REDWOODS & CLIMATE CHANGE INITIATIVE

Save The Redwoods LEAGUE

Redwoods and Climate Change Symposium

Discussion Overview

On January 14, 2011, Save the Redwoods League convened a gathering of 86 redwood forest researchers, landowners, stewards, and educators to discuss the impact of climate change on coast redwood and giant sequoia forest ecosystems. Held at the Gordon and Betty Moore Foundation headquarters in Palo Alto, the day-long Symposium featured the League's Redwoods and Climate Change Initiative (RCCI) scientists and invited panelists who presented their findings on what climate change means for the future of redwood forests and discussed strategies to protect these iconic landscapes as they face unprecedented and rapid environmental change. Even while this symposium took place, the atmospheric concentration of carbon dioxide reached 391.25 ppm (Mauna Loa Observatory, Hawaii), a level not experienced by redwood forests for the past 15 million years.

Healy Hamilton, Director of the Center for Applied Biodiversity Informatics at the California Academy of Sciences and RCCI Scientist, presented data confirming climate change is already occurring across some regions of the coast redwood range. Her laboratory's analysis revealed that, relative to a mid-20th century baseline (1950-1980), temperature in the redwood forest has measurably increased during the past 20 years, especially in the winter, and is predicted to climb further throughout the century. These warmer temperatures in the redwood forest will increase ecosystem evaporation and raise redwood tree demand for water.

Todd Dawson, Professor of Integrative Biology at the University of California, Berkeley and RCCI Scientist, described his laboratory's work to uncover the climate history recorded in the wood of redwood tree rings through stable isotope analysis. Not only does the quantity of rain and fog water taken up by the trees affect tree ring growth, but these water sources leave a stable isotope imprint in the cellulose of wood produced annually. Fog frequency along coastal California has already declined over 30% in the last half century. Using this new stable isotope technique, Dawson's team will soon reveal how changes in water availability have already impacted the growth of redwoods throughout their native ranges.

Stephen C. Sillett, Professor of Forestry and the Kenneth L. Fisher Chair in Redwood Forest Ecology at Humboldt State University and RCCI Scientist, discussed how growth potential and conservation value develop in redwoods as they age. Sillett and his team climb and directly measure trees of all sizes to quantify structure, age, and rate of wood production. Their results show unequivocally that the tree-level rate of annual wood production increases through old age, including the oldest redwoods they have measured (up to 2,000 years-old). As redwoods age, a greater proportion of the wood they produce annually is converted to decay-resistant

heartwood. In addition to their incredible carbon sequestration capacity, Sillett and his team have found that large old redwoods have structurally complex crowns that sustain a high degree of arboreal biodiversity.

During the *Biological Responses to Climate Change* panel, panelists discussed how redwood forest plants, microbes, and animals will respond uniquely to climate change in the coast redwood and giant sequoia forest ecosystems. The redwood trees themselves form the physical structure of the redwood forest and Anthony Ambrose, Research Scientist at the University of California, Berkeley and RCCI Scientist, explained that the interaction of temperature change with water availability may impact tree survival and regeneration as climate changes. David Wake, Professor of Integrative Biology at the University of California, Berkeley, explained that salamander biomass is collectively greater than all other vertebrates in the redwood ecosystem and that warmer temperatures may at first benefit redwood forest amphibians, but drier forest conditions may threaten amphibian populations. Mary Firestone, Professor of Environmental Science Policy and Management at the University of California, Berkeley, explained how critical soil bacteria and fungi are for nutrient cycling in the redwood forest and that microbes need moist soil to make nutrients available to the trees. Decreased fog precipitation in the coast redwood forest may slow nutrient cycling and therefore reduce nutrient uptake by redwood trees.

In the *Adaptation Strategies for Redwood Forests* panel, discussion centered around the pressing need for scientists and land managers to exchange information efficiently in order to build effective science-based adaptation strategies. Jay Chamberlin, Natural Resources Division Chief for California State Parks, and Charisse Sydoriak, Chief of Resource Management at Sequoia and Kings Canyon National Parks, described how difficult it can be for land managers to access the scientific information they need. Solutions offered to improve this communication include building relationships between scientists and land managers through symposia and creating an information clearinghouse that provides research interpretation for land managers. Adrian Das, Ecologist with the US Geological Survey at Sequoia and Kings Canyon National Parks, explained that researchers are more likely to share results quickly with the land managers if there is broad recognition of the data limitations. In addition, Stu Weiss, Chief Scientist at the Creekside Center for Earth Observation, urged managers to collaborate directly with scientists who can efficiently design an experimental or monitoring framework that will address their priority research needs. Sue Fritzke, Branch Chief, Vegetation and Stewardship Supervisory Vegetation Ecologist for Golden Gate National Recreation Area, explained that even when the ecological management priorities are clear, it is still challenging to balance this effort with public use demands for the park. The panelists expressed the critical need for public education on the significance of climate change to build public support for adaptation strategy planning in the parks.

Panelists in the *Carbon Sequestration and Implications for Forest Management* panel discussed the role redwood forests play in carbon mitigation. Bob Van Pelt, Adjunct Professor for the Institute for Redwood Ecology at Humboldt State University and RCCI Scientist, explained that old-growth redwood forests hold records for forest carbon storage because redwoods grow rapidly, produce decay-resistant heartwood, and exhibit enormous stature with maturity. Phil

van Mantgem, Research Ecologist for the USGS Redwood Field Station at Redwood National Park, explained that forests collectively hold almost as much carbon as found in the atmosphere, but cautioned that drought, pests, and disease can quickly damage forests and turn ecosystems from carbon sinks to carbon sources. Michelle Passero, Senior Climate Policy Advisor at The Nature Conservancy, described the carbon offset provisions of the greenhouse gas cap and trade program adopted by the Air Resources Board in 2010, which enables forest landowners who promote carbon sequestration through conservation and management to sell credits for carbon mitigation. Chris Kelly, California Program Director for The Conservation Fund, described a case study where this carbon offset program provided approximately 30% of forest maintenance costs for selected properties in Mendocino County. Mike Jani, President and Chief Forester at Humboldt Redwood Company, explained that both Mendocino Redwood Company and Humboldt Redwood Company sequester more carbon than they remove on their land through timber operations and this is important to their sustainable forestry practice.

Eric Havel, Environmental Education Manager at Chabot Space and Science Center, presented results from a *Citizen Science Program* tracking climate change impacts in the coast redwood forest by measuring sword fern population dynamics. This Communicating Climate Change (C3) program is a nation-wide museum collaboration to educate the public about climate change through direct participation in climate change research. To date, over 230 members of the public have helped measure sword fern frond sizes at Redwood Regional Park in Oakland, CA. Sword fern frond size shrinks with less annual rainfall, and data from this project show that ferns in this forest are in fact smaller than ferns in more northern redwood forests where increased rainfall occurs.

The full participation of our partners throughout the Symposium generated a productive discussion that will lead to new opportunities for collaboration in forest research, adaptation planning, management, and mitigation. Save the Redwoods League thanks the Gordon and Betty Moore Foundation for their participation and for hosting this meeting, and appreciates Sempervirens Fund, the Bay Area Conservation Initiative of the Resources Legacy Fund, and Ken Fisher for their generous support of the Redwoods and Climate Change Initiative.