Examining the influence of climate change on Hawaiian wet tropical forest species using carbon-12 to carbon-13 stable isotope ratios

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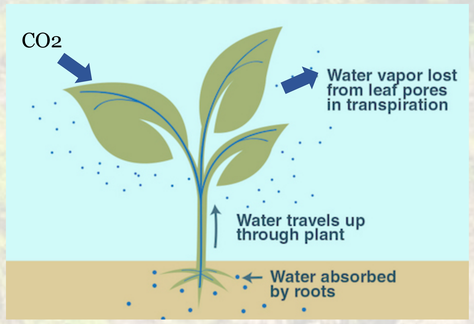
Background

- Water-use efficiency (WUE) of plants fluctuates with various seasonal climate conditions, such as temperature and precipitation
- WUE is defined as unit carbon gain for unit water lost during photosynthesis
- carbon-12 and carbon-13 isotopes can act as tracers for the unique WUE of plants, providing a look into net carbon accumulation and a possible response to climate change



Mechanics of water use efficiency (WUE) [1]

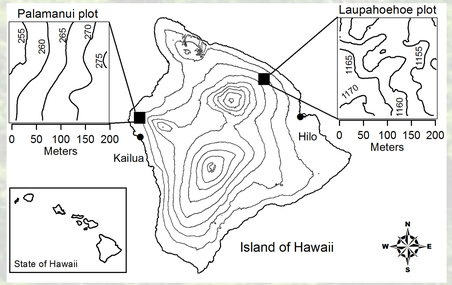
Data Collection

- In the Laupāhoehoe wet forest of HIPPNET[2] (Hawai'ian Permanent Plot Network), leaf litter from various marked plots was collected and stored for 7-10 years
- Study focuses on two dominant forest species: *Acacia Koa* (“Koa”) and *Metrosideros polymorpha* (“Ōhi’a lehua”)
- Climate data such as air temperature and relative humidity are collected daily at the plot


Acacia Koa leaves[3]


Metrosideros polymorpha leaves[4]

Methods

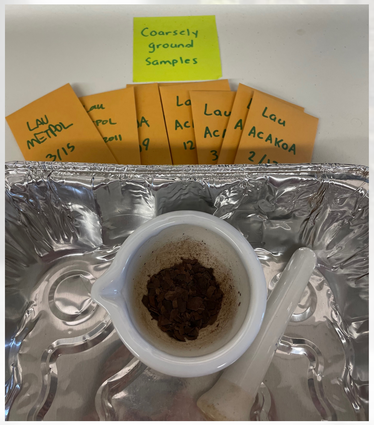


Laupāhoehoe wet forest plot location[5]

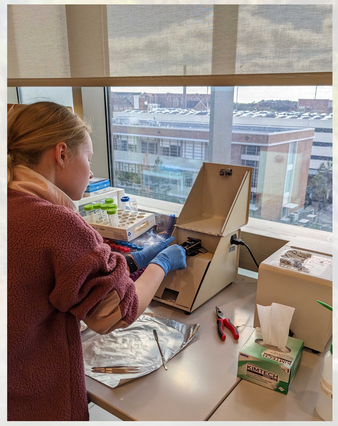

Example litter trap


Sorting samples into the two species


Sorted and labeled species

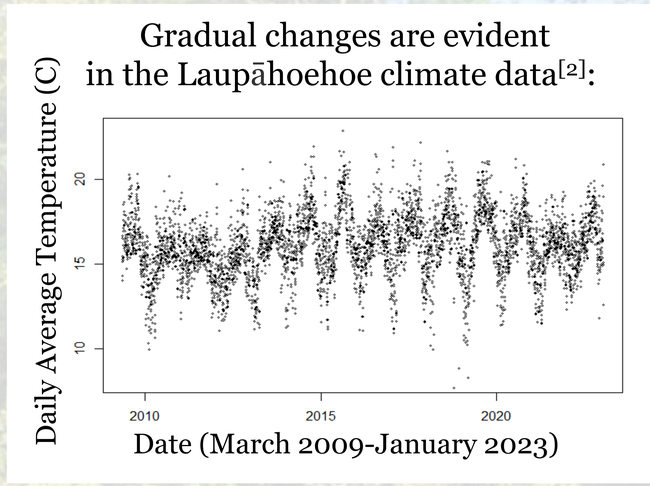


Coarsely grinding the species samples


Using ball mill to finely grind samples

Samples to be taken to a mass spectrometer lab

Results



- Expected Results: Droughts tend to induce less carbon uptake, as the plant partially closes their stomata [6]
- In periods of drought, to conserve water under drought stress, we expect to see a higher ratio of carbon-12 (lighter isotope) to carbon-13 (heavier isotope), more carbon-12 escapes through transpiration diffusion

Implications & Future Work

- Would involve a more robust sample size
- Continue collecting leaf litter samples for years to come
- Expand sites of sample collection in both the Laupāhoehoe wet forest and Palamanui dry forest
- Less carbon uptake contributes to more carbon in the atmosphere, exacerbating greenhouse gas-based climate change[6]

References: [1] *Transpiration*. Icon Water. (n.d.). Retrieved February 3, 2023, from https://www.iconwater.com.au/Water-education/education-resources/ACT-Water-Cycle/Transpiration.aspx [2] Hawaii Permanent Plot Network (2015) Climatological Data Summaries. Retrieved from Ostertag, R., S. Cordell, T. Giambelluca, C. Giardina, C. Litton, M. Nullet, and L. Sack on January 15, 2015. [3] Harms, M. (2014). *Koa, Acacia koa*. flickr. Retrieved February 3, 2023, from https://www.flickr.com/photos/marlinharms/12846839383. [4] Welty, E. (2012). *Leaves of the endemic ohia lehua (Metrosideros polymorpha) along the Pihea Trail, Kokee State Park, Kauai, Hawaii*. WeltyPhotography. Retrieved February 6, 2023, from https://www.weltyphotography.com/image/I0000YfH5lhi_sJw.. [5] Ostertag, R., Inman-Narahari, F., Cordell, S., Giardina, C. P., & Sack, L. (2014). Forest structure in low-diversity tropical forests: A study of Hawaiian wet and dry forests. *PLoS ONE*, *9*(8). https://doi.org/10.1371/journal.pone.0103268 [6] Peters, W., van der Velde, I. R., et al. (2018). Increased water-use efficiency and reduced CO2 uptake by plants during droughts at a continental scale. *Nature Geoscience*, *11*(10), 744–748. [Background image] *Hilo, Hawaii*. (n.d.). Norwegian Cruise Line. Retrieved January 23, 2023, from https://www.ncl.com/shore-excursions/ITO_37/Volcanoes-Tastes-of-Hawaii%20?port=ITO&sort=searchFeatured&sortOrder=asc&perPage=12.