The Effect of Climate Change on Soil Bacterial & Fungal Abundance in Coast Redwood Forests

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INTRODUCTION
Understanding how climate change affects coast redwood (Sequoia Sempervirens) microbial communities is the main focus of this project. Determining how changes in climate impact the size and activity of soil microbial populations is important because they perform several critical ecosystem functions including decomposition and nutrient cycling. The climate of native coast redwood forests, which are spread out along the northwest coast of California, is known to be coolest and wettest in the north and warmer and drier towards the south of their range. However, little is known about how this gradient in climate influences the soil bacteria and fungi in redwood forests. Over the last hundred years, the frequency of fog has decreased in northern CA, and this trend, along with an increase in temperature and changes in rainfall patterns, will likely continue in the future (Cal-Adapt.org; Johnstone & Dawson, 2010). Temperature, precipitation and fog not only directly influence soil water availability but also influence plant productivity and, in turn, carbon availability to soil microorganisms. These factors are important determinants of microbial population sizes and activities. The results from this study will help us understand how changes in climate will affect the abundance of bacteria and fungi in redwood forests.

EXPERIMENTAL DESIGN
1. Soils were transplanted between all three sites in late summer 2004 and collected after one and three years.
2. A three-site reciprocal transplant experiment was conducted across the north-south gradient in climate.
3. Subsamples were frozen at -80 °C, and 0.5 mg of soil was extracted using the Bio101 Fast DNA Spin Kit for each of the soils by quantitative PCR (qPCR) on a CFX96 Real-Time PCR System using SsoFast EvaGreen Supermix (Bio-Rad, Hercules, CA) and the primer sets Eub338-Eub518 (for bacteria) and 5.8s-ITS1f (for fungi) (Fierer et al. 2005).
4. Using analysis of variance, we determined if transplanting soils caused a significant change in abundances. Differences are significant at p < 0.05.

RESULTS SUMMARY
• Bacteria: Only the bacterial abundance in the soil from the drier climate moved to the wetter climate exhibited a significant response after one year, but after three years there was a significant response to differences in climate for all three soil origins.
• Fungi: Fungi did not respond as consistently as bacteria to changes in climate, but there was some evidence for fungal abundance to increase when soils from the driest site were moved into the wetter North climate.

CONCLUSIONS
• Bacterial abundance decreased when soils were moved from a wetter to a drier climate and increased when soils were moved from a drier to a wetter climate.
• It may take a period of a few years for bacterial abundance to change in response to climate change. The bacterial response to a change in climate was widespread after three years, but less evident after only one year.
• Fungal abundance seems to be less sensitive to a change in climate than bacterial abundance, but the abundance of fungi in soils from Big Basin (the drier South) did tend to increase when moved to the North climate.
• If fog frequency continues to decline and redwoods become drier in the summer, bacterial abundance will likely decrease, but fungal abundance may not respond as strongly.

REFERENCES
2. Miranda Claggette, Damon Bradbury, Mary Firestone- Department of Environmental Science & Policy Management, UC Berkeley. I would like to take this opportunity to thank the Environmental Leadership Program (ELP), as well as Make Redwood and the Firestone Lab for providing me with a special and outstanding opportunity for not only academic but personal growth. This research was supported in part by a grant from the Save-the-Redwoods League. A special thank you to Damon Bradbury, the recent post doc who was gracious and meaningful project.

TABLE 1- Site Characteristics

<table>
<thead>
<tr>
<th>Site</th>
<th>North</th>
<th>Central</th>
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<td>Location</td>
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<td>Elevation</td>
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FIGURE 1- Sample Cores

Phots located under closed canopy. Soil cores harvested with plastic core to hold filter paper in place. Filter not yet placed.

FIGURE 2- Three-Site Reciprocal Transplant

FIGURE 3- Bacterial Abundance, Response to Climate Change

3A. After 1 yr, there was no response to transplanting.
3B. After 3 yrs, the abundance of bacteria in Prairie Creek soils was lower in the drier south climate.

FIGURE 4- Fungal Abundance, Response to Climate Change

4A. Prairie Creek Origin (North)
4B. Sonoma Origin (Central)
4C. Big Basin Origin (South)

3C. After 1 yr, there was no significant response to climate, but soils incubated in Prairie Creek tended to have a higher abundance. After 3 yrs., soils in Prairie Creek had a much higher bacterial abundance in the north climate than in the other two climates. There was no difference in abundance among the three climates in year 3.

3D-Bacterial Abundance, Response to Climate Change

3A. After 1 yr, there was no response to transplanting.
3B. After 3 yrs, soils from Sonoma had a lower bacterial abundance in the south climate than in the other two climates. There was no difference in abundance among the three climates in year 3.

3C. Bacterial Abundance, Response to Climate Change

3A. After 1 yr, there was no significant response to climate, but soils incubated in Prairie Creek tended to have a higher abundance. After 3 yrs., soils in Prairie Creek had a much higher bacterial abundance than those in the other two sites.

3D. Bacterial Abundance, Response to Climate Change

3A. After 1 yr, there was no response to transplanting.
3B. After 3 yrs, the abundance of bacteria in Prairie Creek soils was lower in the drier south climate.

ACKNOWLEDGEMENTS
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FIGURE 4- Fungal Abundance, Response to Climate Change

4A. Prairie Creek Origin (North)
4B. Sonoma Origin (Central)
4C. Big Basin Origin (South)

3C. After 1 yr, there was no significant response to climate, but soils incubated in Prairie Creek tended to have a higher abundance. After 3 yrs., the abundance of bacteria in the soil that had been incubated in the north was greater than those in the central climate, and it was intermediate in its own native south climate.