetation health and a loss of green biomass, supporting severe fire impact.
  - This confirms that the fire caused a massive drop in vegetation health, with NDVI values collapsing from healthy vegetation levels (~0.7) to near-bare ground (~0.02). The low post-fire standard deviation also indicates a uniformly degraded landscape

Sept 18, 2023 - Landsat 8 - NBR



Landsat 8 image from September 18, 2023, with the center being Olympic National Park, Port Angeles, Washington. Center of the image is at 47.820872, -123.604725. This image is shown with the Normalized Burn Ratio, showing the area after the 2023 Delabarre Fire in Olympic National Park. High NBR = good vegetation and no burn area; low NBR = burned areas with bad vegetation health

Yellowstone National Park

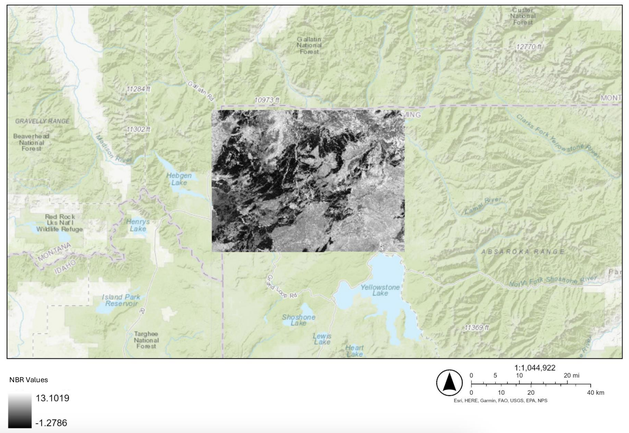
What was the extent of the burn area in regions impacted by the Yellowstone National Park fires in 1988?

In summer of 1988 in Yellowstone National Park, multiple wildfires ignited as a result of lightning strikes. In a single day in August of 1988, more square miles burned in 24 hours than had burned in any other burn periods in the area since 1872[1].

Unfortunately, climate change can play a massive role in wildfire potential:

- Increased soil moisture evaporation during dry periods → greater possibility of ignition[2]
- Projected increase in temperature differences between the land and sea, which can boost wind power → wildfires spread quicker[2]
- Increased ice particle mass in clouds, resulting in more frequent lightning strikes → more fires started due to lightning strikes[2]

Yellowstone National Park, Park & Teton Counties, WY



Landsat 5 image from August 2nd, 1989, in the uppermost, left corner of Yellowstone National Park, Wyoming. Center of image at 44.598107, -110.334934. Arrow points North. Scale is 1:1,044,922. This image is shown with the Normalized Burn Ratio (NBR) Index, depicting an area after the 1988 Yellowstone fires. No color scale applied. Black areas indicate low NBR and are burnt, gray areas are higher NBR, are unburned

Methods

1. Selected Landsat 5 image (September 21, 1987) and Landsat 5 image (August 2, 1989)
2. Applied Normalized Burn Ratio (NBR) index, (NIR-SWIR) / (NIR+SWIR)
3. Compared before fires and after fires in three specialized areas using Zonal Statistics

Analysis

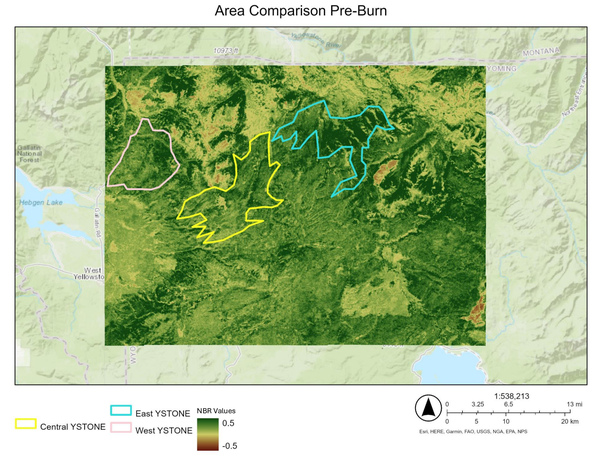
	Mean NBR	Standard Dev.	Median NBR
Pre-Burn Image Statistics:			
West Yellowstone	0.31	0.13	0.29
Central Yellowstone	0.29	0.14	0.28
East Yellowstone	0.39	0.15	0.41
Post-Burn Image Statistics:			
West Yellowstone	-0.28	0.27	-0.40
Central Yellowstone	-0.33	0.23	-0.43
East Yellowstone	-0.23	0.27	-0.35

Fig.1: Table of analysis depicting the mean NBR, standard deviation, and median NBR. Low NBR values = burned areas, high NBR values = healthy vegetation

Conclusions and Limitations

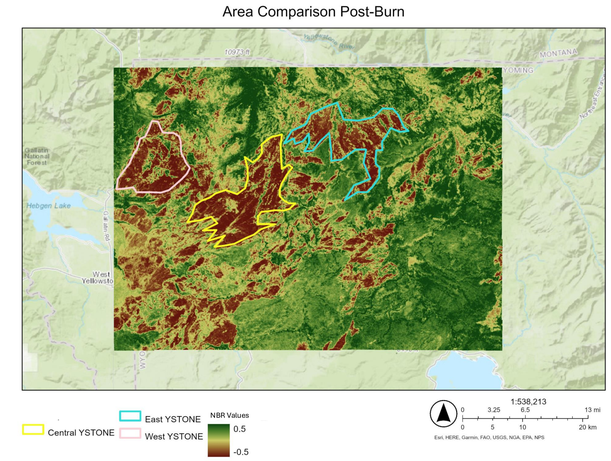
- Decreased NBR Means and Medians in all 3 areas in post-burn analysis indicate significant burn areas
- Restricted time frame for data collection and analysis (project was conducted as part of a quarter-long class)

Area Comparison Pre-Burn



Landsat 5 image from September 21, 1987, in the uppermost, left corner of Yellowstone National Park, Wyoming. Center of image at 44.598107, -110.334934. Arrow points North. Scale is 1:538,213. This image is shown with the Normalized Burn Ratio (NBR) Index, depicting an area prior to the 1988 Yellowstone fires. High NBR = healthy, green vegetation, low NBR = burned, brown areas

Area Comparison Post-Burn



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References

1: Romme, W. H., & Despain, D. G. (1989). The Yellowstone Fires. Scientific American, 261(5), 36–47. http://www.jstor.org/stable/24987472
2: Xu, R., Yu, P., Abramson, M. J., Johnston, F. H., Samet, J. M., Bell, M. L., Haines, A., Ebi, K. L., Li, S., & Guo, Y. (2020). Wildfires, global climate change, and human health. The New England Journal of Medicine, 383(22), 2173–2181. https://doi.org/10.1056/NEJMsr2028985PubMe
3: Parks, S. A., & Abatzoglou, J. T. (2020). Warmer and drier fire seasons contribute to increases in area burned at high severity in western US forests from 1985 to 2017. Geophysical Research Letters, 47(22), e2020GL089858. https://doi.org/10.1029/2020GL089858