April 4, 2016

To the Forest Climate Action Team:

We appreciate the opportunity to review and offer our perspective on the **California Forest Carbon Plan Concept Paper: Managing our Forest Landscapes in a Changing Climate** (March 9, 2016). We applaud your effort to use credible research to inform the development of the California Forest Carbon Plan. In the same spirit, we wish to share additional research from Save the Redwoods League's Redwoods and Climate Change Initiative, a $5 million research program investigating the impacts of climate change on the redwoods forest since 2009. This research shows that the coast redwood forest ecosystem is growing exceptionally well, is not suffering the same negative climate change impacts described in the Concept Paper and is, therefore, a highly effective forest type for carbon sequestration and long-term storage. The research results include:

- **Record-breaking carbon storage documented in coast redwood forests** – Aboveground biomass (5190 Mg ha^{-1}) and carbon (2600 Mg ha^{-1}) in old-growth coast redwood forests is the highest recorded globally for terrestrial ecosystems and is composed of 62-77% decay-resistant *Sequoia sempervirens* (coast redwood) heartwood (Van Pelt et al. Forest Ecology and Management). This demonstrates that forest conservation and management for retention and recruitment of old-growth forest structure and function protects California's best ecosystem for carbon storage.

- **Redwoods of all ages exhibit unprecedented growth rates** – Wood production has increased phenomenally in coast redwood over recent decades throughout its range, concurrent with anthropogenic climate change (see attached Fig. 1; Sillett et al. 2015, Ecological Monographs). Not only is coast redwood wood being produced quickly, but it this wood is known to be retained for centuries under compatible forest management because redwood is incredibly decay resistant and effective for carbon storage in both standing and dead trees (Van Pelt et al. Forest Ecology and Management).

- **North coast redwood forests are buffered from regionally intense droughts** – A recent study of tree rings from coast redwood throughout the ecosystem range shows that for centuries of California history, coast redwood trees up to 2500-years-old recover from drought conditions repeatedly and northern coast redwood trees are highly buffered from statewide drought impacts (Carroll et al. 2014, PLOS One).

- **Stable climate refuge predicted for north coast redwood forests** – Climate forecasts predict that while a significant portion of the coast redwood ecosystem may become warmer and slightly drier in the coming decades, a majority of coast redwood forests in Humboldt and Del Norte Counties will experience little to no change in climate (Fig. 2; Fernández et al. 2015, Global Change Biology). None of the predicted climate changes for the coast redwood region are likely to exceed the physiological thresholds for growth and reproduction.

Given the strong scientific evidence that coast redwood forests are champions at carbon sequestration, currently resilient in the face of climate change, and predicted to be a notable climate refuge in California, the redwood forests are especially worthy of California's investment to help reach the state's carbon sequestration and storage goals. We encourage the Team to reflect the lessons from the research described here in the Concept Paper, and to acknowledge the variability among California forest types and geographies and the corresponding variability in both resilience to climate change and potential for carbon sequestration and storage. Please let us know if we can be a further resource for information on north coast forests. Thank you for your consideration.

Best wishes,

Emily Burns, PhD
Director of Science

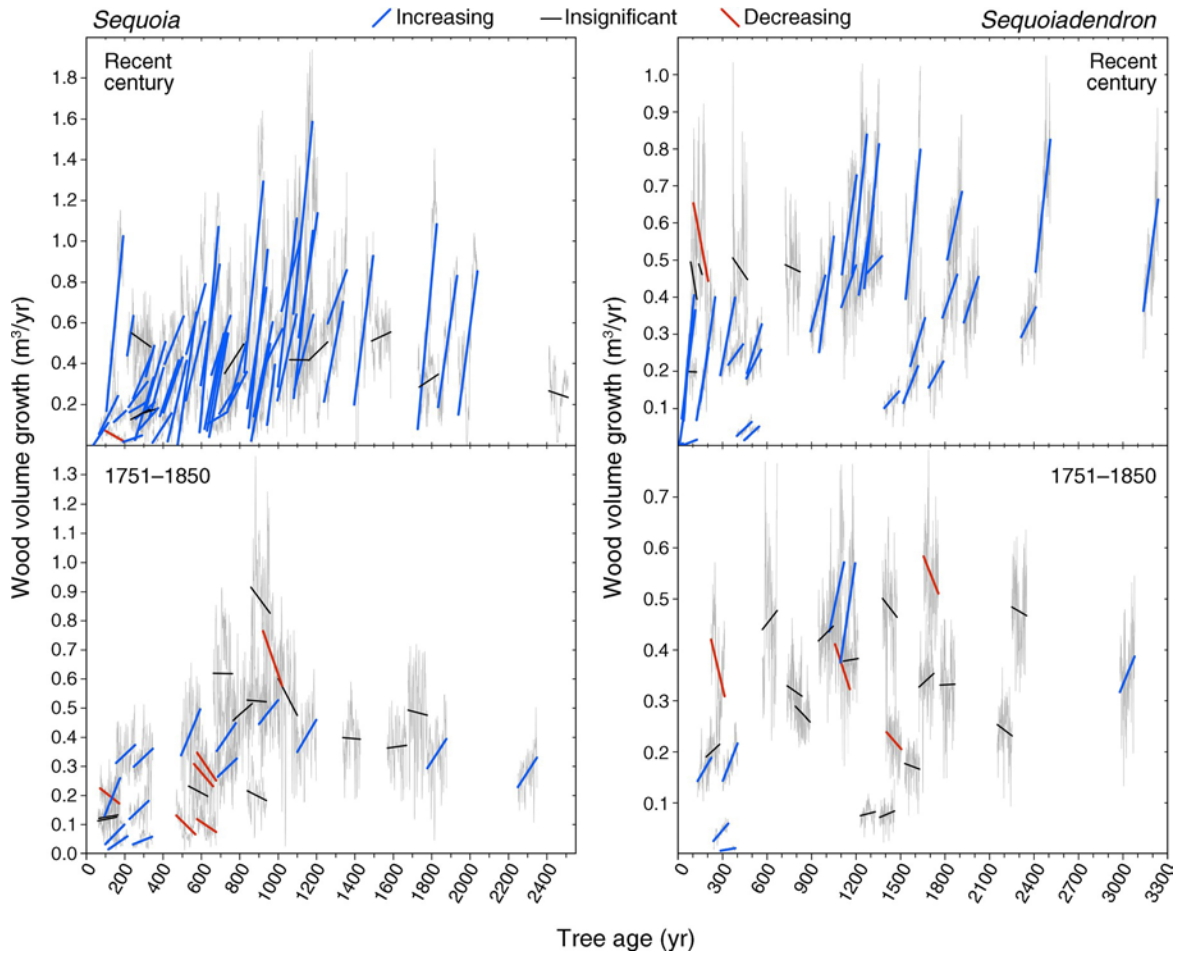

Figure 1 – The trends in coast redwood (*Sequoia*) and giant sequoia (*Sequoiadendron*) trunk growth for the time periods 1751-1850 and the recent century. Each grey line trace represents the growth history of an individual redwood over time. Each trace is fit with a colored line depicting the direction and magnitude of the average growth trend (two-tailed $P < 0.01$). A blue trend line indicates that the redwood increased wood production, a red trend line indicates the redwood decreased wood production, and a black line indicates the redwood showed no change in wood production over the time period. A majority of trees studied in the old-growth Redwoods and Climate Change plot network show significantly increased growth rates during the most recent century (a majority of the trend lines are blue and significantly positive). Figure from Sillett et al. 2014.

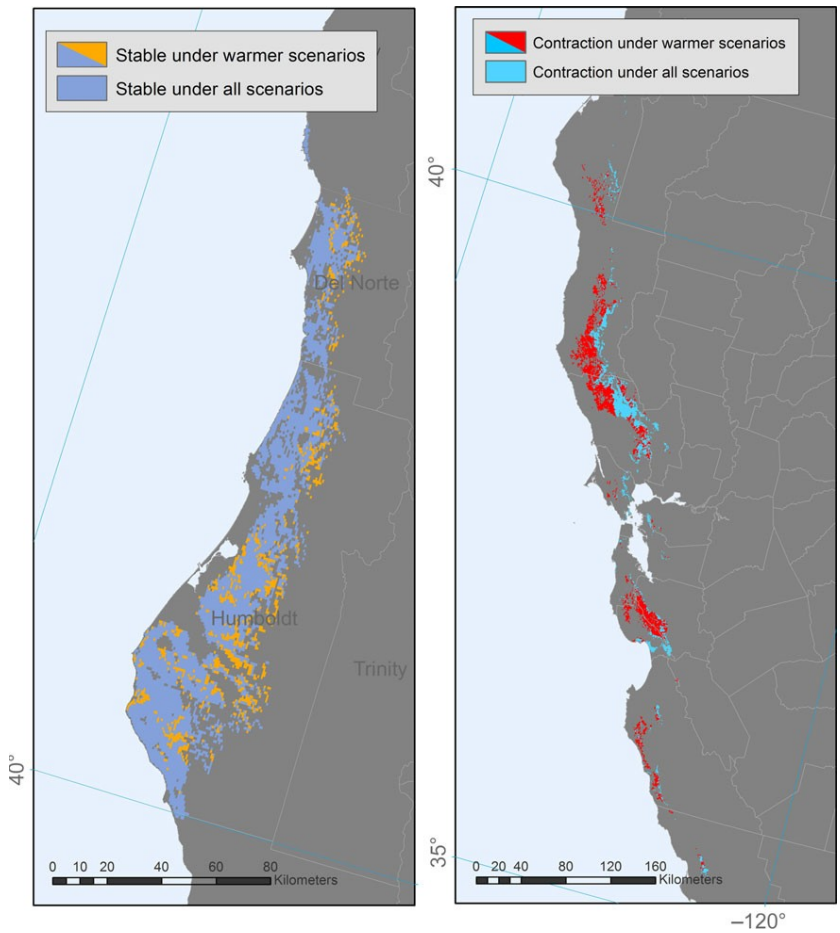

Figure 2 – Ensemble climate model results for the coast redwood range predict climate stability for the north coast redwood region of Humboldt and Del Norte County (left map) and a contraction in the historic climate regime for the central and southern portion of the range (right map). Predicted climate stability suggests that weather patterns will not significantly change, while the forecasted climate contraction of historic climate regime will expose southern coast redwood forest to different, but not necessarily detrimental weather patterns in coming decades. Figure from Fernández et al. 2015.

<u>Literature Cited</u>

Carroll, A. L., S. C. Sillett, and R. D. Kramer. 2014. Millennium-Scale Crossdating and Inter-Annual Climate Sensitivities of Standing California Redwoods. PLOS One, 9: e102545

Fernández, M., H. H. Hamilton, and L. M. Kueppers. 2015. Back to the future: using historical climate variation to project near-term shifts in habitat suitable for coast redwood. Global Change Biology, doi: 10.1111/gcb.13027

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