

## Spruce Trees vs. Spruce Beetles: Who Will Win?

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Image 1. Photo of a Colorado forest, including spruce trees.

As spruce beetles continue to wreak havoc in forests across the Rocky Mountain Region, the ever-loved spruce trees are now battling for their survival against this inexorable pest. These outbreaks are disrupting ecosystem dynamics by intensifying wildfire severity and reducing carbon sequestration. Consequently, spruce trees are being forced to adapt by allocating resources to alter their defense mechanisms and mitigate the pest.

With the help of my mentor, Ehsan Khedive, we aimed to comprehensively study the changes in defense mechanisms of spruce trees in response to beetle infestations, particularly under varying environmental conditions. We were hoping that our research would shed light on how spruce beetles will impact the trees within Colorado's forested ecosystems, as climate change intensifies and creates more favorable conditions for the beetles to thrive.

Our research took us to two different study sites, where we collected resins<sup>1</sup> from the affected trees. The collection process was an exciting beginning to an even more thrilling project, and demonstrated the importance of conducting these studies. In the areas where we took samples, numerous trees are struggling with bark beetles, displayed by the abundance of dead and/or decaying trees. Moreover, the areas where we collected samples from are adjacent to wildfire burns, highlighting the far-reaching impact of spruce beetles on the fire regimes in Colorado.

(1) Resin: A sticky substance that is excreted by woody plants as a form of defense when wounded.



Image 2. Photos of one of the spruce trees that we collected the samples from. The right image displays a close up of the resin.

After the collection, we took the samples back to the lab where they went through a process of analytical test that eventually told us the components, or terpenes<sup>2</sup>, within the resin samples. This allowed my mentor to analyze our data and create graphs that thoroughly explained our results. From here, I took the initiative to interpret all the graphs into our final discussion and conclusion, which showed where we are at with our findings and how we can go even further with this information in the future.

Our results displayed that the terpenes differ within the two different sites we selected and within the different environmental conditions we were looking at; water stress, previous damage to the trees, and whether or not the trees were baited<sup>3</sup>. The differences in the terpenes are an important indicator that **the trees are responding to the spruce beetle outbreaks, even under varying environmental conditions**. Further research will be conducted to better understand what the specific terpenes do for tree defense. This will enable us to gain a deeper insight into how the trees are responding, as the terpenes vary across different sites and environmental conditions.

As stated before, this research project is very important for understanding the future health of Colorado's forests as spruce beetles continue to have heavy impacts on the trees. Once we understand what we are dealing with, hopefully, we can come up with a plan to make trees more resilient to these impacts in the future. By taking action now, we can not only preserve the places we call home but also mitigate the effects of climate change as a whole.

(2) Terpenes: Organic compounds that help protect trees from pests, damage, and diseases.

(3) Baited: Referring to the use of pheromones that attract the spruce beetles to certain trees.