How Temperature and Precipitation Affect Mountain Pine Beetles

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INTRODUCTION

The mountain pine beetle (*Dendroctonus ponderosae*) has increasingly affected the Southern Rocky Mountains (Davenport 2024). Higher temperatures speed up beetle development and survival, while drought stresses pine trees, making them more vulnerable to infestations (Bentz et al. 2015). This study examines how climate influences beetle activity, infestation rates, and tree mortality, essential for mitigating climate change impacts on forests.

METHODS

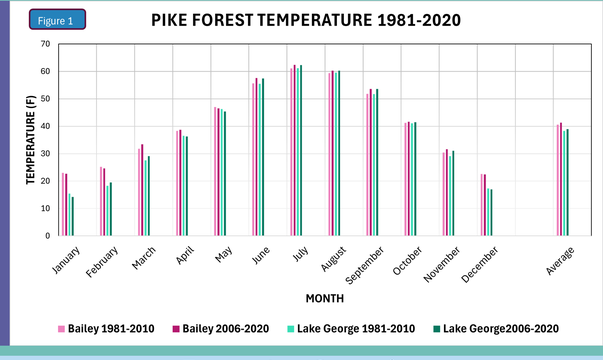
Emergence Cages:
We placed twelve emergence cages on newly infested trees in Pike National Forest to monitor adult beetle emergence rates and collect data on beetle population dynamics, correlating it with temperature variations (Bentz 2006). The image shows a cage used on Redskin Mountain. Our three sites are Manitou Experimental Forest (8,192 ft), Redskin Mountain (7,151 ft), and Payne Gulch (7,928 ft).

Offspring Sampling:
We sampled offspring from infested trees at five sites in Pike National Forest to study larval development and survival rates under current climatic conditions (Robert et al. 2016). The image shows larvae and galleries found in the Manitou Experimental Forest in June 2024.

Climate Data Analysis:
We analyzed climate data from 1981 to 2020 (NOAA), focusing on monthly temperature and precipitation trends. Using hygrometers, we collected real-time temperature data this summer. By correlating these with beetle emergence dates from our cages, we aim to understand how climatic factors influence beetle behavior and tree vulnerability.

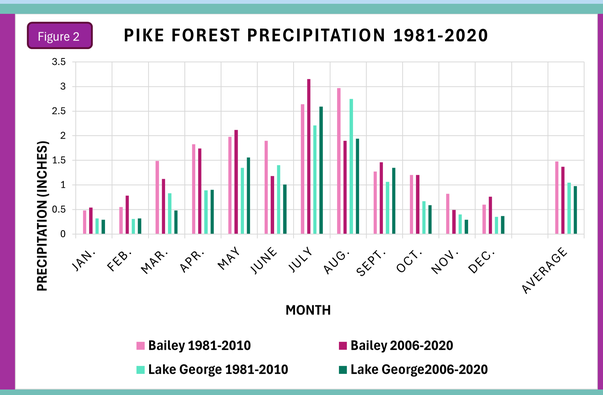
RESULTS

Figure 1



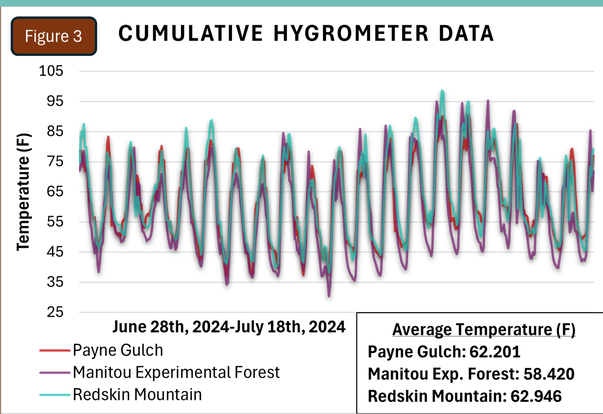
Temperature Comparison
Figure 1 compares average temperatures in Fahrenheit for two Pike National Forest locations (NOAA). Darker colors show data from 2006-2020, while lighter colors represent data from 1981-2010.

Figure 2



Precipitation Comparison
Figure 2 shows the average precipitation in inches for two locations in Pike National Forest (NOAA). Darker colors represent data from 2006-2020, and lighter colors represent data from 1981-2010.

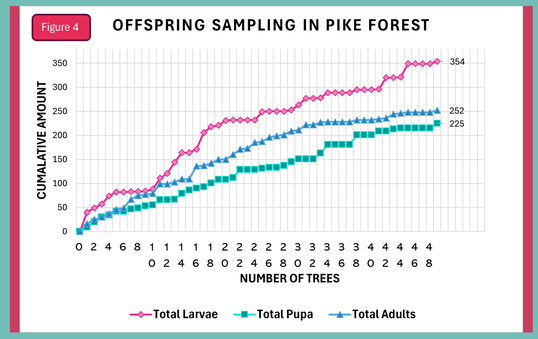
Figure 3



Hygrometers
Figure 3 shows temperatures recorded at the three emergence cage sites—Manitou Experimental Forest, Redskin Mountain, and Payne Gulch—from June 28 to July 18, 2024. The bottom right corner displays the average temperatures.

RESULTS

Figure 4



Offspring Sampling
Figure 4 shows our offspring sampling results from the Pike National Forest. We sampled the north and south sides of 50 mass-attacked trees across 5 sites, recording the number of larvae, pupae, and adults in a 6x6 inch section at DBH height (4.5') on both sides of the tree.

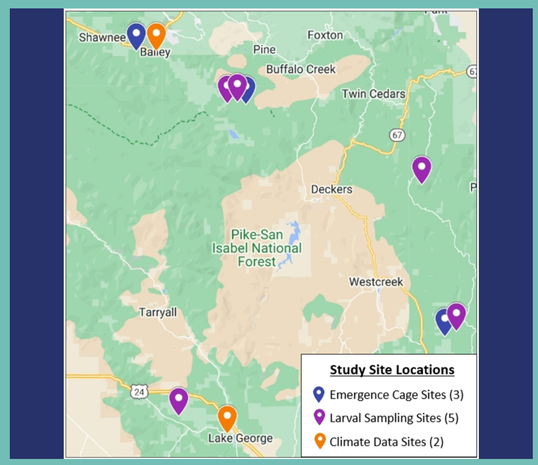


Figure 5

Emergence Cage
Figure 5 shows the first mountain pine beetle found in our emergence cages. This beetle emerged from the south side of Tree #6 at the Payne Gulch site on June 24, 2024. The first three beetles also emerged from the same cage on the south side of Tree #6.

DISCUSSION

Temperature Comparison
Average temperatures have risen in recent years, both globally and in Pike National Forest (Dahlman 2024). Higher temperatures were noted in Bailey and Lake George, Colorado (NOAA). This warming accelerates beetle development and increases winter survival rates, leading to significant population growth potential (Carroll et al. 2003).

Precipitation Comparison
Precipitation levels have decreased since 1981 in Pike National Forest. Decreased precipitation weakens pine trees, making them more vulnerable to mountain pine beetle attack. Mountain pine beetle feeding disrupts the trees ability to transport and retain water and nutrients (CASC 2011). This correlates with the increase in mountain pine beetle population growth and is likely a contributing factor (Carroll et al. 2003).

Hygrometers
We anticipated the highest temperatures at Payne Gulch, where beetles first emerged, but the data does not support this. Payne Gulch's lower elevation than Redskin Mountain suggests other factors are influencing emergence timing. Further research is needed to identify these factors. Manitou Experimental Forest, with the highest elevation and lowest average temperature, had the latest emergence.

Offspring Sampling
The 354 larvae indicate successful reproduction, while the 225 pupae and 252 adults suggest imminent emergence of mountain pine beetles. High larval and pupal numbers point to heavy infestation and potential for significant tree damage or mortality (Carroll et al. 2003). Additionally, 93.67% of the new adults were alive, indicating high survival rates and potential for rapid population growth, likely due to rising temperatures (Benefer et al. 2012). Total numbers of offspring show static beetle populations at three of our sites (Rampart Range, Pulver Mountain, and Manitou Experimental Forest), and increasing populations at two sites (Redskin Mountain & FR 549) (Knight, 1960).

Emergence Cage
Mountain pine beetles typically emerge in July-August in the Southern Rocky Mountains (USFS 2011). Our results show an earlier emergence, likely due to increased temperatures speeding up development (Carroll et al. 2003). Emergence on the south side of Tree #6, which receives more sunlight, aligns with this pattern. We first collected beetles from the Payne Gulch cages on June 24, 2024, and then from the Redskin Mountain Cages on July 15, 2024, the expected emergence date. The majority of mountain pine beetles collected came from Redskin Mountain (27/53).

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ABSTRACT/REFERENCES