METER
ENVIRONMENT

UNDERSTANDING THE INFLUENCE OF COASTAL FOG ON THE WATER RELATIONS OF A CALIFORNIA PINE FOREST

Forests along the California coast and offshore islands experience coastal fog in summer, when conditions are otherwise warm and dry. Since fog-water inputs directly augment water availability to forests during the dry season, a potential reduction of fog due to climate change would place trees at a higher risk of water stress and drought-induced mortality. Dr. Sara Baguskas completed her Ph.D. research in the geography department at UC Santa Barbara on how variation in fog-water inputs impact the water relations of a rare, endemic tree species, Bishop pine, located on Santa Cruz Island in Channel Islands National Park. The goal of her study was to enhance our ability to predict how coastal forests may respond to climate change by better understanding how fog-water inputs influence the water budget of coastal forests.

FOG MANIPULATION

Santa Cruz Island supports the southern extent of the species range in California, thus it is where we would expect to see a reduction in the species range in a warmer, drier, and possibly less foggy future. To advance our mechanistic understanding of how coastal fog influences the physiological function of Bishop pines, Dr. Baguskas conducted a controlled greenhouse experiment where she manipulated fog-water inputs to potted Bishop pine saplings during a three-week drydown period. She installed METER soil moisture (VWC) sensors horizontally into the side of several pots of sapling trees at two different depths (2 cm and 10 cm) and exposed the pines to simulated fog events with a fog machine.

In one group of plants, Baguskas let fog drip down to the soil, and in another treatment, she prevented fog drip to the soil so that only the canopies were immersed in fog. She adds, "Leaf wetness sensors were an important complement to soil moisture sensors in the second treatment because I needed to demonstrate that during fog events, the leaves were wet and soil moisture did not change." Additionally, Baguskas used a photosynthesis and fluorescence system to measure photosynthetic rates in each group.

PHYTOS 31 leaf wetness sensor

RESULTS

Dr. Baguskas found that the fog events had a significant, positive effect on the photosynthetic rate and capacity of the pines. The combination of fog immersion and fog drip had the greatest effect on photosynthetic rates during the drydown period, so, in essence, she determined that fog drip to the soil slows the impact of drydown.

“But,” she says, “when I looked at fog immersion alone, when the plant canopies were wet by fog with no drip to the soil, I also saw a significant improvement in the photosynthetic rates of these plants compared to the trees that received no fog at all, suggesting that there could have been indirect foliar uptake of water through these leaves which enhanced performance.” An alternative interpretation of that, Baguskas adds, is that nighttime fog events reduced soil evaporation rates, resulting in less evaporative loss of soil moisture.

Dr. Baguskas says her “canopy immersion alone” data are consistent with other research: Todd Dawson, Gregory Goldsmith, Kevin Simmonin, Carter Berry, and Emily Limm have all found that when you wet plant leaves, it has a physiological effect,

suggesting the plants are taking water up through their leaves and not relying as much on soil moisture. (These authors performed different types of experiments, but their papers serve as reference studies). Baguskas says, “My results suggest that is what’s going on, but it’s not as definitive as other studies that have actually worked on tracking the water through leaves using a stable isotope approach.”

TEROS 12 soil moisture, temperature, and EC sensor

LESSONS LEARNED

Though Dr. Baguskas did not monitor soil temperature in this study, she says that in the future, she will always combine temperature data with soil moisture data. She comments, “Consistently, the soil moisture in the “canopy-immersed only” plants was slightly elevated over the soil moisture in the control plants. It made me wonder if this was a biologically meaningful result. Does it support the fact that if plants are taking up water through their leaves, they don’t rely on as much soil moisture? Or did my treatment change soil temperature, and is that having a confounding effect on my results? What I’ve learned from this, is that in the future I will always use soil probes with temperature sensors because you may not know until you see your results if temperature might be important.”

FUTURE FOG STUDIES

Baguskas is a USDA-NIFA postdoctoral Research Fellow working with Dr. Michael Loik in the Environmental Studies Department at UC Santa Cruz. She continues to study coastal fog, but now in strawberry fields. Her current research questions are

focused on integrating coastal fog into water-use decisions in coastal California agriculture. She loves the work and continues to rely on soil moisture sensors to make meaningful and reliable environmental measurements in the field and greenhouse.

Discover METER soil moisture + temperature sensors and the PHYTOS 31 leaf wetness sensor