A 100-Year History of Drought at Hawai'i Volcanoes National Park

Extended dry periods can be a deadly situation for many native species across the park

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 increase wildfire risk, decrease tree growth, and increase 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 in the park (left) can be impacted during drought events in several ways (right), including: increased incidences of wildfire, loss of bird habitat, decreased availability of forage, increased growth of non-native shrubs and grasses, increased activity of invasive rodents and insects, and damage to perimeter fences by cattle and invasive mammals. Insects that thrive in warm dry conditions such as *Vespula* (western yellow jacket) could become more abundant during drought.These insects significantly impact natural resources as well as the visitor experience.

A Drought History at HAVO

A total of 17 (park-wide) droughts have occurred since 1920, but the three most severe droughts have all occurred since 2003. The longest drought lasted for a total 119 months (March 2008 to April 2018) 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, and intensity have increased over the past century (Figure 2). When individual park units are considered, droughts can be more common or less common depending on your location. Interestingly, drought is almost twice as likely to occur in the wet windward areas than in the relatively dry leeward areas of the park. For example, in the 'Ōla'a tract, which is the wettest area of park (156 inches of rain per

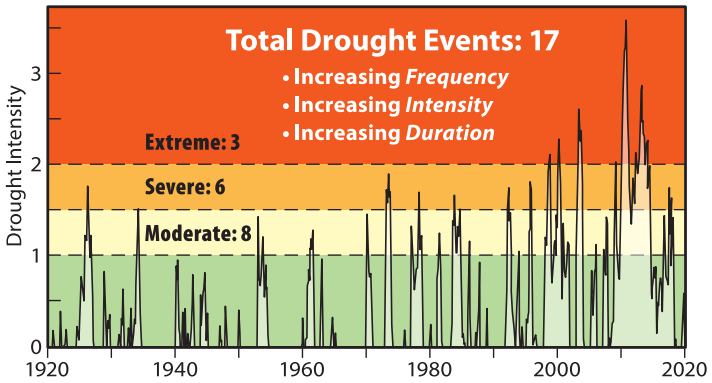

Figure 2: A 100-year drought history at HAVO (1920–2020)[1]. Drier-than average periods are shown in the time series. If the severity of dryness reaches 1, it is considered a moderate drought; if it reaches 1.5, it is considered a severe drought; and if it is greater than 2, it is considered an extreme drought (shown by the dashed lines). HAVO experienced 3 extreme droughts, 6 severe droughts, and 8 moderate droughts (17 total) from 1920–2020.

year), a total of 26 droughts have occurred while in the relatively dry Kahuku forest (43 inches of rain per year), only 14 droughts have been observed over the same 100-year record.

Management Actions During Drought

Resource managers are tasked with the protection of park 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 resources in the park.

Before Drought

Manage invasive species; establish and maintain fire fuel breaks; restore native plant communities; raise public awareness; establish vegetation monitoring plots; collect and store seeds of native species

During Drought

Close areas for fire prevention; supplement food/water for Nēnē; increase fence inspections; adjust restoration activities (no planting); invasive plant control and increase predator trapping

After Drought

If fire occurred, conduct post-fire restoration with fire-tolerant native species; replace rare species; evaluate long-term change 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 Park

Increased frequency, duration, and intensity of drought events can put pressure on water supplies and alter ecosystems in ways that can increase their vulnerability. Drought impacts span a wide range, from small-scale, temporary responses such as stunted plant growth and increased dehydration stress in wildlife, to widespread and persistent ecosystem transformations such as vegetation type conversion or species range shifts. Many threatened and endangered plant species occur in areas susceptible to drought and where drought-related impacts are the greatest. Severe droughts can reduce species populations and sometimes be the driving mechanism for extinction. The risk of wildfire occurrence is also increased during times of drought which may cause managers to close parts of the park to avoid ignitions, which ultimately impacts visitor experiences in the park. Wildfire can also lead to other ecological consequences, including higher rates of erosion from burned areas and increased sediment delivery to streams and nearshore areas[2]. This highlights the importance of management actions that reduce drought effects on wildfire risk. Some examples include, reducing invasive fire prone vegetation, such as fountain grass, and increasing fire resistance in specific sites by rebuilding the structure of the native understory. This increases shade and moisture, decreases wind and fuel bed temperatures, thereby reducing the risk of wildfire spreading into high priority areas (Figure 4).

Figure 4: Broomsedge burn rehabilitation area in the Mauna Loa Strip during July 2011 after 35 consecutive months of drought conditions which began in September 2008. The hō'awa in the foreground of the photo is a native species that is planted to help rebuild the understory. Map shows park boundaries in brown and location of the Broomsedge burn restoration area as a red dot.
Credit: J.B. Friday

[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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