

Evaluation of Contributing Factors to Wildland Firefighter Fatalities in the United States

A Thesis

Presented in Partial Fulfillment of the Requirements for the

Degree of Master of Science

with a

Major in Natural Resources

in the

College of Graduate Studies

University of Idaho

by

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December 2019

Authorization to Submit Thesis

This thesis of Anjeleeca M. Tomayko, submitted for the degree of Master of Natural Resources with a Major in Fire Ecology and Management and titled "Evaluation of Contributing Factors of Wildland Firefighter Fatalities in the United States" has been reviewed in final form. Permission, as indicated by the signatures and dates below, is now granted to submit final copies to the College of Graduate Studies for approval.

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Abstract

Wildland firefighter fatalities are not caused by one single factor. Catastrophic fires are on the rise, civilian and firefighter deaths are on the rise, particularly volunteer firefighters. The WUI is growing at a faster pace than ever recorded and suppression and economic costs are skyrocketing. There is not one contributing factor, thus there is not one solution. Also, a solution is not a one-time occurrence. We must become adaptively resilient, living with fire on the landscape. We cannot extirpate wildfire, however we can learn to use it to our benefit through the use of increased prescribed fire to reduce fuel loading from dead and down woody debris, also reducing insect populations and the spread of diseases. We need to acknowledge the commitment and sacrifice wildland firefighters make in an effort to save our livelihoods. Livelihoods many of us have chosen to build in well documented fire prone areas. Better surveillance systems are needed to track statistics and implement better strategies and technologies. A universal human resource program with standardized job titles, a well-defined career path designed for retention and promotion and health and wellness programs is needed. The data surrounding the effects of poor nutrition, inconsistent fitness programs, insufficient sleep, and arduous working conditions points to a long term effect on today's firefighters. Wildland firefighting is becoming increasingly dangerous and overly demanding resulting in an alarming rate of suicide. There is no top-down or bottom-up approach to this issue. As a society, through poor management decisions, poor policy making, and insufficient knowledge on the environment we are living in, we have created our own worst case scenario, a ticking time bomb, that's showing itself through statistics. It will take each and every one of us at every level to collaborate, and implement innovative and adaptive solutions.

Acknowledgements

There's a saying that it takes a village to raise a child. It also takes a village for success. I would not have made it to where I am without the support and encouragement of many colleagues, classmates, and professors throughout my academic journey: Penny Morgan, Randy Brooks, Alistair Smith, Andrew Nelson, Eva Strand, and Leda Kobziar.

Dedication

Villages often consist of many shops. My village has an army of people that have supported and encouraged me along the way. I would not have started this journey if it weren't for my kids. I'd like to thank Persephone, Cameron, Alana and Kyra for the sacrifices we all endured for me to finish this journey. A short term sacrifice for a long term benefit. I would also like to thank my boyfriend Dean Kiefer and my stepmom Brenda Padmore for their unwavering support.

Finally, I would like to dedicate my thesis to the memory of Tom Zbyszewski, Andrew Zajac, and Richard Wheeler the members of Engine 642 that perished in the Twisp River Fire. Their ultimate sacrifice inspires me daily to make a difference in land and fire management.

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Chapter 1 Introduction

1.1 Introduction

The news is filled with stories about catastrophic wildfires around the United States. Fire prone areas are taking drastic measures, such as forced blackouts during high wind events, to prevent deadly fires like the 2018 Camp Fire in Paradise, California that killed 86 people, injured 12 civilians, two prison firefighters and three firefighters. It destroyed over 18,800 structures, including almost 14,000 residences (III, 2019) making it the most expensive worldwide natural disaster of 2018 for insurance companies at \$12.5 billion in losses (Reyes-Vilarde, 2019; III, 2019). While 2019 has been the most mild wildfire season since 2014 at 4,574,688 acres and 45,420 fires as of November 8th, nearly half of 2018 acreage and only 46% of acres burned in 2017, Alaska's wildfire season was the worst since 2015 and in late October the annual Santa Ana winds ignited dozens of fires in California. Amid lawsuits from the deadly Camp Fire, prompted utility giant PG&E to turn off power to 2.7 million California residents (Newburger, 2019) designated a Public Safety Power Shutoff (PSPS) (PGE, 2019). Winds exceeded 80 mph in places, reducing the relative humidity to as little as 1%, fueling devastating fires like the Kincade Fire in Northern California and Getty Fire in Southern California. Fires that are still under investigation with at least one suspected to be the result of a branch on a powerline. Residents who were spared from the fires, were impacted by heavy smoke and power outages lasting for days, exacerbating economic losses. Wildland fire is often managed through by the historical range of variability (HRV) model. Unfortunately, that HRV is no longer relevant as the fire regime is changing faster than we are adapting. We continue to resist fire instead of learning to live with it and adapting to an anthropogenic fire regime. This current trend is unsustainable long term, and is increasingly unsustainable in the short term as well.

1.2 Wildfire Trends

A wildfire is a fire that was not planned, is uncontrolled and originated in natural fuels. Since the 1970's, wildfire season has grown by 78 days resulting in not only a demand for more firefighters, more frequent and long term exposure, skyrocketing costs, and escalating risks of injury and death for both firefighters and civilians. The paradigm fire season is shifting to a fire year in California as wildfires are occurring almost year round. In 2018, the Thomas Fire broke the record for the largest wildfire in state history, a record that had been set less than one year earlier by the Mendocino Complex. Just three months later, the Camp Fire became the deadliest and most destructive fire in state history. In 2014, the Carlton Complex became the largest fire in Washington state history, only to be topped by the Okanogan Complex in 2015 that also resulted in three fatalities, one serious burn

injury and three minor burn injuries. In 2017, Washington and Oregon fire seasons extended three weeks longer than ever recorded.

These longer fire seasons are attributed to climate change, mismanagement of forests and 100 years of fire exclusion. This is believed by many to be a trifecta for megafires. A megafire is simply a large fire (typically over 100,000 acres) that receives more attention because of its impact on humans and human environments (Williams et al, 2019). They generally occur in forests where fire has been excluded and fuels are continuous both vertical and horizontally resulting in high intensity, high severity fires. Statistics are showing that with temperatures increasing, precipitation decreasing, and forests that are diseased and/or dying, that the frequency and severity of wildfires is increasing. Put simply, climate change is increasing fire frequency. Additionally, acres burned are increasing and the number of fires each year is decreasing, however, the economic costs of wildfire are growing exponentially.

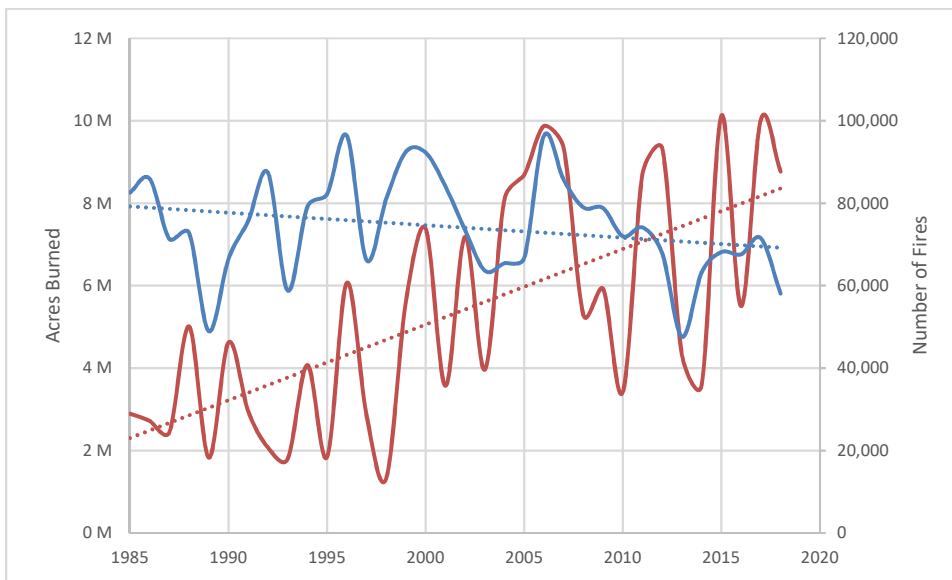


Figure 1 Acres burned versus number of fires (1985-2018). *Source NIFC (2018)*

Yet, one key element is missing from this narrative - the impact of humans on the fire regime. Each year 85-90% of wildfires are human-caused. From 1992-2012, 84% of wildfires and 44% of total area burned were from human-caused fires (Balch et al, 2017). The anthropogenic fire season is three times longer than lightning-caused fire season and adds 40,000 fires annually across the United States. Humans are changing the fire niche by introducing more ignitions, increasing fuel, and dry conditions (Balch et al, 2017).

Currently there is no surveillance system to delineate wildland fires from those in the wildland urban interface (WUI). The WUI is defined as the area where structures and other human development meet

or intermingle with undeveloped wildland (Radeloff et al. 2005). It can be broken down even further into an interface and an intermix. The difference between the two is the percent cover of wildland vegetation. The interface has less than 50% wildland vegetation cover and the intermix has greater than 50% wildland vegetation cover (Martinuzzi et al 2015).

Individual states produce annual reports that show number of fires, acres burned, cause, and ownership/jurisdiction. These reports are showing while the number of acres burned is highest on federal land and increasing annually, the most catastrophic fires are occurring on land under state jurisdiction - in the WUI. In California, for example, five of the top 20 deadliest wildfires occurred 2017-2018, a staggering 25% (CalFire, ND).

It is unknown exactly how many wildland firefighters there are in the United States each year. While federal agencies maintain data on employees with wildfire suppression responsibilities, state, local district, inmate and contractor employment data is unknown as it is dependent on funding, fire frequency and season severity. In addition, private contractors often have a revolving door of employees as many have them have other jobs as their primary income, so they aren't accurately tracked. Local fire districts operate off a large volunteer pool that respond to all hazards. Some will engage in wildland firefighting operations, yet this group is not tracked. The Bureau of Labor Statistics combines all firefighters into one category, regardless of whether they are structure or wildland firefighters. To complicate the situation even further, the United States Forest Service classifies wildland firefighters as forestry technicians, so many of the approximately 10,000 wildland firefighters are not included in any surveillance systems that compiles occupational safety and health data.

1.3 Cost of Wildfire Operations

Costs of wildfire suppression have skyrocketed, and the total financial impact of wildfires is growing exponentially. In 2015, the Forest Service projected that by 2025, wildland fire suppression costs would account for two-thirds of the Forest Service's annual budget and exceed \$1.8 billion. In 2017, 10 million acres burned and suppression costs topped \$2.4 billion, becoming the most expensive fire season on record and far exceeding the 10-year projection. Both the number of fires and acres burned in 2018 were lower, however, suppression costs were higher than 2017, at \$2.6 billion (Figure 1.2).

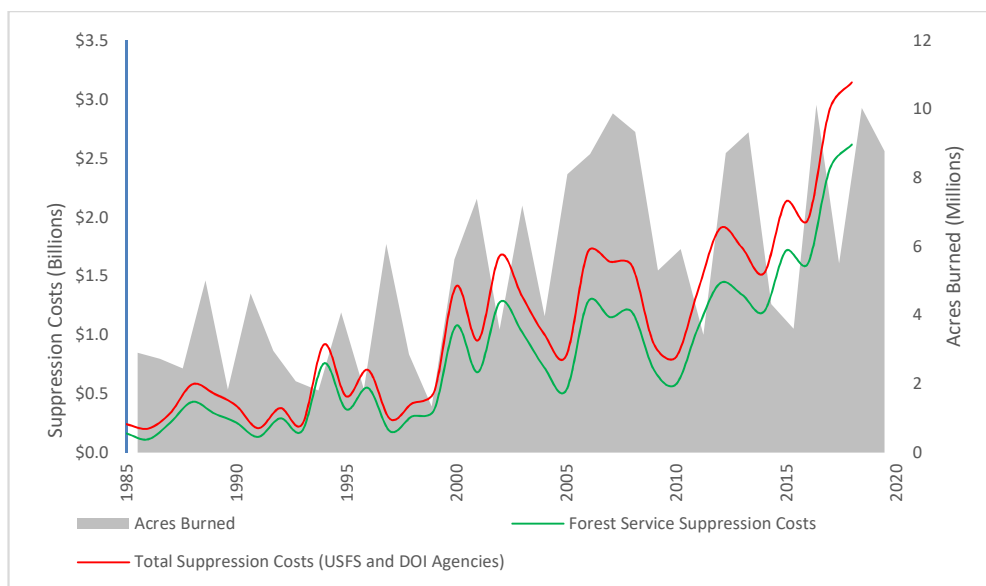


Figure 2. Suppression costs compared to acres burned (1985-2018). *Compiled from NIFC (2018)*

Wildland fire agencies are facing more challenges than ever with a greater demand on resources requiring more reliance on local fire districts that are often operating on reduced budgets and a shrinking volunteer force. For federal agencies dysfunctional hiring processes and fewer people looking for seasonal employment in favor of full time, year round employment is making it more difficult each year to properly staff and prepare for wildfire season. A job that requires being on call, working long hours away from home for weeks at a time, in hot weather with little sleep, reduced nutrition in arduous conditions on a mediocre salary is becoming less and less desirable. The high turnover results in a workforce with less experience and increases training costs, further increasing the cost of wildfire season.

Rural fire districts simply do not have the capacity to manage the increasing population with dwindling volunteers (Verzoni, 2017). Since 1994 the rate of new volunteers has dropped 10%, and this has been attributed in recent years to economic fallout from the 2008 stock market crash coupled with the perceived attitude of the younger generation of “what’s in it for me?” The sense of civic duty seems to be waning, yet rural communities with populations less than 2,500 have a 92.7% volunteer department. Communities with 2,500-4,999 residents have a 74% volunteer department. The demographics of volunteer firefighters shows that volunteer firefighters are getting older, as 42% of volunteer firefighters have been with their department for more than 10 years. (Verzoni, 2017; NFPA 2017). It is estimated by the NFPA that 86% of local fire departments have wildland fire suppression duties and are staffed primarily by volunteers. Determining the total wildland firefighter workforce is not possible, but as the burned area, season length and frequency of wildfires increase, the workforce is expected to continue to grow (Butler et al, 2017).

The Fiscal Year 2020 Forest Service budget increased almost 23% over 2019 with a 30% increase in wildland fire management and a 14% decrease in Forest and Rangeland Research (Table 1.1). The budget increasingly favors being reactive instead of proactive. Solutions the wildland fire crisis are only going to result from the results of research to find new technologies in detection, suppression, and emergency notifications.

(numbers in millions)	FY 2019 Enacted	FY 2020 President's Budget	FY 2020 House Bill	Change from FY 2019 Enacted	FY 2020 Senate Bill	Change from FY 2019 Enacted
Total USFS	6087.132	5699.76	7639	25.49%	7471	22.73%
Forest and Rangeland Research	300	254	277.155	-7.62%	257.64	-14.12%
Wildland Fire Management	3004.97	2880.34	3959.545	31.77%	3914.73	30.28%

Table 1. Forest Service's FY 2020 budget request (Source: ESA, n.d.)

The property loss rate is growing exponentially with each passing year. From the four year period 2015-2018, it grew from under \$3B to a staggering \$24B. The data makes it clear that wildfire in the wildland urban interface is a critical issue in the United States and, most notably in California.

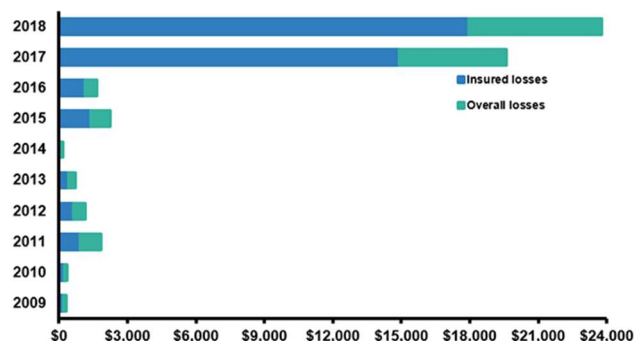


Figure 3 Wildfire Losses (2018 \$ Millions) in the United States (2009-2018). Source: Insurance Information Institute (2019)

The full economic cost of wildfires is difficult to measure because pre-emptive measures that shut down entire cities are not included in these cost breakdowns. Some estimates for 2018 in California put the total impact at \$400 billion (Myers, 2019). It's estimated that the true economic cost of wildfires is 30x the cost of suppression (Schoennagel, 2017).

The indirect economic costs are even more elusive. In 2015, the Forest Service projected that by 2025 two-thirds of the annual budget would be used for wildfire operations, and that is now expected to occur in 2021 (USFS, n.d.).

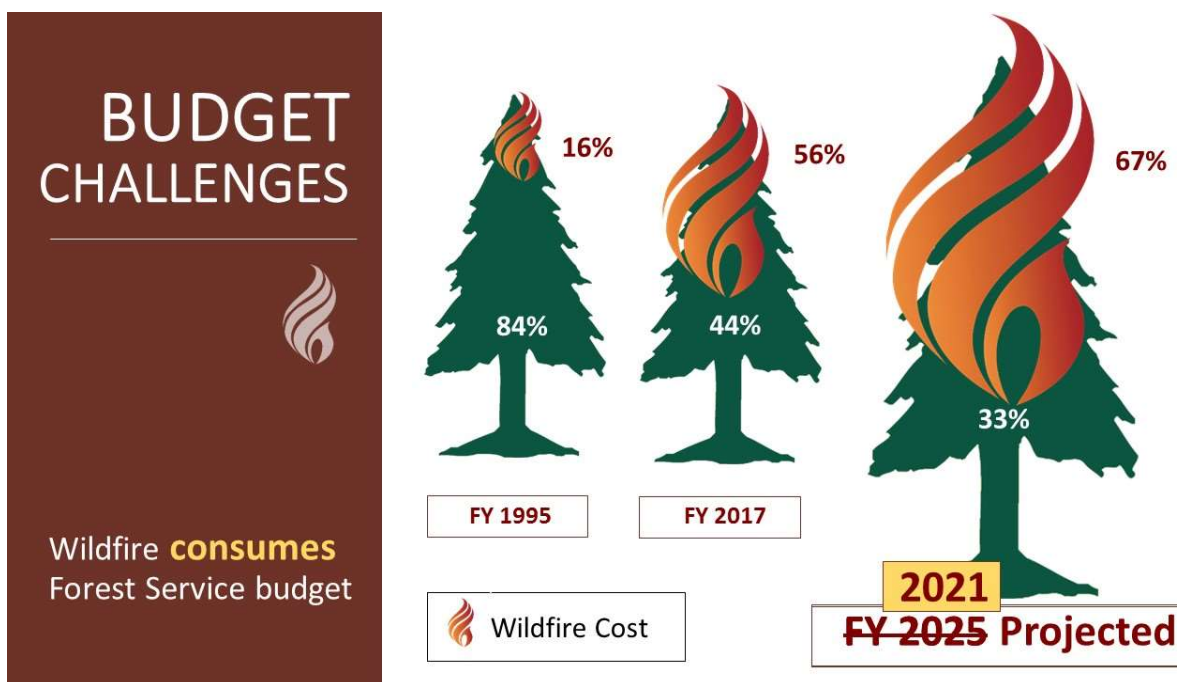


Figure 4. Forest Service Budget Challenges (USFS, 2019)

Wildfires have traditionally been funded based off a 10 year average. With wildfire costs rapidly increasing, this model no longer provides the funding necessary to shift from reactive to proactive response.

In addition to affecting research activities, prevention and education programs are almost nonexistent. Forest health programs have suffered budget cuts as well, perpetuating the growing forest health crisis resulting from 100 years of fire exclusion and forest mismanagement. Public perception surrounding fire is that all fire is bad, thanks to the most successful prevention and education campaign in United States history, Smokey Bear. This fear of fire coupled with an intolerance of smoke resulting from wildfires has resulted in more stringent air quality requirements that limit land managers when utilizing good fire on the landscape through the use of controlled burns. These controlled burns are crucial to landscape resilience by restoring fire to the landscape and are becoming more accepted by the public. Fire managers have been working diligently to inform the public that wildfire will happen. It's not if, it's when, and there will be smoke as a result. Controlled burns utilize favorable weather and best available technology to minimize the smoke impacts to the surrounding communities. How do you want your smoke?

1.4 Wildland Urban Interface

The population of the United States is on an upward trend with urban sprawl occurring at an unprecedented rate, faster than any other land use type in the United States. From 1990-2010 the

number of new houses increased by 41% and the land area increased by 33%. The formation of these new WUI areas were primarily a result of increased housing density, not increased wildland vegetation. This increases the risk of both life and structure loss and also increases wildfire ignitions (Radeloff et al, 2018). Most communities do not have the infrastructure in place to be proactive with the growth. There are programs available to help communities reduce their risk of catastrophic fire by becoming fire resilient.

Over 38% of homes in the United States are in the WUI, while the WUI is only 10% of all land. Estimates from the State Foresters Association put 66,000 communities in the United States at risk from wildland fire (Butler et al, 2017). As farmers and other landowners sell to housing developers, building codes remain largely unchanged, except in California where building codes specific to the WUI have been modified (DGS, n.d.). Programs that encourage communities to be fire resistant and fire resilient offer some defense against wildfire risk. These preventive measures are voluntary within existing communities in the WUI. Some developers building new housing developments in the WUI have utilized the FireWise USA model for wildfire preparation and hazard mitigation. The community of Fountaingrove II in Santa Rosa, California was one such community developed in 2009. The Tubbs Fire proved that even a FireWise community such as this was no match for hurricane force winds as 470 homes were lost. It was not considered a failed attempt by the community though as wildfire had been mitigated for almost a decade (Deaton, 2018). The top 10 costliest wildfires for property losses in the United States have all occurred in California (III, 2019). Six of those occurred in a 13 month period October 2017-November 2018. Seven of those are considered the most destructive wildfires in California with the top 10 all resulting in deaths of firefighters and/or civilians. In 2018 California had the highest number of acres burn at 1,823,153 acres and the second greatest number of fires at 8,054 with Texas having the greatest number wildfires at 10,541. California has the highest number of properties at high to extreme wildfire risk with 2,019,800. That's equal to the number of properties at risk for the states ranked two through eight, combined.

The increasing population in the United States has resulted in communities expanding into areas previously considered to be wildland. This urban sprawl often extends into historically fire prone and fire dominated landscapes. This is increasing conflict between humans and fire as illustrated in California as well as Washington in recent years, thereby creating a complex environment and making an already dangerous job even more dangerous. These manmade structures are unnatural fuel sources, and when placed on the landscape, are now considered resources at risk when wildfire occurs.

This puts pressure on fire managers to engage in direct attack suppression strategies where fire behavior far exceeds the capacity of ground resources. Ground resources can only effectively engage in fire suppression with flame lengths less than four feet before heavy equipment, such as dozers, is required. Heavy equipment can only effectively engage in fire suppression with flames less than eight feet. Engaging in suppression tactics at the head of the fire, essentially in the fire's path, without having created an anchor and secure fireline on the least active part of the fire is irresponsible and highly dangerous. These standard operating procedures are ingrained in every wildland firefighter from initial training and are being ignored during point protection, also known as structure protection. Yet, it's a tactic used frequently during a wildfire in the WUI, justified by the structures at risk. This blatant safety violation is exposing firefighters to increased dangers from flaming fronts well over eight feet, as well as the inhalation of potentially dangerous chemicals in the event that a structure does burn during suppression efforts. Wildland firefighting techniques have not changed since the 1930's and structural firefighting techniques, equipment and safety gear are not practical in a wildland fire environment.

In addition, civilians are increasingly exposed to the dangers of wildfire by settling in areas that are fire dominated. Humans need to learn to live with fire, resilient and fire adapted, instead of resistant and defiant. Adding to this conflict, historically fire dominated landscapes now have increased manmade fuels in the form of structures. Fuel is defined as the vegetation, both living and dead, which feeds a fire. Fuels are typically placed into one of 13 categories dependent on their characteristics. They can generally be simplified even further into three basic fuel types: 1) grass, 2) chaparral and shrub fields and 3) timber litter and slash. These fuel type classifications are useful for modeling fire behavior, smoke emissions, and creating land management and fire management strategies. Manmade fuels, structures, cannot be used in fire modeling with current technology. The closest is the existing classification for carrier fuels called Nonburnable (NB1). NWCG states that areas mapped as NB1 may experience structural fire losses during a wildland fire incident; however, structure ignition in those cases is either house-to-house or by firebrands, neither of which is directly modeled using fire behavior fuel models (NWCG). In October 2017, The Tubbs Fire in Sonoma County California burned 36, 807 acres and largely occurred within the footprint of the 1964 80,000 Hanly Fire. In contrast to the 106 structures lost in the Hanly Fire, 5,643 structures and 22 lives were lost in the Tubbs Fire. It was quickly referred to as an "urban conflagration" where the fire spread through home to home ignition (Foley, 2019).

1.5 Fire Suppression Policy

Following the 1910 Fires that burned 3 million acres in 2 days, a war on fire was launched. The Forest Service felt if they had the resources and funding they could have prevented the devastation. Prior to the Fires, the Forest Service had little funding and few employees. As a result the 10 AM Policy was instituted in 1935, mandating that all fires be suppressed by 10 am the day after the initial report. This resulted in a drastic reduction in annual acres burned through the 1980's.

In 1944, a fictional bear was adopted as a symbol for wildfire prevention (then referred to as forest fire prevention). While the message has changed over the years, Smokey Bear has been the most successful marketing campaign in US history. Fire had become the enemy and all fire was bad.

Over 100 years later, this fire suppression policy, coupled with increased human development in the WUI, and a warming and drying climate has created the perfect trifecta for catastrophic wildfires. The complexity of fire management increases drastically when people build homes and communities further and further into these forests.

1.6 Firefighter Deaths and Injuries

The rates of wildland firefighter fatalities in the line of duty are on the rise and suicide rates are steadily increasing, exceeding line of duty deaths at least twofold at the estimated rate of 25 to 30 deaths per year (DeGrosky, 2018). NWCG releases a periodic report on wildland firefighter fatalities in the United States. Recent data shows that heart attacks have now become the leading cause of death of wildland firefighters, over vehicle accidents and entrapments. A report produced by the U.S. Fire Administration for 2018 shows heart attacks as the leading cause of death of all firefighter deaths at 40% nationwide with an additional 5% attributed to stroke and heart failure (FEMA).

1.7 Purpose of Study

The purpose of this study is to evaluate contributing factors to wildland firefighter fatalities in the United States by first comparing trends and statistics in wildland firefighter deaths between the United States, Australia and Canada, and then narrowing down potential reasons fatalities are increasing. Heart attacks have become the number one cause of death in wildland fire, with volunteer firefighters having the highest rate of death. Since volunteer firefighters have the highest rate of death in wildland fire, it is imperative to evaluate wildfire in the WUI as a contributor, as well as cultural and organizational contributors. Wildfire is a dynamic and complex matrix of cultural, societal, social, political, and economic systems that often have conflicting objectives and has become a critical issue in the United States. We have to adopt an adaptive resilient approach to changing fire regimes as our current defense model is unsustainable. We have created our own worst scenario with

regard to wildfire risk that's creating a ticking time bomb toward catastrophic fatalities that will far surpass the Camp Fire.

When looking at existing data for wildland firefighter injuries and deaths in the United States, there are five different surveillance systems: United States Fire Administration (USFA), National Fire Protection Association (NFPA), NWCG - Safety Gram, and National Institute of Occupational Safety and Health (NIOSH), and Fire Fighter Fatality Investigation and Prevention Program (FFFIPP). Each system has different criteria for inclusion as they all have a different focus. Subsequently, they have different reporting procedures resulting in inconsistent frameworks for comparison (Butler et al, 2017). Standardizing case definitions would help provide the true occupational fatality rates and provide guidance for prevention strategies. Additionally, none of the existing surveillance systems have a mechanism to track chronic health impacts due to occupational exposure. Even though data is collected on firefighter injuries and deaths, data specific to wildland firefighters is usually combined with data for structure firefighters. Data usually only includes serious incidents and near misses. An example of inconsistency within a surveillance system is the NWCG reports released at 8, 9, or 10 year intervals. Data has to be converted to percentages based on the reporting period and can result in unequal comparisons over time. Injuries in particular are hard to quantify as they are often self-reported. If the firefighter works for a contract crew or is a volunteer, they may not even report an injury or illness due to exposure.

Chapter 2 Cross Comparison of the Causes of Wildland Firefighter Injuries and Fatalities in the United States, Australia, and Canada

2.1 Statistics and Trends

The United States has the most comprehensive wildland firefighter fatality reporting system of the three countries, however, injury reporting systems are sparse, incomplete and based off of various types of summary reports. HW Heinrich developed Heinrich's Law that essentially draws a pyramid of industrial workplace safety showing a few fatalities on top of a pyramid and then for every 29 serious injuries, there were over 300 minor injuries and near misses (SkyBrary).

The National Wildfire Coordinating Group (NWCG) releases a report every ten years on Wildland Firefighter Fatality Statistics. In the 2007-2016 report released December 2017, heart attacks have surpassed vehicle accidents as the primary cause of firefighter fatalities. The criteria for heart attacks or strokes was expanded from previous reports to include the Hometown Heroes Survivors' Benefit Act of 2003. By definition in this Act, a heart attack or stroke occurred in the line of duty if the firefighter became ill on duty or within 24 hours after engaging in the activity. Firefighters and emergency responders were also included if they engaged in any wildland fire activity: support, fire suppression, damage repair, fire rehabilitation work, mobilization status, demobilization status, training and work capacity tests. Vehicle accidents were included whether they occurred in agency owned vehicles or privately owned vehicles if the firefighter was responding to a wildland fire incident. The periods 2007-2016 and 1999-2006 showed a sharp increase in total firefighter deaths over the period 1990-1998 from 137-170, a 24% increase. When comparing firefighter fatalities from the previous reporting period, 1999-2006, heart attacks had dropped from 4.9 fatalities per year to 4.1 fatalities per year. One note in the report is if the new criteria for evaluation was excluded, the heart attack rate from 2007-2016 would have dropped to 3.2 fatalities per year. The report did not give the statistics if the criteria from the Act were applied to the 1999-2006 report. The rate of heart attack training or taking the work capacity test dropped from 11 firefighters to three. This has a positive correlation to the implementation of the health screening questionnaire.

The second leading cause of firefighter death in the United States is vehicle accidents, however the occurrence rate dropped from 5.8 to 3.4 fatalities per year between the two reporting periods for a 28% decrease in fatalities. The third leading cause of death, aircraft accidents dropped from 4.9 to 3.1 fatalities per year as well for a 15% decrease. Multiple fatality events account for 24% of the total fatalities. Entrapments are the fourth leading cause of death and dropped from 4.3 to 2.8 fatalities per year. Single fatality events have decreased by 75% from 16 to four over the recent reporting period.

Deaths from falling trees or rolling rocks for the period 2007-2016 equaled the combined total from the previous two reporting periods 1990-2006. Even though heart attacks are a medical cause, the high occurrence of them creates the need for a separate category. Other medical causes have a low occurrence are combined into one general category. Some of these deaths had an element of cardiac issues, but were not heart attacks. The numbers of these types of deaths is on the rise, however it is unclear if it due to an increase in occurrence, improvement in reporting criteria or better investigations. Any other death that occurs on a rare occasion is listed as miscellaneous and the rates vary between reporting periods.

Causes of deaths are typically tracked by individual deaths, however, these numbers can skew the data, impacting the areas focused on by fire managers during training, risk management and risk mitigation. If deaths are evaluated by number of events, the data reveals a different pattern. All causes of death increased, except entrapments that dropped to 12% to five percent, with heart attacks having the highest rise at 8%.

Volunteer firefighters have a higher frequency of mortality than any other group during the period 2007-2016, accounting for 22% of all deaths. Heart attacks were the number one cause of death accounting for 38% of volunteer firefighter deaths with 36% of heart attacks occurring in the 24 hours following the wildfire response.

Local firefighters had the same individual deaths as the volunteer firefighters from 2007-2016 at 38, however, 19 of those were a result of the Yarnell Hill Fire that killed 19 firefighters of the Granite Mountain Interagency Hotshot Crew. Comparing trends from city/county/rural resources is even more complex as many of these organizations are comprised of high percentage of volunteers. When comparing individual deaths, entrapments are 50% and heart attacks are 21% of the local firefighter deaths. If the deaths are compared as number of events, heart attacks rise to 40% of firefighter deaths and entrapments drop to 5%. Of those 40%, 38% were delayed heart attacks. If these multiple fatality incidents were compared as single events, city/county/rural firefighters would be the organization that has the highest death occurrences in wildland fire response.

The leading cause of firefighter deaths for state agencies is heart attacks. While fewer state firefighters have died in the reporting period 2007-2016 in comparison to volunteer and local firefighters, heart attacks remains at 38% of all deaths, followed by vehicle accidents at 21%. Heart attacks doubled from 1990-1998 to 1999-2006 and again 1999-2006 to 2007-2016.

Federal firefighters account for 18% of firefighter fatalities 2007-2016 and was lower than the 1999-2006 reporting period. The leading cause for federal firefighters was vehicle accidents followed by

falling trees or rolling rocks. Heart attacks account for 14% of federal firefighter death with four fatalities which was a decrease from six in the previous reporting period of 1999-2006.

Canada in contrast has more comprehensive long term monitoring, tracking fatalities from work related exposure. Their tracking system includes cancer and cardiovascular disease. Of the 1153 fatalities reported 2006-2015, 47% were attributed to cardiac events. Tracking long term health effects for volunteers in Canada is as difficult as it would be in the United States, should such surveillance systems exist (Ramsden et al, 2018).

Australia has a surveillance system that monitors all deaths related to wildfire, both civilian and firefighter making comparisons unequal. The surveillance system does break down fatality by activity at time of death (Haynes et al, 2010).

2.2 Personal Protective Equipment

When looking at all three countries standards for personal protective equipment, fire resistant clothing called nomex, hardhats leather gloves, and eye and ear protection are required and typically provided. Lug soled eight inch leather boots are also required in the United States, but not provided. Some agencies have a stipend to assist firefighters with the cost of boots, however, it rarely covers the cost of boots, either by amount or frequency of stipend. The main difference between the three countries is that, in the United States, wildland firefighters are required to carry a fire shelter with them at all times when away from their vehicle.

Fire shelters are not employed as personal protective equipment in Australia or Canada. In Australia, where fast moving bush fires are common, vehicles are armored against fire and become the fire shelter in the event of an entrapment situation. Australia also has a policy of leave or early or prepare to defend for homeowners. In Canada, indirect suppression tactics are utilized to keep firefighters out of areas that are steep, inaccessible or dangerous, focusing resources on communities with a technique called “point protection”.

2.3 Fitness Assessment

In the United States, NWCG has developed an initial fitness test for physical fitness called the work capacity test (WCT). The participant carries a 45 pound pack over a distance of three miles with little elevation change and must complete it in less than 45 minutes. It is considered a pass/fail arduous test and is required annually. Additional fitness assessments may be administered for qualification to be a Hotshot or Smokejumper. Federal, state, contractor, and military crews are required to pass this test, however, NWCG defers to city/county/rural and volunteer crew fitness standards as acceptable for wildland firefighting. Many of these crews have no minimum fitness standards and no medical

screenings beyond an initial screening upon employment. Regular fitness routines are not required by NWCG to maintain fitness standards and policies vary by organization. The United States Forest Service, for example, provides three to five hours of paid fitness time per week with group physical training encouraged. This helps develop crew cohesion, provides valuable training opportunities, as well as maintaining fitness levels that firefighting demands. Some agencies not only do not provide paid fitness time, they actually prohibit it, forcing firefighters to engage in fitness routines outside of work hours. One reason given is that the agency wants to avoid paying for injuries obtained during fitness activities. This self-directed system can put firefighters at risk for injury during firefighting activities such as hiking, hauling hose, and digging fireline. Another aspect of fitness requirements in the United States that often goes without consideration is that wildland fire is a seasonal profession and there are no programs in place to provide for year round fitness programs for returning firefighters.

The work capacity test in Australia is comparable to the United States. The participant carries 45 pounds for a distance of three miles. The main difference is that instead of a time limit of 45 minutes, there is a time range of 38-45 minutes. The more demanding hover and rappel positions have different requirements. The pack test must be completed in 38 to 42.5 minutes and a circuit must be successfully completed. The circuit test involves two components: lift and carry a 66.1 pound (30 kilogram) pack, five times over a distance of 49.2 feet (15 meters); and lift a 66.1 pound (30 kilogram) pack ten times to a height of 3.9 feet (1.2 meters).

Canada has a completely different fitness assessment than both the United States and Australia. The work capacity test is a four part timed circuit on a 131.2 ft. (40 m) course. The first part requires the participant to carry a 62.7 lb. (28.5 kg) simulation pump on their back for four laps, traversing a four ft. (1.22 m) high ramp with a 35 degree pitch every 65.6 ft. (20 m). The second part is to pick up the simulation pump from a 3.3 ft. (1 m) platform, carrying it for two laps without traversing the ramp. The third part consists of carrying a 55 lb. (25 kg) hose pack for 25 laps, traversing the ramp every 65.6 ft. (20 m). The final part requires the participant to drag a weighted sled for two laps on level ground to simulate advancing a charged hose.

2.4 Health Assessment

The United States has implemented a health screening questionnaire to screen for potential heart or lung issues requiring further evaluation by a medical professional prior to the work capacity test. If a firefighter answers “yes” to any of the questions, the firefighter must get a doctor’s approval before attempting the work capacity test.

The Department of Environment, Land, Water and Planning (DELWP) and Parks Victoria pays for a pre-employment that consists hearing, vision, lung function and range of motion tests.

Canada does not have a pre-employment health screening process, relying mainly on the fitness assessment as the standard measure.

2.5 Conclusion

Comparing wildland firefighter injuries and deaths between the United States, Australia and Canada is not possible due to organizational structure and surveillance systems as well as a lack of literature. Qualitative conclusions can be drawn between the rise or fall of injuries and deaths within each country's surveillance system. That conclusion is that both wildland firefighter and civilian deaths are on the rise, rates of cancer and chronic diseases are on the rise and rates of post-traumatic stress disorder (PTSD) and suicide are rising faster than all the other causes of death combined.

Chapter 3 Analysis of Factors Leading to Wildland Firefighter Deaths in the United States

3.1 Wildland Urban Interface/Intermix Contributors

3.1.1 Trends

The difference between an interface and an intermix is the percent cover of wildland vegetation. The interface has less than 50% wildland vegetation cover and an intermix has greater than 50% wildland vegetation cover (Martinuzzi et al, 2015). Wildfires have almost a willful disregard for ownership boundaries on the landscape. While the number of fires across the United States are decreasing annually, there is an increase in the burned acreage. The rate of urbanization in the wildland is unprecedented in modern times, leaving urban planners scrambling to adapt to this disturbance on the landscape and provide for both the environment and public safety. Wildfires that used to occur in wildland vegetation are now occurring in urban developments that have inundated the landscape. Homes built in, and among, the undeveloped forest redefine the land use. The WUI is the fastest growing segment of urban development. The most recent data on growth trends in the WUI is from 1990-2010 shows more than half of all new houses were built there (Ali, 2019). Current estimates say that the WUI is 10% of the land area in the United States, yet 60% of it has yet to be developed. Experts believe the growth is not going to slow down for the foreseeable future. Traditional methods for urban planning were not well organized or regulated and demand has dictated infrastructure expansion beyond existing capabilities, i.e. emergency response, utilities, communications. In California over at least 15% of wildfires are attributed to powerlines with many fires not having a determination of cause. Many communities have limited ingress and egress for emergencies. . Urban development. Typically urban areas are associated with high housing density, however, every new urban area starts as the WUI. This rapid growth has resulted in a rapid deterioration of the ecosystem and lower biodiversity consequently resulting in an anthropogenic fire regime. A fire regime is the overall variability of fire, characterized by attributes of all the patches of burned area within a particular landscape (usually thousands of hectares) over a particular time period (usually several hundred years or more) (Baker, 2009). This is not a result of fires occurring in different locations, but rather a result of the human expansion into the wildland vegetation. Farmers are selling their land and developers are buying acreage in the forest to subdivide it into smaller parcels from one to 20 acres. Developers are building housing developments in rural areas, most without regard to fire mitigation. Current building codes in most states, except California (III, 2019), do not require special building materials or considerations to prepare the community for the inevitable wildfire. Statistics from the Camp Fire show that 51% of homes built with updated building codes survived the fire, while 18% of

homes without the updated building codes survived. Communities in fire dominated landscapes are at a greater risk for experiencing wildfire and now the landscape has dangerous amounts of fuel in the form of structures. Some of these communities are built with a high density resulting in other homes lying within the home ignition zone. More and more people are moving to rural areas searching for privacy, nature and a slower pace compared to living in urban areas, yet have no experience with land management and can quickly get overwhelmed with the maintaining their property at a level needed to reduce their risk to home loss from wildfire. There is no consistent public education messaging. Many local fire districts rely on volunteers and budgets do not support training and education on fire prevention and mitigation measures. Local and state agencies often have budget shortfalls with researchers and specialists being considered nonessential. This leads to the perpetuation of poor decision making by leaders with little training and knowledge, inhibiting change. Many communities are now participating in the FireWise USA program designed to assist small landowners with reducing fuels and improving forest health on their land. Usually it is a one-time financial reimbursement, not designed for routine maintenance. Trees, shrubs and forbs continually grow and shed material that can build up quickly on the landscape if there is a slow rate of decomposition.

Local fire districts have limited protection areas meaning that a landowner is potentially not protected. If a wildfire occurs on their property, the fire district is not obligated to respond as it lies outside their jurisdiction, however they will often respond when a “closest forces” agreement exists between agencies. Typically, that means that it would be under the state’s jurisdiction, but as state agencies have limited resources, response time can be lengthy. In Eastern Washington, for instance, there is a mutual aid agreement between federal, state and local agencies that includes a closest forces agreement. That allows the nearest resource to respond to a fire regardless of the jurisdictional ownership. The responding agency is responsible for suppression costs for the first operational period, regardless of jurisdiction. The increased occurrence of wildfire in the WUI has increased the complexity of wildfires, creating the need in some areas to have localized firefighting teams on standby that have the capacity to manage these higher complexity fires. These teams are often interagency and comprised of a variety of federal, state, and local resources. One comment often heard is that the Type 3 fires today would have been at least Type 2 fires 20 years ago. The Interagency Standards for Fire and Fire Aviation Operations or “Red Book” has guidelines that determine a fire’s complexity by evaluating not only the size of the fire and fuel type but also how many and what type of resources are assigned (NIFC, 2019). It’s been shown that a person can only effectively manage 3-5 tasks at a time. In wildland fire this is referred to as span of control. The least complex fires are classified as Type 5 fires and the most complex of fires are classified as Type 1 fires. While acreage burnt is considered when evaluating the complexity, it is only one of several

factors in determining complexity. If relationships between local agencies are strong, then complexity defined by the Red Book may be adjusted downward.

3.2 Organizational Contributors

In the United States, the wildland fire service is comprised of many agencies from federal agencies all the way down to local volunteer rural fire districts. The mission of the National Wildfire Coordinating Group (NWCG) is: to enable interoperable wildland fire operations among federal, state, local, tribal and territorial partners. NWCG works to establish national wildland fire operations standards as well as establishing training requirements and standards. Wildland firefighters are classified in seven categories by NWCG “Safety Grams”. These include data on all fatalities and life threatening incidents associated with wildfire events. The categories are federal, state, city/county/rural (local), volunteer, ground contractors, aviation contractors, and military personnel.

People who engage in wildland fire suppression have different primary roles. Federal agencies such as the USFS primarily train firefighters for wildfire suppression and yet they are classified as forestry technicians, not wildland firefighters. State agencies are beginning to adapt organizational structure to classify wildfire suppression as a separate function within the agency, however, many state agencies like the federal agencies, only employ firefighters approximately six months per year. Washington restructured its workforce to have Wildland Fire as a separate Division resulting in reclassifying all firefighters in 2019 as Wildland Firefighters from Natural Resource Specialists. Also, due to additional funding, began hiring year round engine leads that can assist for forest health projects in the off season. Local fire districts are primarily trained as structure firefighters, but with the increased frequency of fire in the WUI, they are often the first responders on scene so are integrating more into wildland fire operations, training and planning. An increased reliance on these local firefighters, many often volunteer, has led to more pressure for local firefighters to obtain wildland fire qualifications. As was mentioned earlier, local districts have had reduced numbers of volunteers and their volunteer workforce is getting older, especially in rural areas. The demographic of rural fire districts is generally older, overweight and out of shape. Retirees seem to have more time to volunteer, especially in a society where younger people generally need more than one income to make ends meet. Volunteer rates in the United States increased drastically after the events on 9/11, then dropped off gradually finally dropping sharply after the stock market crash of 2008 resulting in massive job losses. The volunteer rates have not recovered. Volunteer rates in Australia have dropped off in recent years as well with similar economic drivers (McLennan, 2008). The sense of civic duty seems consistent across all age groups refuting the idea that younger generations are more selfish. The goal of keeping fires smaller becomes more difficult when there are less rural volunteers. There

is an alarming trend with this group also experiencing the highest rate of death. Since wildland firefighting is a physically demanding job, it is possible that the requirements exceed the physical capabilities of the individual firefighter.

NWCG classes are required to obtain wildland fire qualifications, and classes such as S-230 - Crew Boss, touch on wildfire in the WUI, but the main focus is point protection, and examples include structures that are spaced a good distance apart. Point protection is protecting a value at risk, such as a structure without engaging with the fire directly. It seems assumed that Forestry Technicians will instinctively know how to account for the increased fuel loading and potential fire behavior imposed by structures intermingled on the landscape.

The wildland fire operational structure was adapted from the military structure. In an organizational capacity, it is essentially an unofficial branch of the military. Yet, the infrastructure for employee safety, health, financial, career development is patchy and often non-existent. Once a service member separates from the military, they are considered a military veteran. If they have mental or physical impacts related to their service, they have access to services through Veterans Affairs (VA). Once a wildland firefighter separates from the fire service, there are no additional services available.

The longer fire seasons and more complex fires have led to an overburden on local resource capacity, leading many communities scrambling to find solutions to this widening gulf of infrastructure. Some federal agency hiring channels have gotten so dysfunctional by centralizing hiring for the entire country, yet not having the resources to accomplish the large amount of human resources tasks required to employ an army of seasonal employees that crews are left shorthanded. Job announcements for seasonal positions are now being advertised almost a full year in advance, with limited timeframes that applications are being accepted. The expectation that people will apply for a 6 month seasonal position almost a year in advance for a salary that is hardly above minimum wage in some states, is ludicrous. It also overlooks a significant portion of the population yet to even realize what their job plan are the following year – high school students entering their senior year. The ability to advance positions and thus earn more money and make firefighting a career by eventually earning the coveted permanent position, is severely hampered by the qualifications required to apply for the next level. It is not unreasonable for it to take five years to obtain status as a Firefighter Type 1 (FFT1) which is required to qualify at a GS-5 level. In 2019 a GS-5 paid \$16.27-\$19.74 an hour depending on locality pay. As a firefighter makes their way up in the organizations, fewer and fewer positions are available and become very competitive. This all has resulted in a low retention rate for those pursuing a long term career, costing agencies more money to constantly retrain personnel. Wildland fire suppression is not structured as a career path, except for those with the most grit and

determination to work seasonally for up to 10 years. The hiring process has gotten so disconnected with local fire managers that they often have limited input. People often sound apologetic that they have been wildland firefighters their whole career as if it is something to be ashamed of. The divorce rate of wildland firefighters is on the rise, suicide is on the rise, and sacrifices are often priceless. Next to the military (although inherently more dangerous, does have a structured career path), wildland firefighters are the epitome of service before self.

Now the demands of the job are increasing and becoming more complex and inherently dangerous. Yet the culture seems to be regressing instead of advancing.

3.3 Cultural Contributors

As people expand into the WUI at an unprecedented rate, public perception and expectation is trying to apply urban development strategies to the WUI. The common perception is that these manmade values introduced on the landscape be protected from wildfire at all costs, in spite of the escalating costs and increased risk for firefighters. The costs of fighting wildfire in the WUI and protecting private property has largely been externalized on the nation through taxes and the unrestricted expansion into the WUI. This essentially is an incentive to continue making poor decisions. It is perpetuating the problem. Economists call this a “moral hazard” (Reilly, 2015). This expectation has permeated down to those fighting the fires and created a culture of rewarding risk taking. Fire was on the landscape long before European settlement and, as a society, we are delusional if we think we can eliminate fire from the landscape. The only approach that will bring success is learning to live with fire on the landscape by understanding the role of fire on the landscape. Some species of plants and animals actually rely on fire for survival. Smokey Bear created a paradigm shift, but it took over a generation because the campaign created a paradigm shift by educating the public through the children. Similarly, a paradigm shift is again needed to educate the public on how to live with the fire. Fire cannot be extirpated; it will happen. The question is when, where and how severe? We must learn to live with smoke, but we can choose when and how much there is, as well as where it goes. Wildfire is considered by many to be a natural disaster, much like hurricanes, floods, and earthquakes. The only difference is that we can manage, manipulate and even create fire. We can't fight a hurricane with a hurricane, or a flood with a flood, but we can fight fire with fire. Prescribed fire in various severities, a mosaic, mimics the natural fire regime. In some areas up to 90% of wildfires are human caused through negligence or noncompliance with fire restrictions and burning regulations. Unfortunately, many regulations use confusing language and difficult to understand by the general public. These human caused fires are not occurring as much in the wildland as they are in the WUI, often on the undeveloped portion of private property or along highways. Simplifying

information and disseminating broadly to the public is an easy step to education. Increasing educational programs at schools is a long term investment to create a culture of change toward wildfire. Unfortunately, many fire prevention programs have all but disappeared, other than local fire district engagement with the public about both structural and wildland fire. Media coverage during fire season is nonstop and is the ideal opportunity for fire information personnel to disseminate fire prevention messages including simplified fire restrictions. Social media is another platform for information dissemination, however, some agencies have strict policies that prevent the type of localized, candid messaging needed to reach the communities.

There is no nationally standardized classification, surveillance or training system for wildland firefighters. The closest and most common classification and surveillance system utilized to track trends and statistics is primarily for federal agency employees. These systems have wide gaps in metrics that provide an inaccurate account of the state of the wildland fire service.

3.4 Human Contributors

3.4.1 Physical Demands

It can be said that the arduous work conditions fighting fire require firefighters to train at the level of a tactical athlete. NWCG defines arduous work as “duties involve field work requiring physical performance calling for above average endurance and superior conditioning. These duties may include an occasional demand for extraordinarily strenuous activities in emergencies under adverse environmental conditions and over extended periods of time. Requirements include running, walking, climbing, jumping, twisting, bending, and lifting more than 50 pounds; the pace of work typically is set by the emergency condition.”

3.4.2 Body Composition

Since heart attacks are now the leading cause of death in firefighters, body composition, sleep, fatigue nutrition, hydration as well as smoke exposure are important considerations. Excess body fat is known to cause or exacerbate acute and chronic health conditions. While there is no data to separate structure from wildland firefighters, it is an alarming statistic that 79% of career (urban and wildland) firefighters are classified as overweight or obese (Poston et al, 2011). Depending on the surveillance system used, heart attacks account for 19.8 to 24.2% of deaths for the period 2001 to 2012 (Butler et al, 2017)

3.4.3 Sleep

Sleep disturbances, either from inadequacy or disruption, are correlated with cardiovascular diseases as well accidents and injuries. According to the Center for Disease Control (CDC), average adults

need 7 to 9 hours of sleep per night to operate at optimum effectiveness (Collins, 2019). In contrast, wildland firefighters have reported getting less than six hours of sleep while on a fire assignment (Collins, 2019) with work days ranging from 8 to 16 hours and assignments lasting up to 21 days. Lack of sleep has been shown to reduce cognitive function and place individuals at higher risk for injury. Sleep deprivation quickly affects endocrine function and metabolic function, both increasing the risk of obesity (Collins, 2019).

A study by the Center for Sleep Research at the University of South Australia showed that after 17 hours of work, driving performance is the equivalent to having a blood alcohol content of 0.05%. Working 24 hours continuously without sleep resulted in the equivalency of a blood alcohol content of 0.10%. An interesting finding is that the participants were unaware of the affect that the lack of sleep had on their performance (Aisbett, 2012). The same study found that Australian wildland firefighters were averaging three to six hours of sleep per night on multi-day incidents.

A USFS Health and Safety Report found that wildland firefighters self-reported averaging 6.1 hours of sleep at fire camp, ranging from 3.5 to 9 hours. They reported waking up zero to six times per night and average sleep quality on a 10-point scale was reported at 6.6. Of those surveyed, less than 25% felt rested or well rested in the morning.

3.5 Conclusion

There is a “one size fits all” mentality with regards to fitness, nutrition, performance and role within wildland fire leading to a huge disparity in reporting systems and standards. There is a subtle cultural pressure for wildland firefighters to risk their lives to save structures, despite the official stance from the upper most leadership down to the general public that safety is paramount. Wildland firefighters are regarded as heroes in a war on fire that is occurring in our backyards.

Chapter 4 Recommendations and Conclusion

4.1 Overview

When this study began, common influencing factors were thought to be driving wildland firefighter fatalities. Factors such as longer fire seasons causing increased exposure to hazardous conditions and smoke, increasing drought, increased fuel loading, and human factors such as fatigue, fitness, and body composition. What is known is that catastrophic wildfires are on the rise, populations are increasing, the wildland is being urbanized at a faster rate than ever before, and wildland firefighter fatalities are on the rise with heart attacks overtaking vehicle accidents as the most common cause. When looking at the demographics associated with these deaths, volunteer firefighters not only have the highest incidence of heart attacks, they also have the highest rates of deaths overall. This is particularly alarming because these statistics carry over to structural firefighting as well (NFPA, 2019). While there are no statistics available delineating deaths between the WUI and undeveloped forests, volunteers primarily work for rural fire districts that operate as an all hazard resource, meaning they are highly unlikely to be fighting fire on undeveloped forest land. What factors within the WUI are contributing to an increase in deaths?

While the factors mentioned earlier do contribute to elevated risks for wildland firefighters during suppression activities, the increased death rate is indicative of the overall wildland fire issue in the United States. This issue encompasses organizational, preventative, social, cultural, and political systems as well as externalities such as climate change. Urbanizing the wildland has changed the fire regime, interrupting natural ecosystem processes as well as reducing biodiversity. This expansion has resulted in increased ignitions on landscapes that have been artificially manipulated without regard for these natural processes and has become the single greatest risk for catastrophic wildfire in the United States. The development in the WUI is not projected to slow down over the next 20 years.

There is an urgent call to action to reverse the accrual of ineffective management decisions spanning over 100 years coupled with urban planning inefficiencies. Each year destructive fires are more prevalent, with financial losses rising exponentially and the emerging incidence of civilian deaths. The current tactic of structure defense is unsustainable. Learning to live with fire is the only option to mitigate the risks of building communities in fire dominated landscapes before the cumulative effects of ineffective management result in catastrophic loss of life.

What can be done to effectively learn to live with fire? The current wildfire issues were not created by one misguided policy or one agency's management approach or even climate change. It is a result

of a culmination of factors. If development in the WUI continues to occur with the same variables on the same trajectory, we can expect to experience more catastrophic fires, urban conflagrations, and loss of life. A paradigm shift will require all groups of stakeholders to take action on a local and landscape level. Homeowners have an obligation to build with fire-resistant materials and coatings, remove fuel sources in the home ignition zone and reduce fuels out to 200 feet to reduce risk, reduce fuel loading and height and thus reduce risk. Communities have the biggest obligation as they are able to unite homeowners and public land managers to collaborate and partner together to implement fuels reduction projects. Periodic prescribed fire surrounding individual communities should be utilized to reduce surface fuels. Insurance companies can incentivize such efforts for individual homeowners/small landowners as well as communities.

4.2 Financial

As local fire districts face shortfalls in budgets and volunteers, yet responding to more wildland fire calls through mutual aid, state agencies should increase funding to districts. In addition, more extensive education and training on fire prevention and mitigation needs to occur on a local level for easy public education and awareness.

4.3 Organizational

The United States needs to develop a universal surveillance program for wildland firefighter demographics, injuries, fatalities, and long term exposure monitoring program in addition to suicide prevention support programs. The wildland fire service operates organizationally much like a branch of the military, yet has no standardized human resource infrastructure. When a military servicemember leaves the military, the title of “Veteran” is applied for life. It brings with it certain benefits and services to account for the hardships and sacrifices endured. When a wildland firefighter leaves the fire service after one year or 30 years, it is almost as if they never existed. Long term monitoring and surveillance becomes impossible. Part of this organizational adaptation needs to include standardizing the job title as wildland firefighter. Without sufficient surveillance programs that cover all federal, state, tribal, local and contract firefighters, it is impossible to obtain accurate data to use in improving workplace safety. Additionally, wildland firefighters should have a predefined career path built off of advancement with salary directly correlating with risk. If a wildland firefighter was paid at fair wage with regard to level of risk and work days were shortened, performance would increase and injuries would decrease, reducing risk of fatal incidents.

4.4 WUI Paradigm Shift

Changes need to be made with respect to allowing unregulated growth in the WUI. Putting a moratorium on building adjacent to public land until fuel reduction projects can be implemented is a simple way to address the issue of unhealthy forest lands from a community perspective, in conjunction with federal and state land management agencies completing projects. Another short term solution would be to limit building in fire prone areas, predesignated based on fire history, much like a 100 year flood plain. Also, the moral hazard can be reduced by shifting the burden of fire suppression to the residents of the WUI, either through privatizing fire protection, raising taxes or the creation of a new type of insurance program specific to wildfire, National Wildfire Insurance Program (NWIP) (Reilly, 2015).

Conclusion

Wildland firefighter fatalities are not caused by one single factor. Catastrophic fires are on the rise, civilian and firefighter deaths are on the rise, particularly volunteer firefighters. The WUI is growing at a faster pace than ever recorded and suppression and economic costs are skyrocketing. There is not one contributing factor, thus there is not one solution. Also, a solution is not a onetime occurrence. We must become adaptively resilient, living with fire on the landscape. We cannot extirpate wildfire, however we can learn to use it to our benefit through the use of increased prescribed fire to reduce fuel loading from dead and down woody debris, also reducing insect populations and the spread of diseases. We need to acknowledge the commitment and sacrifice wildland firefighters make in an effort to save our livelihoods. Livelihoods many of us have chosen to build in well documented fire prone areas. Better surveillance systems are needed to track statistics and implement better strategies and technologies. A universal human resource program with standardized job titles, a well-defined career path designed for retention and promotion and health and wellness programs is needed. The data surrounding the effects of poor nutrition, inconsistent fitness programs, insufficient sleep, and arduous working conditions points to a long term effect on today's firefighters. Wildland firefighting is becoming increasingly dangerous and overly demanding resulting in an alarming rate of suicide. There is no top-down or bottom-up approach to this issue. As a society, through poor management decisions, poor policy making, and insufficient knowledge on the environment we are living in, we have created our own worst case scenario, a ticking time bomb, that's showing itself through statistics. It will take each and every one of us at every level to collaborate, and implement innovative and adaptive solutions.

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