

**An Assessment of Prescribed Burns in Hawai‘i to Identify
Training Opportunities and Limitations to Mitigating Long-
Term Damage of Wildfires to Communities and Ecosystem.**

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I certify that I have read this thesis and that, in my opinion, it is satisfactory in scope and quality as a thesis for the degree of Bachelor of Science in Global Environmental Science.

THESIS ADVISOR

A handwritten signature in black ink, appearing to read "Parker Clayton Trauernicht", written in a cursive style.

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For my Hawai‘i family and our surrounding community for the health and safety of the
island of O‘ahu and its native ecosystem.

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Abstract

Wildfires are an important part of terrestrial ecosystems and plays a large role in the recycling of nutrients and clearing of debris to allow for new vegetation growth. However, in recent decades increased human activity has resulted in millions more acres of land being burned that would otherwise not occur naturally. The purpose of this thesis is to assess the benefits and ideal size and frequency of prescribed burns in Hawai‘i and to identify the potential wildfire training opportunities for first responders. This critical assessment discusses the various weather and topographical parameters, necessary burn plans, and public communication that is necessary to have a safe and effective prescribed burn in the state of Hawai‘i. Comparisons between mainland and Hawai‘i agencies help establish that burn techniques differ in each region. Conducting in-person interviews with state and fire officials and surveying a live prescribed burn offer an effective way to gather information on the possibility of state-wide burn plans. This research is ultimately limited to the current state of the climate and may need to be revised to account for climate change.

Table of Contents

Acknowledgments.....	iv
Abstract.....	v
List of Figures.....	vii
1.0 INTRODUCTION	8
1.1 What are Prescribed Burns?	8
1.2 The Issue with Non-native Plant Species.....	8
1.3 The Effects of Wildfires on the Community and Ecosystem	9
1.4 The Importance of Prescribed Burns in Hawai‘i	10
2.0 METHODS.....	11
2.1 Collecting Fire Ignition Data and Burn Parameters	11
2.2 Assessing Prescribed Burn Areas and Conducting Interviews.....	11
2.3 Researching/Assessing Other State Agencies Burn Plans	13
2.4 Assessing Training Opportunities and Standardization	14
3.0 RESULTS	15
3.1 Ignition Data and Burn Parameters.....	15
3.2 Field Research and Interviews.....	17
3.3 Different State Agency Plans and Coordination with Hawai‘i	19
3.4 Standardizing Operations and Training in Hawai‘i.....	19
4.0 CONCLUSION	22
APPENDIX.....	24
LITERATURE CITED.....	25

List of Figures

Figure 1. [Human vs. Naturally Caused Wildfires]	10
Figure 2. [Image of Control Burn at Schofield].....	13
Figure 3. [Image of Control Burn at Schofield].....	13
Figure 4. [Image of Control Burn at Schofield].....	13
Figure 5. [Map of Maui Hotspots]	15
Figure 6. [Map of O‘ahu Hotspots].....	15
Figure 7. [Contingency Plan at Schofield].....	17
Figure 8. [Contingency Plan at Schofield].....	17
Figure 9. [Contingency Plan at Schofield].....	18
Figure 10. [Tanner Taking Notes at Burn Site]	18

1.0 INTRODUCTION

1.1 What are Prescribed Burns?

Prescribed burns, also known as controlled burns, are fires that are started deliberately in a specified area by fire department staff, to prevent future and even active wildfires from expanding and causing further damage to a wildland or urban area.

Prescribed burns in Hawai‘i are conducted for fuel control, to burn out vegetation in and around dry regions that are easily ignited during wildfires, while additionally providing training opportunities for the firemen to prepare for the dry season (Maui News, 2019).

Doing so has resulted in mitigating wildfire spread and intensity across Maui and other islands in Hawai‘i. Currently, the only prescribed burns being conducted on O‘ahu are through the Army Garrison wildland fire department at Schofield Barracks. The associated risk, public opinion, and the consensus of the Fire Operations Division for each department have prevented prescribed burns from becoming common practice on O‘ahu in the past. The research conducted in this project aims to address these concerns and compare them to other agencies policies and operations to help produce a safe and conducive plan for Hawai‘i first responders, such as the division of forestry and wildlife or the fire departments, objective for maintaining a healthy native ecosystem.

1.2 The Issue with Non-native Plant Species

One of the problems in Hawai‘i that contributes to excess wildfires is the extent of non-native grasses such as guinea grasses (*Megathyrsus maximus*) and shrubs such as haole koa (*Leucaena leucocephala*). These plants are widespread throughout the islands

and are major sources of fuel for wildfires. Many of these invasive species can self-pollinate and have root systems that grow deep below the soil which are protected from the wildfires on the surface (Zouhar, et. al., 2008). This allows for some invasive vegetation to access remaining nutrients in the soil before other plant species, growing back more rapidly and in greater volume than some native plants. These factors make it difficult to determine the best method for long-term effectiveness across the state. One thing to consider when evaluating the best place for prescribed burn sites is whether the departments heading prescribed burns are targeting the invasive species, logging their regrowth between burns, or just burning out what they can each time. The department's awareness of the ever-adapting vegetation and environment and the current knowledge on invasive plant species in Hawai'i may aid in improving burn site locations, frequency, and overall mitigation of wildfire extent.

1.3 The Effects of Wildfires on the Community and Ecosystem

Wildfires in Hawai'i burn roughly 0.5% of the land every year, even more surprising, over 98% of these wildfires are caused by human activity which is greater than any other state in the country, this is shown in figure 1 for visualization (Upton, 2017), (Trauernicht, et. al., 2015). The excess amount of human caused wildfires affect the ecosystems natural processes in a multitude of ways, infiltrate urban areas, and can even burn down homes increasing the intensity and extent of wildfires. Concerning the ecosystem, excess wildfires destroy the native vegetation and harden the soil, this makes it more difficult for native vegetation to obtain the required nutrients and reach sufficient regrowth levels (Hawai'i EMA, 2018). Furthermore, excess wildfires harden the soil lowering the soil saturation point and creating larger amounts of run-off that contribute to

flash floods.

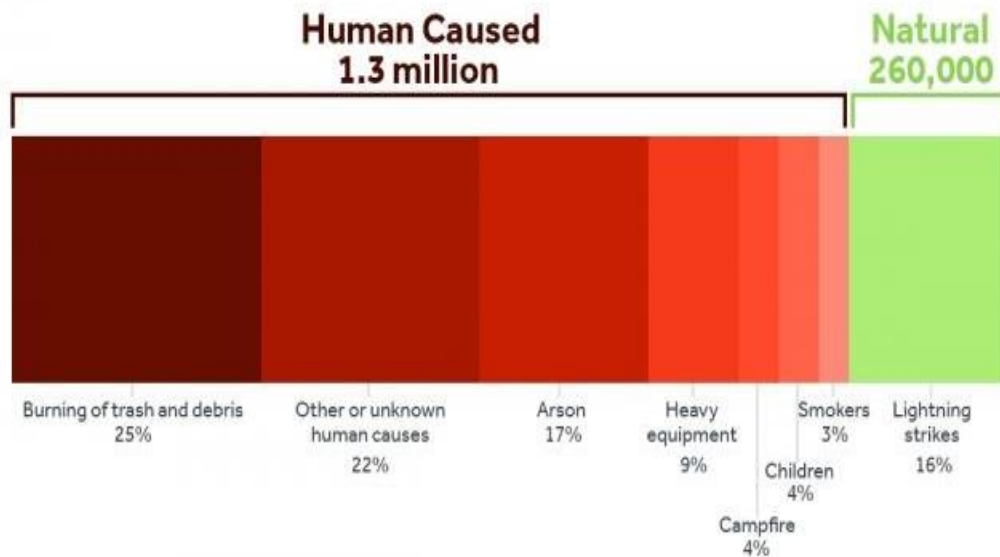


Figure 1. Showing human vs. naturally caused wildfires from 1992-2013 (Upton, 2017).

1.4 The Importance of Prescribed Burns in Hawai‘i

According to the Hawai‘i Hazard Mitigation Plan, over 60% of Maui’s population resides within high-risk area for wildfires, larger than any other island in the state. Since 2012 over 94,000 acres or 147 square miles of land has been burned from wildfires which equates to a little over 20% of the total square miles of the island of Maui (Hawai‘i EMA, 2018). Therefore, communicating Hawai‘i’s prescribed burn mitigation techniques to other state agencies, as well as interviewing the fire departments that currently conduct prescribed burns are so important. The results from this analysis may provide an increased sense of safety in the higher-risk communities as well as preparedness through standardizing procedures across agencies and providing training opportunities for first responders.

2.0 METHODS

2.1 Collecting Fire Ignition Data and Burn Parameters

Collecting fire ignition data is an easy but time-consuming process. For this part of the research, data was given as a list of fires that occurred on Maui from 2012 to June 2021. The data was given in the form of acres burned and street addresses which were turned into longitude and latitude points, from there a map of the data was created using the coordinate points for a visual aid to identify the hotspots around the islands. Due to the volume of ignition data supplied, not all the data was logged for this research project. However, the completed ignition data is sufficient to identify the hotspots around the islands.

Identifying burn parameters was the more difficult portion of this data collection because in tropical regions, the burn parameters can change with the topography of the islands (J. Turnbo, personal communication, April 18, 2022). Further research found the National Weather Service has a Hawaiian Fire Weather Products which can assist with identifying safe weather parameters for prescribed burn safety. However, the Hawai'i fire operations division within the Honolulu County Fire Department on O'ahu is still hesitant to organize any prescribed burns with the local fire departments. Therefore, further research was done to identify a range of weather parameters that would be considered safe for prescribed burn operations.

2.2 Assessing Prescribed Burn Areas and Conducting Interviews

One of the only organizations that actively conduct prescribed burns on O'ahu is the Hawai'i Army Garrison Wildland Fire Department (AFD). The field research was

conducted at Schofield Barracks during the department's annual prescribe burn for fuel management along the Ka'ala mountain range. This research was conducted over three days during active burns on the range (see figures 2-4). Throughout the three days, the safety procedures were examined, the overall objectives, the weather, and the contingency plans of the operation to help identify ways to standardized practice among fire departments in Hawai'i. The burn boss of the operation was Justin Turnbo, who provided their incident action plan which was used as a guide to narrow down weather parameters and address the environmental and community safety concerns which have prevented prescribed burn operations from being conducted in more areas across the island.

Furthermore, direct contact was made with members of the Honolulu fire department (Logan Tomokiyo, Keith Ito) and Division of Forestry and Wildlife (Michael Walker) to conduct interviews regarding prescribed burns on O'

ahu. These interview questions have been constructed to further assess the understanding of and experience with wildfires on the islands, what they believe the benefits are to conducting prescribed burns, their overall awareness of the sites they burn for example, what type of vegetation is primarily burned at these sites, how often they are done, and whether they achieve the goal of sufficiently preparing the first responders for real life wildfire scenarios.



Figure 2. Burning the center of the field at Schofield Barracks range.



Figure 3. Burn spreads outward toward fire break at Schofield Barracks range.



Figure 4. The area captured is the site of the entire prescribed burn. It was burned along the fire break first and then from the center of the field outward (Schofield Barracks).

2.3 Researching/Assessing Other State Agencies Burn Plans

After completing the field research and interviews, available information was gathered from other state wildfire agencies regarding their prescribed burn plans. State wildfire agencies in Washington and other high-risk states for wildfires have extensive

burn programs and a long history of conducting prescribed burns. The weather parameters can vary and there is a vast amount of wildland in other mainland states. However, because of the many wildfires that occur in these states there are extensive burn practices, techniques, and training opportunities that operations in Hawai‘i can benefit from. For example, the Washington Department of Natural Resources integrates restoring fire adapted habitats for wildlife into their prescribed burn plans. This information combined with addressing the concerns of the interviewees may help further develop a localized burn plan for departments across Hawai‘i.

2.4 Assessing Training Opportunities and Standardization

To conclude the research, the interviews, data collection, field research, and state agency research were reviewed to see what aspects could be standardized for use before, during, and after prescribed burns are conducted in Hawai‘i. The opportunities to provide safe and constructive training for the fire departments and associated organizations were assessed and organized which will help bring a better sense of understanding and peace of mind about prescribed burns in the local community.

3.0 RESULTS

3.1 Ignition Data and Burn Parameters

After collecting enough fire ignition data from the island of Maui and using prior data on O‘ahu, two maps were created of the islands to identify wildfire “hotspots” across these islands. These maps are depicted in figure 5 and 6 below.



Figure 5. Showing map of Maui and wildfire locations over the course of a few recent years.



Figure 6. Showing a map of O‘ahu and wildfire locations from 2012-2021.

According to figure 5, a large amount of the fires in Maui are concentrated around central and north-central Maui. In figure 6, there is much more available data and many of the wildland fires occur in or around urbanized areas. As stated before, 98% of wildfires in Hawai'i are due to human activity and the data for O'ahu fires suggests that this is what is occurring on the island. However, Maui is a much less populated island, and the data suggests that most of the wildland fires there are occurring in dry regions of the island (western and leeward areas) where there is not as many people but plenty of vegetation and open land. Therefore, prescribed burn techniques and locations may vary from island to island depending on where risk is greatest, or mitigation is most needed.

When examining the burn parameters, the main thing to consider for Hawai'i is the temperature, relative humidity, and wind speed. The difficulty with gauging these conditions is that the weather parameters that are considered ideal for one area of an island may not be for another. For this reason, a range of weather parameters can be considered for safe conditions and further narrowed down based on the area. For example, in most areas around the island if wind and temperature are high but relative humidity is also high a burn may be able to be conducted. However, if in an area with steep inclination like near the base of a mountain wind cannot be too high no matter the other conditions as the wind may cause the prescribed burn to "ladder" up the side of the mountain (Justin Turnbo personal communication, 2022). There are guides out there currently being used, such as the website provided by the National Weather Service, and "red flag warnings" put out for the state when weather conditions can produce a wildfire and no prescribed burns should be conducted during that time.

3.2 Field Research and Interviews

After 3 different days of conducting field research, the objectives, procedures, contingency plans, and overall setup of the operation was compiled. The first day of research had required the use of one of the Army fire department's contingency plans. As shown in figure 7, 8, and 9, the prescribed burn began traveling up the side of the mountain and jumped over the fire break. Therefore, they called in the Black Hawk pilots who were on standby to dump water on the fire. The army burns this area every year, so they have a water reservoir (shown in figure 9) near the range for these pilots to use in case the fire spreads over the fire break like it did in figure 7.



Figure 7. The prescribe burn jumps the fire break and begins traveling up the mountain, this is known as “laddering”.



Figure 8. Black Hawk pilot dumping water on fire to prevent further spread up the mountain.



Figure 9. Black Hawk dipping “Bambi Bucket” into pond in place in case of contingency plan.



Figure 10. Tanner Ritchey (me) taking notes during day 2 of the prescribed burn at Schofield range.

The interviews conducted with wildfire experts contained questions regarding the interviewees position, experience with wildfires, and opinions and ideas on prescribed burn plans. These interviews have provided feasible ideas to assemble a prescribed burn program in Hawai‘i. For example, the state may work with the state of Arizona to train an initial set of personnel for prescribed burns before conducted them on O‘ahu. This would allow for a smaller group to be trained in a safe controlled area and then apply that training to teach the fire departments in Hawai‘i safe operating procedures for their burns (personal communication, 2022). Furthermore, the consensus on the size and frequency of the prescribed burns were established based on 4 main concerns: the topography, limited land in Hawai‘i, community safety and awareness, and fragile native ecosystem. Collectively, everyone agreed the prescribed burns should be small, targeted burns while limiting smoke spread that aim to clear out invasive grasses and shrubs and dead organic matter along the forest floor (personal communication, 2022). These are major fuel

sources that allow wildfires to spread quickly across the islands which is why the frequency of the burns in Hawai‘i need to be more often than most mainland states. In other words, tropical weather patterns year-round allow vegetation to grow much faster and require more frequent treatment.

3.3 Different State Agency Plans and Coordination with Hawai‘i

There are a few commonalities between mainland states, Maui fire department, and the Hawai‘i Army Garrison prescribed burn programs. To include a few, the first goal of every program is and should remain safety, that includes the safety of the firefighters, the wildlife, and surrounding communities. Another similarity is smoke mitigation techniques which help keep smoke pollution from spreading to nearby communities affecting air quality. Further research found that most organizations, such as the Washington State Department of Natural Resources, follow burn plans that are aimed to reduce fuels on the ground. A few differences between agencies were noticed as well. For example, Washington follows a burn plan that clears trees prior to burns, helps reintroduce nutrients into the soil, and restores fire-adapted habitats for wildlife (Washington DNR, 2021). Furthermore, there are differences in the frequency of the prescribed burns in west coast states versus those in Hawai‘i. Most agencies on the mainland conduct their prescribed burns every 5-20 years, whereas the tropical weather in Hawai‘i requires some burns to be prescribed every year before the dry season.

3.4 Standardizing Operations and Training in Hawai‘i

Through this research, it was found due to the size, environmental, and community differences between the mainland states and Hawai‘i that standardizing across the country is not feasible but can still be done at the state level. However, there

are still techniques and plans from mainland agencies that can be beneficial if integrated into Hawai'i's prescribed burn programs. The first step to standardizing burn practices across the state is identifying the first objective which for many agencies including the Hawai'i Army and Maui fire departments is safety. This objective includes the safety of those conducting the burns, the safety of the native ecosystem, and the safety of the surrounding community.

Further safety measures can be integrated with the Hawai'i National Guard or Army Garrison (when available), on days when prescribed burns are being conducted making sure there are pilots on standby for wetting down the perimeter before the burns and as a contingency plan in case the fires need suppression like in figure 7. Something specific to Hawai'i prescribed burns is because of the environment and high-risk associated with prescribed burns, departments would benefit most from small, targeted burns with minimal smoke pollution. Due to the cultural significance of the environment and smoke production from the fires it would be important to inform the local communities, in addition to the directly involved parties, of the time, location, and purpose for the prescribed burn. This would not only prevent people from flooding emergency services with phone calls during the burns but also provide peace of mind to the communities that there is a plan in place to keep everyone safe and that no cultural sites are harmed.

In addition, weather parameters seem to be the most difficult thing to standardize which is why Hawai'i agencies may benefit most from continuing to follow the Hawaiian Fire Weather Products and red flag warnings. These products can be used as a baseline for burns and then an assessment can be made for specific areas based on their

topography. Burns conducted near the base of mountain ranges, for example, are best if the wind is in the range of around 15 miles per hour. Winds that are higher make the fire difficult to control, winds much lower tend to want to climb straight up the mountain range (personal communication, 2022).

The Army Garrison at Schofield Barracks and Maui fire department have had success conducting these types of operations and other fire departments in Hawai‘i could use their experience in conjunction with training received from working with other states to further expand their training for wildfire suppression. For some states these are large operations and require a plethora of staff to conduct but for Hawai‘i it is not necessary to achieve the goals put forth by the DLNR and State Department of Health (DOH). Therefore, the extent of training would be for the select department(s) conducting the prescribed burn which usually involves 10-15 fire burners and about 5 federal fire department burners depending on the size and location of the prescribed burn. One way to include more fire department staff would be for the experienced local personnel and federal personnel to conduct burns with different departments each time and allow other fire departments to observe the prescribed burns as they have for previous burns at Schofield Barracks.

Ultimately, the decision to include these prescribed burns throughout the state is up to the fire operations management team within each department. Once a complete system is put into place, permits are granted for burns through the DOH, and after a few are conducted, they will determine based on effectiveness and community opinion whether they continue the program.

4.0 CONCLUSION

Prescribed burn programs are a multi-faceted and require the conjoined approval and effort of the DLNR, DOH, local fire departments, National Guard and/or Army, and the community. The local fire departments include the 4 county fire departments of Hawai‘i, Kaua‘i, and Maui counties, and the City and County of Honolulu. These county fire departments are the typically the initial responders to wildfires in Hawai‘i, however, the Hawai‘i Division of Forestry and Wildlife is the primary response agency for Hawai‘i wildfires. The environment and people are unique, protecting and ensuring the longevity and health of both is of utmost importance. A joint operation of all the agencies working to mitigate wildfires in Hawai‘i (DLNR, DOH, MFD, HFD, Hawai‘i Army Garrison, Hawai‘i Wildfire Management Organization) can be successful and gain community approval. This requires sharing standardized safety protocols to include how the safety objectives will be met and what contingency plans are in place, weather parameters for temperature, wind speed, relative humidity, and their specifics based on topography, as well as properly training an initial set of staff to oversee the operations and continue to train fire fighters within the state. In the future, further research may need to be conducted on the weather parameters and suggested size of the burns to account for climate and environmental changes.

Overall, conducting prescribed burns is high risk and the suppression techniques used may need to be adjusted for different islands. For example, the ignition maps in figures 5 and 6 show that Maui prescribed burns should be aimed around flat, dry, and rural areas whereas on O‘ahu prescribed burns should be aimed around the urban areas

and near the base of mountain ranges on the western side of the island. Hawai‘i has different fuel types than mainland states and the tropical weather contributes to irregular wildfire location and frequency. Therefore, Hawai‘i’s unique criteria for conducting prescribed burns stresses the need for communication amongst agencies and the public, prior to burns, so that anyone affected can make informed decisions for themselves. These objectives can be obtained through collaborative effort amongst state officials, media outlets, fire departments, and the community. Ultimately, providing a safer and healthier environment for the all the island communities and ecosystems.

APPENDIX

Interview Questions for Firefighters

1. What is your name and position within the department?
2. How long have you been with the fire department?
3. Have you conducted and/or observed a controlled burn before? And if so, how many?
4. In your opinion what is the purpose of conducting these controlled burns?
5. Do you feel these controlled burns achieve the purpose for which they are conducted?
6. Do you feel the current training opportunities through controlled burns are sufficient training for real wildfires? If not what other training opportunities, if any, would you recommend be introduced to current controlled burn practices?
7. Does the department have burn plans? If so, what are the plans or how do you go about planning them?
8. What type of vegetation is most commonly burned during these practices? Are they majority native, non-native, or a mix? Grasses, shrubs, sugar cane, crops?
9. Are the controlled burns done often enough or should they be conducted throughout the year due to the irregularity of wildfires in this tropical region?
10. What is the safe window of weather conditions for conducting the controlled burns? (are there quantifiable temperature, wind speed, and humidity parameters to conduct control burns?)
11. Do you think other departments or first responders outside of the fire department should be included in these practices for awareness and preparedness purposes?

LITERATURE CITED

- Albery, G. F., Turilli, I., Joseph, M. B., Foley, J., Frere, C. H., & Bansal, S. (2021, September 23). *From flames to inflammation: How wildfires affect patterns of wildlife disease - fire ecology*. SpringerOpen. Retrieved June 3, 2022, from <https://fireecology.springeropen.com/articles/10.1186/s42408-021-00113-4>
- Coordinator, P. F. X. (2021, January 13). *Pacific Island Fuel Breaks & Management Strategies*. Pacific Fire Exchange. Retrieved June 3, 2022, from <https://www.pacificfireexchange.org/research-publications/category/quick-reference-guide-pacific-island-fuel-breaks>
- Hanson, L. (2022, June 1). *Wildfire Statistics - Federation of American scientists*. Wildfire Statistics. Retrieved June 3, 2022, from <https://sgp.fas.org/crs/misc/IF10244.pdf>
- Hawai'i Emergency Management Agency. (2018). *State of Hawai'i Hazard Mitigation Plan*. Section 4: Risk Assessment . Retrieved June 3, 2022, from <https://dod.hawaii.gov/hiema/files/2018/06/Draft-Section-4.15-Wildfire-Placeholder.pdf>
- News, U. H. (2020, September 22). *UH team to develop wildfire risk system*. University of Hawai'i System News. Retrieved February 3, 2022, from <https://www.hawaii.edu/news/2020/09/22/wildfire-risk-system/>
- Rubin, W. (2021). *Prescribed fire program: WA - DNR*. Washington State Department of Natural Resources. Retrieved June 21, 2022, from <https://www.dnr.wa.gov/prescribedfire>
- Stevens-Rumann, C., & Morgan, P. (2016, September 26). *Repeated wildfires alter forest recovery of mixed-conifer ecosystems*. Ecological applications : a publication of the Ecological Society of America. Retrieved June 3, 2022, from <https://pubmed.ncbi.nlm.nih.gov/27755710/>
- Trauernicht, C., Pickett, E., Giardina, C.P., Litton, C.M., Cordell, S., and Beavers, A., 2015. The Contemporary Scale and Context of Wildfire in Hawai'i 1. *Pacific Science*, 69(4), pp.427-444.
- Upton, John, J. (2017, February 27). *Humans blamed for starting most wildfires in the U.S*. Climate Central. Retrieved June 3, 2022, from <https://www.climatecentral.org/news/humans-blamed-for-most-wildfires-us-21197>

US Department of Commerce, N. O. A. A. (2021, September 3). *Hawaiian fire weather products*. National Weather Service. Retrieved June 3, 2022, from <https://www.weather.gov/hfo/firewx>

Zouhar, K., Smith, J., Sutherland, S., & Brooks, M. (2008, September). *United States Department wildland fire in forest service ecosystems*. Wildland Fire in Ecosystems . Retrieved June 3, 2022, from https://www.fs.fed.us/rm/pubs/rmrs_gtr042_4.pdf