Redwood forest ecosystem of northern California depends on fog to stay hydrated during rainless summers

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A newly emergent frond of *Polystichum munitum* is covered with fog drip in the redwood forest ecosystem of Prairie Creek Redwoods State Park in Humboldt County, California. Credit: Photo by Emily B. Limm

As the mercury rises outdoors, it's a fitting time to consider the effects of summertime droughts and global warming on ecosystems. Complex interactions among temperature, water cycling, and plant communities create a tangled web of questions that need to be answered as we face a rapidly changing climate.

Drs. Emily Limm and Todd Dawson (University of California, Berkeley) recently tackled one aspect of the challenging question of how climate change can impact plant communities that obtain water from fog. Their

results are published in the July issue of the American Journal of Botany.

Fog is an important source of water to ecosystems around the world, because fog allows plants to stay hydrated even during times without rain. Fog may condense and drip to the soil, where it can be taken up by roots. Alternatively, some plants are able to absorb the water from fog through their leaves, allowing these plants to immediately benefit from the atmospheric moisture that may never reach the forest floor. The fern Polystichum munitum covers the forest floors of the redwood forests in northern California. Limm and Dawson examined variation in the ability of the leaves of P. munitum to absorb the water from fog.

The researchers found that the quantity of water the plants absorbed varied in the different regions of the redwood forest. "Today, summertime drought conditions are greater in the southern end of the redwood forest ecosystem of Northern California, and this reduces P. munitum abundance and plant size. These smaller ferns in the south are less able to capture fog water that drips to the forest floor during the summer, and they may therefore suffer more drought stress than ferns in the northern end of the redwood forest ecosystem," Limm stated.

This has important implications for the structure of plant communities. Limm explained, "If climate change causes further shrinkage of these ferns, this will change how fog water is distributed on the forest floor and may lead to dramatic changes in how the redwood understory functions."

Limm and Dawson are hoping that native ferns may be able to acclimate to increasing drought conditions, and this acclimation would allow the plants to mitigate the effects of drought on the ecosystem and reduce the potential for local population extinctions. "If these ferns can make morphological and physiological adjustments to survive when drought intensifies, then they will be less impacted by climate change in the near

future," Limm commented.

Limm and Dawson have involved the public in their research through a Citizen Scientist program. The public helps to collect data on the abundance of P. munitum in a redwood forest near Oakland, California. This not only has contributed to the research on the effect of climate change on P. munitum, but also has resulted in a change in people's impressions of the forest.

"I've often heard people exclaim that they never realized that there where even plants on the forest floor in the redwood forest because they are always looking up at the giant coast redwoods…After they learn about P. munitum's amazing ability to absorb fog water through their leaves in much higher rates than the coast redwood, they often tell me that they will never look at a fern the same way again," Limm said.

More information: Limm, Emily B. and Todd E. Dawson (2010). Polystichum munitum (Dryopteridaceae) varies geographically in its capacity to absorb fog water by foliar uptake within the redwood forest ecosystem. American Journal of Botany 97(7): 1121-1128. DOI: 10.3732/ajb.1000081

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