A 100-Year History of Drought at Pu‘u Wa‘awa‘a

Extended dry periods can be a deadly situation for many native species across Pu‘u Wa‘awa‘a

What is Drought?

The term “drought” is generally used to describe a prolonged period with less-than-average amounts of rain in a particular area. A lack of rainfall can reduce soil moisture or groundwater, reduce stream flow, and cause water shortages. Low rainfall can also be associated with higher-than-average temperatures and reduced cloud cover. An individual drought event may last for weeks, months, or even years and the severity of a drought will depend on how long the area receives below-average rainfall. Hot temperatures can make droughts worse by evaporating moisture from the soil. Drought can also create environmental conditions that lead to wildland fire, stunted tree growth or mortality, and the spread of invasive species. In Hawai‘i, drought is a significant feature in the climate system that has profound impacts on ecosystems (Figure 1).

Figure 1: Native dominated ecosystems at Pu‘u Wa‘awa‘a (above, left) can be impacted during drought events in several ways (above, right), including: increased incidence of wildfire, increased growth of non-native shrubs and grasses, and increased activity of invasive insects and mammals which all lead to habitat loss for the area’s native species. Non-native hoofed mammals, such as the feral goat (above, right), increase their foraging on native plants during drought. These animals can significantly reduce the survival of native trees by trampling, bark stripping, and browsing.

A Drought History at Pu‘u Wa‘awa‘a

A total of 13 droughts have occurred across Pu‘u Wa‘awa‘a since 1920, and the two most severe droughts have occurred since 2003. The longest drought lasted for a total of 106 months (January 2006 to November 2014) and had the highest intensity of any drought in the record. Even though drought is a natural part of the climate system, when we look at drought events over time, we can see that drought frequency, duration, intensity, and severity have all increased over the past century (Figure 2). Droughts can be more or less common depending on your location. Drought is almost twice as likely to occur at lower elevations in Pu‘u Wa‘awa‘a (<900 ft.). For example, in the upper Forest Bird Sanctuary (5300 ft.)

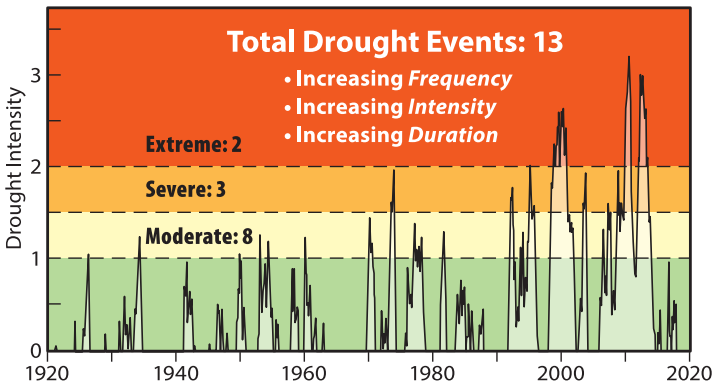

Figure 2: A 100-year drought history at Pu‘u Wa‘awa‘a (1920–2020) calculated as the inverse of the 12-month, Standardized Precipitation Index (SPI-12)[1]. Drier-than average periods are shown in the time series. If the severity of dryness reaches 1, it is considered a moderate drought; if it reaches 1.5, it is considered a severe drought; and if it is greater than 2, it is considered an extreme drought (shown by the dashed lines). Pu‘u Wa‘awa‘a experienced 2 extreme droughts, 3 severe droughts, and 8 moderate droughts (13 total) from 1920–2020.

which is the wettest area in Pu'u Wa'awa'a (27 inches of rain per year), a total of 12 droughts have occurred, while in the lower elevation area of Kīholo Bay (28 ft.), which is the driest area at Pu'u Wa'awa'a (11 inches of rain per year), 18 droughts have been observed over the same 100-year record.

Management Actions During Drought

Land managers are tasked with protection of the resources. Therefore, it is critically important that they are equipped with the tools and knowledge necessary to plan effective management strategies. These include an array of management actions that can be taken before, during, and after a drought event to minimize impacts (Figure 3). Effective management can be the key to reducing impacts on natural and cultural resources.

Before Drought

Manage invasive species; establish and maintain fire fuel breaks; restore native plant communities; raise public awareness; establish monitoring plots for rare species; collect and store seed for post-drought restoration.

During Drought

Close areas for fire prevention; supplement food/water for endangered species; increase fence inspections; adjust restoration activities (no planting); increased invasive species and non-native ungulate control.

After Drought

If fire occurred, conduct post-fire restoration with fire-tolerant native species; replace rare species; evaluate long-term changes in vegetation and formulate a response.

Figure 3: Possible management actions before, during, and after drought[1].

Why is This Important?

A Range of Impacts Across the Landscape

Many threatened and endangered plant species occur in areas of Pu'u Wa'awa'a that are susceptible to drought and where drought-related impacts are the greatest.

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Severe droughts can reduce species populations and sometimes be the key factor driving extinction. The risk of wildfire occurrence is also increased during times of drought which may cause managers to close parts of Pu'u Wa'awa'a to visitors to avoid ignitions. Wildfire can lead to other ecological consequences, including higher rates of erosion from burned areas. Reducing invasive fire prone vegetation such as fountain grass, is an important and essential action that managers can take to mitigate drought effects on wildfire risk. One strategy for forest restoration is to plant drought tolerant native tree species in sites heavily impacted by drought (Figure 4). Effective management can reduce alien species invasion, and the frequency and severity of disturbances such as wildfire during periods of drought.

Figure 4: Dead kikuyu grass (died from the drought), and dead māmane trees (likely killed by a combination of drought, pests, and competition with weeds, etc.), this photo was taken in October, 2010, in the southwest part of Pu'u Wa'awa'a (Elevation 3583 ft.) following 21 consecutive months of below average rainfall.

Credit: Elliott Parsons

[1] Drought history is calculated as the inverse of the 12-month, Standardized Precipitation Index (SPI-12).

[2] Frazier et al. (2019) https://www.fs.usda.gov/treesearch/pubs/59164

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