Managing Fire, Understanding Ourselves:

Human Dimensions in Safety and Wildland Fire

13TH INTERNATIONAL WILDLAND FIRE SAFETY SUMMIT
& 4TH HUMAN DIMENSIONS OF WILDLAND FIRE

BOISE, IDAHO, USA • APRIL 20-24-2015 • #IAWFCon15

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INTRODUCTION TO THE PROCEEDINGS OF THE 13TH INTERNATIONAL WILDLAND FIRE SAFETY SUMMIT & 4TH HUMAN DIMENSIONS OF WILDLAND FIRE

Wildland fire management has risen to the forefront of land management and now receives greater social and political attention than ever before. As we progress through the 21st century, these areas of attention are continually presenting challenges never experienced before.

We may consider ourselves well positioned to move into the future. Our knowledge of many areas of fire management pertaining to the physical fire environment, ecological interactions, science and technology, and management strategies and tactics has never been greater. But, an improved understanding of human behavior - at individual, group and organizational levels – is vital to making fire management safer, more active, progressive, and adaptable. This is a far-reaching topical area that includes, but is not limited to, firefighter and public safety, best practices in safety training and operations, safety related research, new approaches to safety, fire response, safety issues in wildland urban interfaces, training, equipment and technology, risk assessment, risk informed decision-making, high reliability organizations, sense-making, shared responsibility, preparedness, organizational discipline, organizational performance, organizational breakdown, decision making, communications, resilience, risk, decision support, community and homeowner fire protection and hazard mitigation, fire education, and social, economic, and political effects of fires. Each year's fire seasons around the world reinforce that we have much to respond to and to learn in these areas.

The International Association of Wildland Fire (IAWF) is extremely proud to present the 13th Fire Safety Summit and the 4th Human Dimensions in Wildland Fire Conferences this year together for the first time. The IAWF recognizes the importance for both these areas to wildland fire management and the challenge for interested individuals to attend two separate venues. As a result, we feel that a combined single conference will afford the maximum benefits of a substantially elevated conference program during a single event.

This conference is designed to be innovative, revolutionary, and not focused only on a single component, but rather on the many aspects of human behavior and safety in wildland fire management. The conference will bring together at one time the significant body of knowledge about these program concerns. It will provide a forum for discussion, a stage where workshops, oral presentations, poster paper presentations, special sessions, workshops, and plenary presentations by leading experts in the field can facilitate the sharing of what is known, what needs to be learned, what lies ahead, how to advance knowledge, and how to use this knowledge to effectively respond to increasing concerns. During this conference you will be able to explore ways to expand collaborations, gain new knowledge, discuss the latest relevant research findings, learn about and from management treatments, engage in policy discussions, and conduct global fire management interaction.

On behalf of the International Association of Wildland Fire, all conference sponsors and partners, I welcome all participants and hope that this conference will meet, and even exceed your expectations of increasing awareness, knowledge, and capability in this important field in addition to networking with peers to establish future avenues of discovery. We hope that you will enjoy attending and gain significant information from what promises to be the most informative, enlightening, and powerful conference to date on safety and human dimensions in wildland fire management.

If you were not previously a member of the IAWF, you are receiving a one-year membership in the association included in your registration. By participating as an active IAWF member you can help to improve communication between firefighting organizations, enhance firefighter and public safety, increase our understanding of wildland fire science, and improve our ability to manage fire. Your membership in the IAWF provides you with a connection to other wildland fire professionals from across the world.

Our membership, which is truly international, includes Professionals from the fields of fire ecology, suppression, planning, contracting, fire use, research, and prescribed fire. Our members are scientists, firefighters, mangers, contractors, and policy makers. As an association, we are unique in that we represent all areas of wildland fire management.

On behalf of the Board of Directors of On behalf of the Board of Directors of the IAWF, thank you for your support of our association. *Thomas Zimmerman*

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A special thank you to the conference planning committee who worked hard to pull together a very successful event:

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ABOUT IAWF

The International Association of Wildland Fire (IAWF) is a non-profit, professional association representing members of the global wildland fire community. The purpose of the association is to facilitate communication and provide leadership for the wildland fire community.

The IAWF is uniquely positioned as an independent organization whose membership includes experts in all aspects of wildland fire management. IAWF's independence and breadth of global membership expertise allows it to offer a neutral forum for the consideration of important and at times controversial, wildland fire issues. Our unique membership base and organizational structure allow the IAWF to creatively apply a full range of wildland fire knowledge to accomplishing its stated mission.

Vision: To be an acknowledged resource, from the local to global scale, of scientific and technical knowledge, education, networking and professional development that is depended on by members and partners in the international wildland fire community.

INTERNATIONAL JOURNAL OF WILDLAND FIRE

Our official fire science journal, published on our behalf by CSIRO, is dedicated to the advancement of basic and applied research covering wildland fire. IAWF members have access to this leading scientific journal online, as a members benefit. For those members who want to receive the hard copy version of the journal, they may receive it at the IAWF discounted rate of US $220, which includes your IAWF membership and a 1-year subscription to WILDFIRE.

WILDFIRE MAGAZINE

All IAWF members receive WILDFIRE magazine, official publication of the IAWF. Our authors submit fire articles from all corners of the world and our topical editors cover a broad array of important issues in wildland fire. We encourage you to submit articles and photographs for inclusion in the magazine. Visit www.wildfiremagazine.org for more information such as Writer's Guidelines.

There are so many reasons to become a member of the International Association of Wildland Fire but most importantly, the opportunity to be a member of a professional association that is committed to facilitating communication and providing leadership for the wildland fire community. Join today at www.iawfonline.org.

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Historical wildfire characterization and clustering

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Abstract:

Public outreach, planning, and training benefit from the innovative use of historical wildfire behavior datasets and real-time interaction with wildfire models. Quantitative analysis of historical wildfire records are used to derive empirical characterizations that can contribute to understanding the nature of wildfire events. Similar previous fire events can be recalled during fire situation assessment, in both training and operational modes, to provide qualitative guidance on possible fire behaviors. In addition to representations of basic data, semi-empirical fire progression spatial models are used to provide a continuous fire progression conditional on historical perimeters, and then further to infer rate of spread at sites in the domain. Analysis methods including machine learning, spatial modeling, and clustering provide the means to recall from the historical database by example.

Additional keywords: wildfire historical analysis, wildfire quantitative analysis

Introduction

The study of wildfires and the construction of wildfire models hinges on the study of historical datasets. The quantitative analysis of structured digital datasets can be used to construct semi-empirical computer models, such as those used in this analysis. The goal for these systems is to provide real-time and interactive modes of exploration of fire behavior, for training, outreach, and wildfire event scenario analysis; that is, response and policy analysis rather than scientific study. In modeling real fires, the fidelity and quality of available initial and boundary conditions (for example, pre-fire fuel state and weather conditions) do not support high fidelity predictions, and so unfolding events will be best served by leveraging simpler models that are more amenable to tuning to empirical observations. This paper outlines SimTable's methodology for clustering historical progression rates to partially inform the tuning of its fire simulation models.

The next section discusses basic data available for wildfires for this work, as well as some of the possible derived datasets including imputed rate. Next, examples are given showing how these data sources can be used to compose characteristic statistics, or fingerprints, of a wildfire. Then we show how constructed features can be used as a quantitative distance, allowing clustering of similar wildfires and recall of similar wildfires from the database from a given example. We conclude with discussion of potential and future work.

Wildfire data and derived data

In order to support wildfire historical and situation analysis, SimTable has collected a repository of standardized datasets corresponding, currently, to fires from 2012-present (SimTable). The information includes consistent image registered elevation, fuel type, and fire perimeters. All of these data can be used to construct statistics that will characterize aspects of a wildfire. Examples of these are shown in Fig. 1. Perimeters are vector representations in the KML format. Elevation and fuel are interpolated onto a standard grid size (e.g., 512 by 512), where the grid spacing is set at a scale so that the outer perimeter of the fire fills the frame. Thus the grid spacing varies between fires. We have found that the perimeter data requires filtering to be sensible monotonic progressions over time.

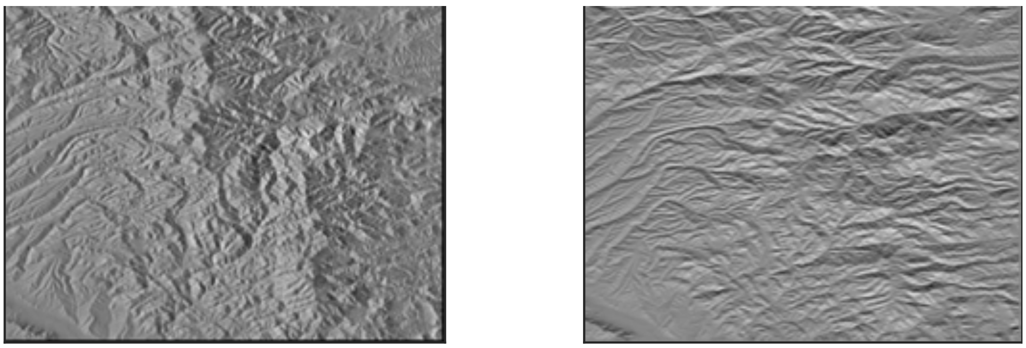
Fig. 1. Data related to the Silver fire. On the left is the elevation; in the center is the fuel map, and the right panel shows the available fire perimeters, with areas color coded by the time of the next enclosing perimeter.

Information sources that could be very useful but are not readily available include local wind fields, precipitation fields, detailed fuel moisture, local temperature and insolation, and records of details of interventions (the activities taken to mitigate the fire, such as brush cutting, air drops of water and fire retardant, etc.). Finally, potentially important additional data that may not be easily available in the standardized imagery and mapping products are the location and significance of small bodies of water (streams, rivers) and a physical description of roads (e.g., width and shoulder clearing). These features may have significant effects on fires in themselves, and in addition form natural lines of defense for interdictions. One outcome of data analysis can be the assessment of the potential impact of additional data sources, and how they may clarify specific questions and decisions.

From these basic data, derived data have been constructed. Applying a Sobel filter to elevation data gives an estimate of the slope vector, as shown in Fig. 2. The slope computed is the mean elevation change between the sites in the analysis grid, which is interpolated from available 10m elevation datasets. Since slope is a vector quantity, two images are shown for the Northward and Eastward components of the vector, with magnitude of the vector components in grayscale.

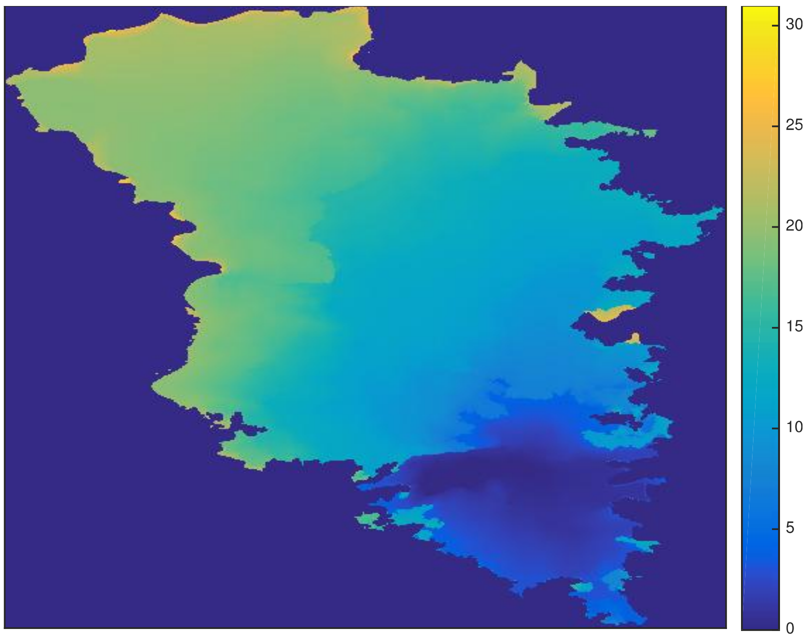
These can be potentially used as a single magnitude scalar value, or combined with other (e.g., rate) vector quantities.

Fig. 2. Slope data for the silver fire. Show here is the magnitude of the Eastward component of the slope vector on left, and the Northward component on the right.



The progression perimeters are the most direct observations of the fire behavior itself, although they actually are data products estimated from the direct observations of infrared imagery. It is highly desirable to have the progression as a time of fire arrival at each site. This is necessarily a model-based estimate. We describe the basic model in terms of diffusion, although it is also consistent with the concepts of kernel smoothing, for example (Diggle 1985). An observed perimeter is laid out on a grid, matching the grid established for the fire dataset. Starting from a current perimeter and the next future perimeter projected onto the grid, the progression diffuses out to neighboring cells, maintaining a propagation increment for each cell, until all grid cells between the perimeters are populated. The cell increment is then scaled to an appropriate time value consistent with the perimeter times. This method is not expected to deliver physically plausible fire behavior at a fine scale, but is a deterministic summary method that yields a useful interpolation between perimeters. A fire progression using this method is shown in **Error! Reference source not found.**.

Fig. 3. The fire continuous progression as interpolated by the diffusion method. Color represents seconds after the initial progression.

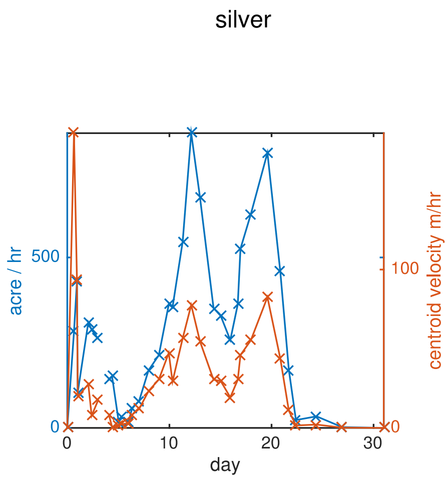


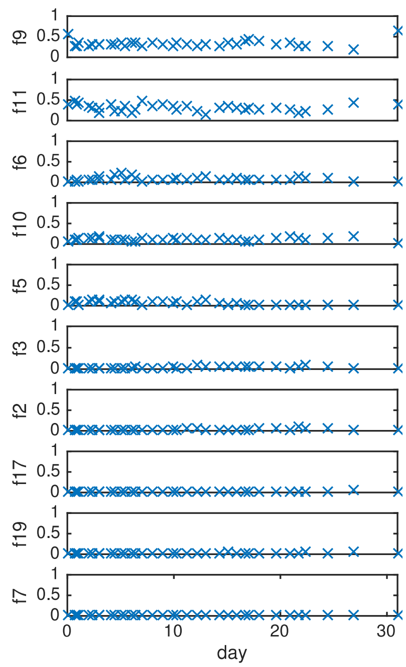
Wildfire empirical characterization

Our goal is to consider the relationships between the wildfire data; to investigate whether there are systematic patterns that can be exploited to group fires. All examples in this section continue to use the Silver fire as an example. A summary view of fire characteristics vs. time is shown in Fig. 4. This uses only the wildfire progression perimeters and perimeter area at observed perimeters, rather than progression approximation. The intent here is to examine characteristics of the area burned between perimeter observations. The top plot shows two traces. In blue are the acres per hour burned, while orange shows the centroid velocity. Centroid velocity is the change in location of the geometric center of the cumulative fire area, divided by the time between increments. The right plots show proportion, of each of the top 10 fuels in the fire, burned in each perimeter increment.

Fig. 4. Silver fire characterization plot, by observed perimeter increment. The x-axis in all panels is days into the fire. The left plot shows two traces; blue is the acres per hour burned, while

brown shows centroid velocity. The right plots show proportion of each of the top 10 fuels burned at each perimeter increment.

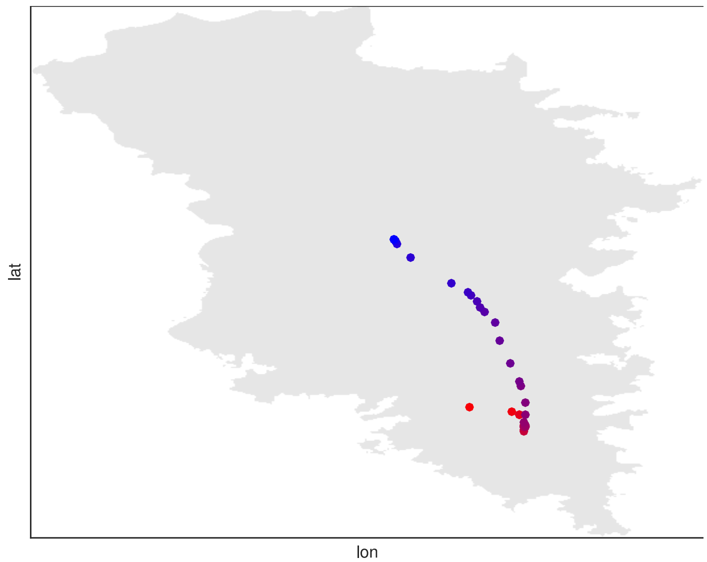




This plot shows three main things. First, the fire has three distinct phases of growth separated by relatively quiescent periods. Second, the fire is dominated by fuel types 6, 9, and 11. Fuels are the 13 fuel model of Anderson and Albini, but could equally well be the Scot and Burgan 40 Fuel Model (Scott and Burgan 2005). Although the composition of fuels changes through the fire, the fuel in this fire does not appear correlated with the fire time or rate. Third, there is a very strong correlation between fire spread, and the centroid velocity. This shows that the fire spread rate is not random with respect to the fire's location, but rather the spread changes the location very predictably. This suggests that the fire's progression is driven not as a general spread, but rather guided by some boundary condition. We have (qualitatively) eliminated fuel as the driver of this bias, and there is not significant consistent elevation increase in the direction of the centroid movement, leaving likely candidates of elevation change, or wind.

As an additional validation, the fire centroid movement is shown in Fig. 5. It is clear that, after the initial outbreak, the fire was systematically driven toward the North and Northwest.

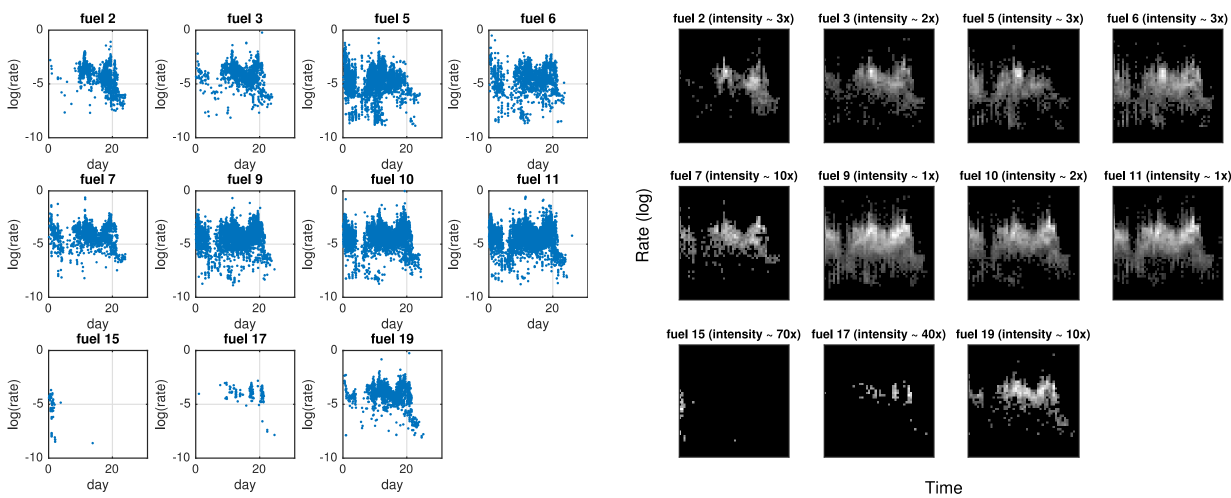
Fig. 5. Silver fire centroid movement. The color per perimeter index changes from red to blue over the wildfire perimeter times.



More detailed information is desired for rate, but inducing a rate at each site has considerations that should be noted. Fire physical spread is a complex process of ignition of fuel elements, burning of those elements, and consequent ignition of neighboring fuel elements. Analysis supported by models that can represent this sort of behavior accurately is a research issue in high-performance computation. Pragmatically, fire propagation is often conceived of in terms of emergent features: the fire front, the direction of travel of the front, and a continuous concept of fire spread. We pursue modeling consistent with this level of analysis, which is how we define semi-empirical models: non-physically based models of emergent properties that can be constrained to fit observations. The diffusion fill is a good method for visualization of fire progression, and can be used further for the derivation of fire rate information, recognizing the limitations of this model. The diffusion model produces a fire arrival time at each site in the analysis domain, but this does not directly yield rate of spread. After much reflection on the proper use of the semi-empirical diffusion model and its results, and analysis of alternative formulations, we have arrived at method for calculating rate of spread at each site according to these principles: 1) The vector direction of the fire front is that of the gradient of the arrival time estimated by the diffusion model, and 2) The magnitude of the front rate vector is the inverse of the arrival time gradient vector magnitude. These quantities are estimated with a Sobel method for approximating the gradient in a discrete field, which is equivalent to a best linear model (plane) fit applied at each 3x3 neighborhood.

We now consider the more detailed progression data that is available using the semi-empirical fire model. With this fully resolved fire progression, we have time, rate, slope magnitude, and fuel for each element of the fire representation grid. This can be put on a single 3D plot where fuel is coded by color, but that presentation is difficult to assess in a static format. Instead, we will first examine the plots of time by rate by fuel, shown in Fig. 6. Log rate is shown to better reveal the body of the profiles. These plots are capped at 10,000 data points per panel (although many fewer exist for some fuels) for greater clarity in the plots, with the drawback that the absolute amounts of the main fuel types are obscured. Fig. 6 also shows a visualization of this data, by accumulating the data into an image grid (50x50 in this case), which reduces the resolution of the plotted data points on the x-y axes, but with the advantage that the number of data instances is made more clear by encoding in the grayscale.

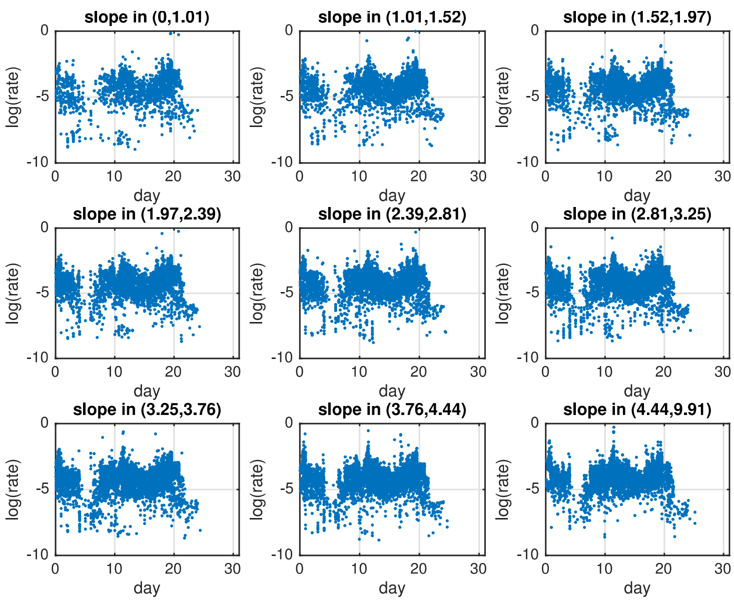
Fig. 6. Left: Plots by fuel type in the Silver fire of time vs. log rate. Right: Plots by fuel type in the Silver fire of time vs. count of log(rate). Note that each frame is normalized so that maximum brightness is achieved in each plot, otherwise the minor fuels would not be visible. The value in each panel title expresses the scale of the normalized grayscale.



Continuing the discussion above, we still clearly see the three main phases of the fire. Also, the fuel types do not explain differences in fire over time, or in fire rate. The change over time of minor fuels is not explanatory.

As another view of this data, we can examine the relationship between the time, the log rate, and the slope, by separating the slope into 9 groups of equal population. This is shown in Fig. 7. This again shows only the profile of the three major phases of the Silver fire. Recall the discussion above suggested that the fire is driven in a biased way, suggesting a biased boundary condition. These plots show no strong correlation discernible between slope and rate or time. The remaining major alternative is that the critical boundary condition explaining the fire migration (and perhaps the fire phases) is wind. As discussed, at this time the wind data is not available in this dataset.

Fig. 7. Plots by slope range in the Silver fire of time vs. log rate.



Fire data clustering

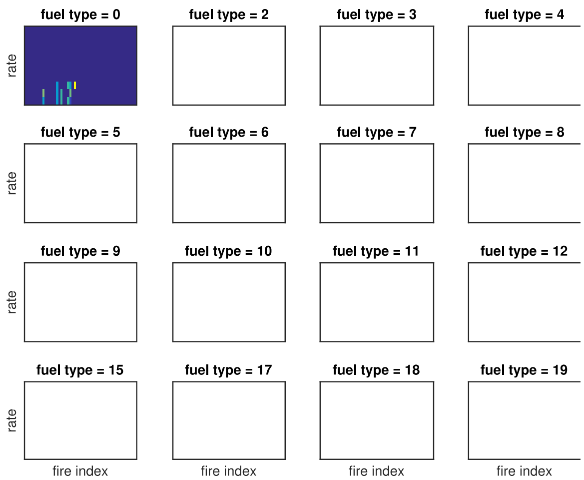
We will focus on the wildfires from 2013. Given the several available quantities shows above, we will now demonstrate how a summary fingerprint measures can characterize a wildfire example, and can be used to compare examples. Clustering of wildfire related data has been examined before, for example the evaluation of measures of wildfire severity connecting with satellite examination of burn scars (Holden and Evans 2010). Clean and sufficient data is available for 50 fires considering rate and fuel. The lower limits of data requirements have not been systematically evaluated, but rules of thumb have been applied, and a dataset of 50 examples is sufficient for investigation. As mentioned above, this data cleaning removes fires that have a small number of observed perimeters (suggesting short duration) or perimeters that are problematic for quantitative treatment (resulting in a large proportion of outlier values in progression rate). Of the full 2013 dataset of 185 fires the 50 remaining are shown in **Error! Not a valid bookmark self-reference.**.

Fig. 8. Names and designation of the 50 fires used in this analysis.

1 AZ-KNF-HT4H mud
2 AZ-SCA-HJ22 fourmile
3 AZ-SCA-HK2E creek
4 CA-ANF-HH9J powerhouse
5 CA-BTU-HE8J panther
6 CA-KNF-HS98 salmon river complex
7 CA-RRU-HQ0T mountain
8 CA-SNF-HR6W aspen
9 CA-SRF-HS91 butler
10 CA-SRF-HU49 corral complex
11 CA-STF-HV2F rim
12 CA-TNF-HU11 american
13 CA-VNC-HE9W springs
14 CO-SJF-HKX5 west fork complex
15 ID-BOD-HUJ6 pony complex
16 ID-BOF-HUL0 elk
17 ID-NPF-000347 california point
18 ID-PAF-HRT5 thunder city
19 ID-PAF-HX4J weiser complex
20 ID-SCF-HP5V papoose
21 ID-SCF-HRT7 lodgepole
22 ID-STF-HV1T little queens
23 ID-STF-HXM6 kelley
24 ID-TFD-HUB8 mccan
25 MT-BRF-HR1U gold pan
26 MT-GNF-HVZ4 miner paradise complex
27 MT-LCF-HRP6 red shale
28 MT-LNF-HQU8 west mullan
29 MT-SWS-HV9J lolo creek complex
30 NM-GNF-HJ20 silver
31 NM-N4S-HH9A tres lagunas
32 NM-SNF-HH96 thompson ridge
33 NM-SNF-HJ7C jaroso
34 NM-SNF-HJC4 thompson ridge
35 NV-EKD-HV00 red cow
36 NV-ELD-HM1P black
37 NV-HTF-HM7D carpenter 1
38 NV-WNA-HNV1 bison
39 OR-712S-HS0E big windy complex
40 OR-73S-HSG9 douglas complex
41 OR-954S-HV1Q government flats complex
42 OR-BUD-HU7Z lava
43 OR-UPF-HSP8 whiskey complex
44 UT-BRS-HUH5 state
45 UT-SLD-HU2S patch springs
46 WA-CHLN-HSU3 colockum tarps
47 WA-COA-HU2G westside complex
48 WA-YAA-HR71 mile marker 28
49 WY-SHF-HR4Q hardluck
50 WY-YNP-HUP6 druid complex

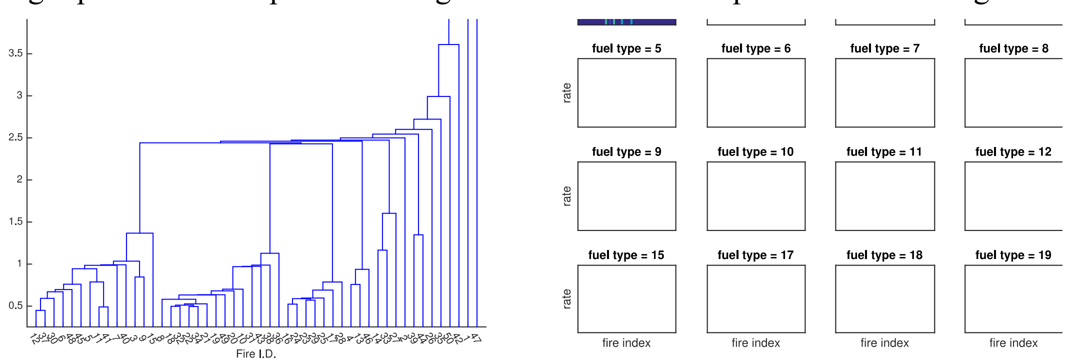
The statistic extracted for this discussion is the profile of count versus rate, by each fuel. A summary plot of this data is shown in Fig. 9. The panels are again data accumulated into a regular grid in rate, with the grid boundary values of the cube, which arguably has better properties than a logarithmic transform, of a regular spacing in (0,1) resulting in 10 total bins. Data exists in a long tail above 1.0 m/s; we discard this data from this analysis to favor characterization of the body of the distribution, but analysis of tails would be another avenue to approach such a study.

Fig. 9. For each of 50 fires (x axis), and at a number of progression rates (y axis) the number of instances is represented by color; for each fuel.



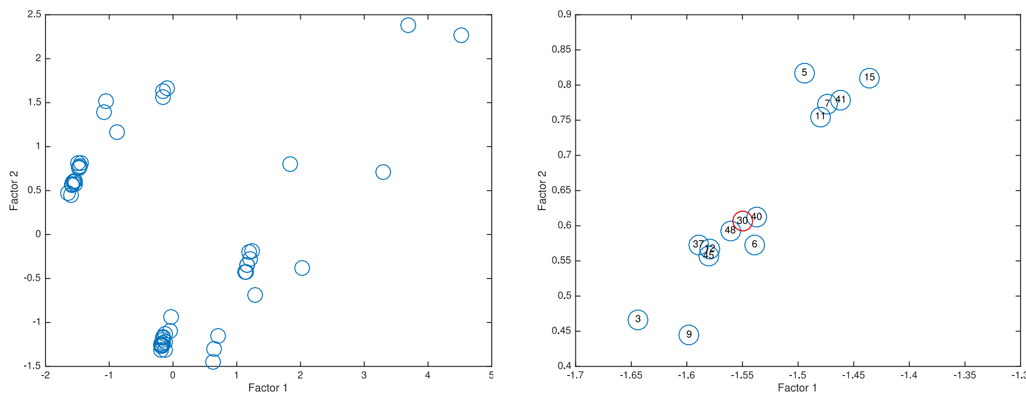
Each fire then has a vector of 10 values. Using a simply Euclidean distance metric, these 50 profiles are clustered based on the data for the concatenated rate vectors. Any subset of fuels could be the target of the clustering. The dendrogram corresponding to the distance metric is shown in Fig. 10. Sorting based on the dendrogram ordering gives the reordered data in the right panels of Fig. 10.

Fig. 10. Dendrogram of clustering fires based on the progression rate profile distance. The right plots show the profiles in Fig. 9 reordered to correspond to the dendrogram.



The distances are difficult to interpret qualitatively. For purposes of inspection, we use classical multidimensional scaling to present the first two explanatory factors, which explain 80% of the distance relationship between the fire data. Figure 11 shows the 50 fires plotted in the first two factors. The most important aspect to note is that there are very distinct clusters in the measures presented, which are both similar within cluster and distinct from other examples/clusters. In addition, there are examples (wildfire summary data vectors in rate vs. fuel) that are not similar to any other fires, consistent with the right side of the dendrogram distance summary. Expanding a view of one cluster, the right panel of Fig. 11 shows the leftmost group.

Fig. 11. The data plotted in the first two factors of classical multidimensional scaling, showing a representation of the spatial clusters. The left panel shows all fires, the right panel is expanded to show the leftmost cluster (axes share a common scale), along with fire dataset number.



This validates the goal of finding similar wildfire examples in history. If, for example, we are interested in fires similar to the Silver fire, fire 30 shown in red, we can easily see in quantitative distance that the closest fires are: (37) carpenter 1, (6) salmon river complex, and (12) american. These are not the closest in the plots because of the additional 20% of distance not present in the two factor summary, but even so they can be seen to be very similar, and within a characteristic group. These are the leftmost examples in the dendrogram in Figure 10.

Whether this particular feature set and corresponding distances are reasonable for a particular purpose is very dependent on context. The features in the example presented obviously encode information about relative presence of fuels and rates of spread, over relative fire progression time. One can imagine a situation where these features are relevant as in a training or outreach scenario where the fire location and general scenario is specified, which will specify the fuels and a general concept of progression. The similar wildfires in the database will then be available for construction of detailed scenarios that are consistent with, but not identical to, historical examples.

Discussion and conclusion

The indications from this data analysis are that wildfire data summaries show significant features of interest. Using data directly available, plus the addition of an approximation to fire arrival time and rate of spread, we can see a significant clustering in the fires using a metric based on rate, fire time, and fuel type.

There is an inherent high uncertainty in many aspects of wildfire assessment and projection due to inherent limitations in dataset detail (e.g., relevant meteorology at tens of meters) and in the limitations of phenomenological models suitable for fast user interaction. When using wildfire models, the historical data are a potential resource for tuning model parameters and analyzing the limits of model predictions.

In the mining of historical wildfire datasets, the result overall is that there are distinct patterns that have the potential for query-by-example, that may be useful for training, outreach, and in evaluating strategies in an unfolding situation. Next steps are to focus on the construction of a suite of possible relevant metrics, and then to present to use of these metrics to experienced wildfire responders to determine which of these produce the most interesting and useful results. We continue to evaluate additional data sources as potential elements of wildfire fingerprints.

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SimTable http://simtable.com.

Localized risk perception of wildland fire hazard

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Abstract

Individual perceptions of wildfire can differ substantially from one person to another and from the reality of wildfire risk. This variability in wildfire risk perception can result in inconsistent responses to wildfire mitigation at the individual and community level. Although several studies in wildfire risk perception have found that subjective risk is shaped by both personal and social considerations, exploring various undiscovered key factors is necessary for identifying a reliable formation of risk perception in a multistage process. In this study, we examined the interconnection between private property owners and social-contextual characteristics related to wildfire risks, such as views of nature, place-based influence, and vulnerability. Using a mail survey, the findings show that risk perception for wildfire is formed at the individual level as guided by psychological factors, however, it is substantially influenced by social context. With a better understanding of those influences, communication efforts to promote wildfire protection can significantly strengthen community engagement in wildfire management.

Additional keywords: vulnerability, place-based influence, social context, Cultural Theory, multilevel analysis, survey study

Introduction

The need to protect lives and property in the expanding wildland-urban interface (WUI) across western North America increases the pressure to reduce risks of wildfires. As the threat of wildfires continues to rise, state and federal agencies and local fire departments are challenged to establish a risk-reduction program for local areas that incorporates individual landowner decisions and/or collective action within the community. A community's perception of exposure to wildfire risk plays a significant role in a landowner's decisions to protect private property. However, for community members to be mobilized against wildfire hazards, they must first acknowledge that a risk exists. We explore the link between landowners' perception of risk and scientifically quantified wildfire risks that vary across hazard zones in communities in three states (Arizona, California, and New Mexico). Spatially stratified random sampling was applied based on respondents' hazard zones and proximity to the WUI to ensure a consistently representative sample of perceived risk relative to objective risk over the study area. By utilizing a multilevel response model from community public opinion surveys, combined with remote sensing and parcel data indicating areas of potential wildfire risk, we investigated the relationship between the patterns of risk perception and individually perceived wildfire risks at multiple scales. Results suggest that perceptions of residents in wildfire zones were aligned with the actual fire danger. However, the respondents in at-risk areas tend to be more optimistic about their situation when compared to the general population. Not surprisingly, the more conscientious respondents are about protecting their properties; the more likely they are to perceive a higher level of risk.

Wildfire risk perceptions

The study of wildfire risk perception is not new; however, the study of its determinants and its links to homeowners' decisions to mitigate risks is a relatively recent and critical aspect of this field. McCaffrey (2008) observed: 'By reflecting the spatial dynamic of risk perception, research has shown that homeowners tend to assess the risk of wildfire for the general area as higher than that for their individual homes.' Objective risk of a potential disaster is calculated as a function of probability and magnitude of loss from a disaster, whereas individual perception of risk, known as subjective risk, focuses on understanding and direct experience on an individual level. Social-psychological variables such as personal values, spiritual beliefs, and worldviews influence individuals' risk perception from natural disasters (Slimak and Dietz 2006). The assessment of individual perceived risk also accounts for attitude, sensitivity to risk (Sjöberg 2000), and a feeling of control over the situation (Rachman 1990). In addition, when disastrous events occur frequently, individuals are more likely to underestimate the associated risks, while the dramatic character of striking and rare events tends to cause an opposite response (Lichtenstein *et al.* 1978). Differences in individual assessments and responses to risks can become a challenge to local fire authorities as they attempt to communicate risk.

We studied the relationship between the perception and scientific measurement (e.g., fire occurrence, severity) of wildfire risk. This insight is essential as wildfires have become more frequent and devastating with the expansion of the interface between urban and rural areas. However, people living in the WUI do not always respond appropriately to an increase in public communication regarding wildfire safety. Every fire season, federal agencies are confronted with protecting the millions of acres in public ownership from wildfires. Public land managers are well aware of the dangers and have strongly encouraged methods of mitigating the damage. Yet some residents of WUI areas refuse to believe that wildfire could actually cause damage to their properties (Steelman 2008). Risk tolerance, or the trade-off between facing risk from wildfire and benefit of living in the forest, is taken into personal considerations in responding to wildfire (Daniel *et al.* 2007). Moreover, the recent occurrence of a wildfire tends to foster the belief that another fire in the same general location is less likely to occur in the near future (Cohn *et al.* 2008).

The disconnection between risk perceptions and degree of exposure to wildfire has increased the need for more extensive wildfire research and the study of its relationship to psychological factors. The psychological phenomenon of a mismatch between objective and subjective risk is often referred to as unrealistic optimism, and is encountered in a wide range of situations beyond natural hazard risk (Sjöberg 2000). Therefore, unduly optimistic risk judgments for residents in wildfire zones are to be expected (Kumagai *et al.* 2004). Indeed, researchers have discovered inconsistent positive relationships between risk perceptions and exposure to wildfire risk (McCaffrey 2004; Arvai *et al.* 2006; Martin *et al.* 2009; McGee *et al.* 2009). Recent research has found that community involvement is related to perceived risk and consequences of a past wildfire (Brenkert-Smith *et al.* 2013), but not always (Hall and Slothower 2009). For example, homeowners perceive the danger from fires as higher when they believe their neighbor's properties to be overrun with dense vegetation. Thus, the psychological variables related to wildfire are important to address in order to determine how individuals perceive the risk of wildfires.

Sociocultural constructions of risk perceptions

Extensive research on risk perception has found that responses to fire threat are shaped by a number of social and cultural processes. Cultural Theory (CT) explores the sociological aspects of risk. Individuals' risk perception is said to be rooted in their interpersonal relationships and 'ways of life' – their values, beliefs, and preferences (Sjöberg 2000). For example, one's perception of wildfire risk may be associated with whether one believes nature to be benign or capricious, a core distinction in CT. Four categories of risk perception have been identified through CT: *nature capricious* (fatalist), *nature perverse/tolerant* (hierarchist), *nature ephemeral* (egalitarian), and *nature benign* (individualist) (Schwarz and Thompson 1990). Although the use of CT in the wildfire context is limited, research concerning environmental risk perception has shown important concepts that are similar to basic tenants of this theory (Steg and Sievers 2000; Lima and Castro 2005; Tikir and Lehmann 2011). CT states that individuals adhering to the *nature ephemeral* (egalitarian) view have the greatest tendency to attempt to preserve the environment. Those who hold the *nature benign* (individualists) view believe that nature is always in balance, and technology is the only solution for environmental problems. However, individuals who hold the *nature capricious* (fatalist) view believe that risk is unpredictable, as is nature, and the quantity of resources is limited. The *nature perverse/tolerant* (hierarchist) group prefers to rely on experts' opinions about hazards of nature. Thus, understanding aspects of CT, such as individuals' primary values as they relate to perceptions of nature, could yield a deeper understanding of perceptions of wildfire risk. [Note that the term 'views of nature' will be used through the rest of this study referring to this perception.]

The role of place-based influence transcends simple location; rather 'place' has a social meaning for risk perception. Brenkert–Smith *et al.* (2006) found that attachment to place (or place-based influence) shapes the decision-making process when individuals choose whether to participate in a wildfire risk reduction plan. The emotional attachments and environmental conditions related to place may influence perceptions of how much would be lost in the event of wildfire, but may also increase reluctance to change environmental conditions associated with sense of place. Residents with strong feelings of attachment to their place tend to be the most inclined to engage in mitigating wildfire to protect their properties (Kyle *et al.* 2010). Gordon *et al.* (2013) showed that risk perception is influenced by the disruption of a shared place-based influence in which the changing social and environmental conditions affect residents' attitudes about potential disasters and subsequent mitigation behaviors. However, the reality of hazard exposure could be biased by knowledge and memory about places. For example, in Australia, the memory of one's place appears to play an important part in one's tendency to underestimate the risks and ignore fire safety measures (Reid and Beilin 2014).

Research also has found that social and geographical vulnerability affect local residents' perception about the risks of wildfires. (Wisner *et al.* 2004) define social vulnerability and biophysical hazards as key components that indicate a risk of impending environmental disaster. Social vulnerability is an understanding as being:

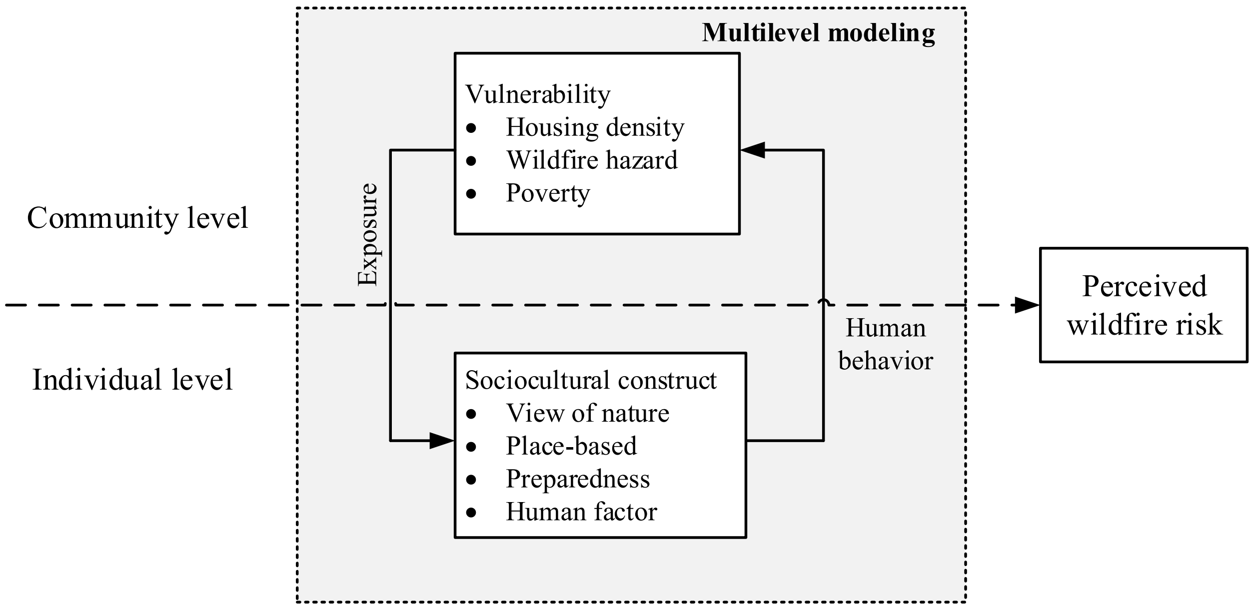
> *'…essentially about the human ecology of endangerment…and is embedded in the social geography of settlements and lands uses, and the space of distribution of influence in communities and political organization'* (Hewitt 2014).

In general, social vulnerability has placed attention on the role of socioeconomic factors such as income and poverty levels in the capability to recover and in the ability to access resources for mitigating hazards. Low-income and part-time residents are among the most vulnerable groups to wildfire exposure as the high implementation costs and marginal income critically limit their capabilities to protect themselves from hazards (Collins and Bolin 2009). From a geographical perspective, hazard vulnerability rests on the human-biophysical relationships in which people's susceptibility to harm and loss influences their capacity to prepare for, respond to, and recover from hazard events (Wisner *et al.* 2004). As such, in local areas with rapidly changing socio-demographic characteristics, residents tend to have conflicts with believing in the threat of hazards and the pleas of fire managers (Gordon *et al.* 2010).

Model specification

In this study, we explored how the predictability of factors indicating hazard vulnerability from wildfire would influence an individual's perception of wildfire. We examined risk perception related to wildfires within complex social and environmental contexts. Our conceptual framework (Fig.1) illustrates the hierarchical connection of factors that influence individual wildfire risk perception.

Fig.1. The conceptual framework of this study illustrates a property owner's risk perception of wildfire. The multilevel nature of wildfire risk perception is inherent in individual experience and psychological processes (small scale) and factors particular to the neighborhood and community (larger scale). A feedback loop presents itself as social factors influence an individual's viewpoints and sense of place, leading to decisions about whether and how to prepare for wildfire which, in turn, affect the neighborhood's vulnerability.



To test the framework we used multilevel modeling (MLM). The purpose of MLM in risk research is to integrate individual and aggregate samples of risk perception for analysis. Because the connection is inherently hierarchical, in theory, incorporating multiple levels of influential components into the study can improve the explanation of both individual mitigation behaviors and the societal-environmental reaction to them. We assume that although individuals responded to our survey independently, each one shares similar common social and environmental settings, which may result in similar perceptions among those living in the same communities. In order for community members to mobilize against wildfire hazards, they must acknowledge that this risk exists. We focused on identifying both individual characteristics and contextual factors that help explain variations in perceptions of wildfire in various spatial domains. Specifically, we investigated whether a WUI resident's likelihood of acknowledging the existence of wildfire risk varied across communities. Then, we investigated how community-level factors help explain variability in individual-level perceptions. Thus, MLM allows us to consider higher (community-level) factors to explain lower (individual-level) proposition without committing ecological errors about data structure (Snijders and Bosker 1999). This study employed a two-level model: individual-level and community-level (in three different states).

Hypotheses

This study tested the following four hypotheses:

H1: Individuals perceive their homes or neighborhoods to be at a lower risk than those in broader areas, such as the county, region, or state.

H2: There are two aspects to the variations of wildfire risk perception: among individuals and among communities. People who live in the same community tend to have similar perceptions about wildfire hazards and are more homogenous in terms of perception. Therefore, people living in different communities are likely to have more heterogeneous perceptions about wildfire risk to their communities.

H3: Individual perception of the threat of wildfires is influenced by worldview and level of preparedness to protect a property. After controlling for socio-demographic characteristics (age, income, education, length of residence), the greater a person's aversion to risk (*i.e.*, having an ephemeral worldview), the higher is the likelihood he or she will perceive wildfire as a risk. The degree of preparedness for protecting properties is positively related to risk perception. Similarly, the perceiving risk factors for wildfires caused by human activities are positive to risk perception.

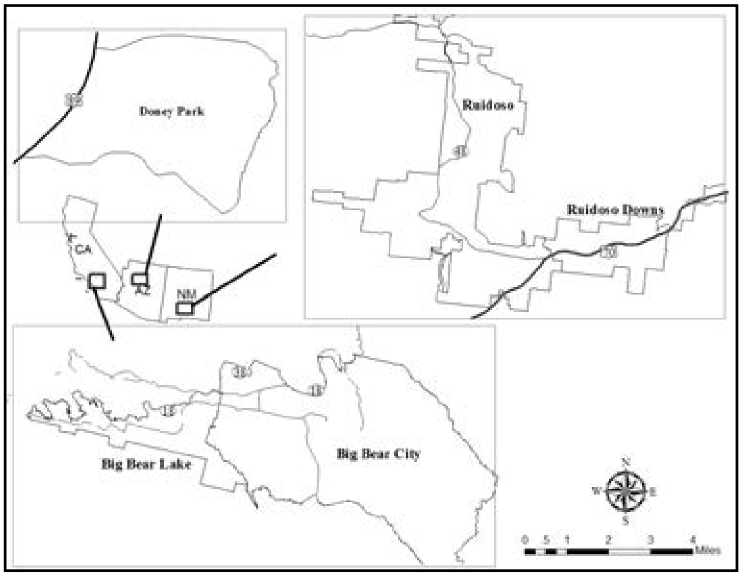
H4: Community wildfire risk perceptions on average are influenced by the community's general geographic characteristics and social vulnerability factors such as housing density in the WUI, scientifically measured wildfire risk, and poverty level. Wide spacing of houses in a community leads to a lower perceived risk from wildfires. The negative relationship between perception and scientific measurement is expected, whereas the greater the exposure to wildfires (indicated by poverty level), the more negative the perception will be.

Methods

Study area and sampling method

The three study areas are located in western USA as shown in Fig. 2.

Fig. 2. Map of study areas: Doney Park in Arizona, Big Bear Lake in California, and Ruidoso in New Mexico.



We focused on three Southwestern-US interface communities identified by fire prevention officials as having a significant wildfire risk. The specific study communities were selected for having greater-than-normal diversity of socioeconomic, ethnic and cultural backgrounds based on U.S. Census Bureau data. Sampling of private property owners was conducted using a stratified random method. Biophysical characteristics such as wildfire hazard and vegetation density were taken into consideration and combined with a property tax parcel map to create a list of property owners, from which survey recipients were randomly selected. A mail survey, conducted in May 2014, followed Dillman's tailored design method (Dillman 2011). Property owners were first contacted by postcard; 11 postcards were undeliverable. The survey was administered to 1,070 landowners one week later. Three weeks later, 1,059 thank you/reminder postcards were sent and followed by a second wave of surveys (900). Of the 220 received surveys, 24 respondents did not complete the questionnaire and thus were eliminated, resulting in a response rate of 20.8%. Because response was relatively low, we tested for non-response bias, but found no significant differences between respondents and non-respondents in demographic variables including gender, ethnicity, and education (Cohen 1992). Therefore we conclude that the dataset for this study has minimal non-response bias.

Measurement

A complete list of variables used in this analysis is provided in Table 1. The dependent variable was the degree to which respondents believe wildfires in their local area are a serious risk. Respondents answered the question 'Within the next 10 years, what is the probability that a wildfire will damage your home?' on a scale from 1% - exceptionally unlikely to 99% - virtually certain.

Table 1. Description of variables in the multilevel statistical model (n=196)

Variables	Descriptions	Mean	S.D.
Dependent variable			
Risk perception	Self-reported risk perception rating from 1 to 7, ranging from very unlikely (=1) to very likely (= 7).	0.93	0.68
Independent variables Level-1: individual level			
View of Nature	Indication of the role of environmental worldviews using 16 items related to the Cultural Theory	1.60[A]	0.63[B]
Preparedness	Likelihood of undertaking Firewise-suggested landscaping activities (alpha[C]=0.69)	0.44	0.25
Human risk factor	The importance of human-related factors in creating a wildfire hazard (alpha = 0.67)	3.3	0.55
Length of residency	A period of time that a person lived at current property (year).	17.38	12.81
Place-based influence on wildfire risk			
Probability of a home burning in the community	Self-reported risk perception rating from 1 to 7, ranging from very unlikely (=1) to very likely (= 7).	1.19	0.67
Probability of a home burning in the state	Self-reported risk perception rating from 1 to 7, ranging from very unlikely (=1) to very likely (= 7).	1.36	0.82
Independent variables Level-2: community level			
Scientific measure *of physical vulnerability variables*	Wildfire risk potential zones, low (=0), moderate, and high (=2)	1.22	1.03
Housing density	WUI housing density units per square km. in terms of a log transformation	2.38	0.61
Socioeconomic vulnerability variables Poverty level	Percent of total people below the poverty level in 2012	17.17	4.04

Note that all variables are grand-mean centered

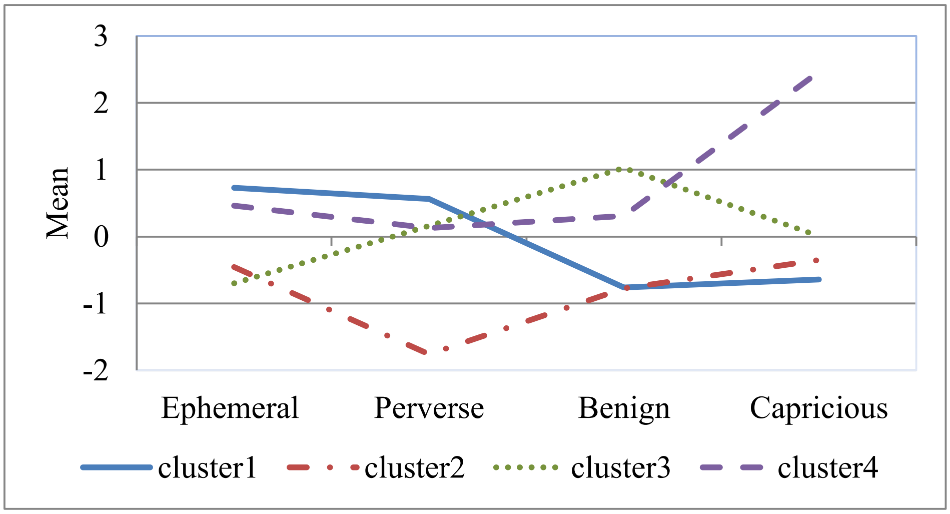
[A] and [B] are calculated from the distance of each response from its classification cluster center in cluster analysis. [C] Cronbach's alpha indicates a degree to which the items measures are closely correlated (alpha > 0.6 is acceptable).

The independent variables were based on relevant factors of local risk in multiple-scale data. Individual-level variables included each respondent's demographic information and length of residency. The degree of home protection from wildfire hazards was measured using a preparedness index, determined by responses to a series of items asking if respondents were undertaking certain landscaping activities. The place-based influence associated with a perception of wildfire risk was measured at different spatial scales, such as the neighborhood and state. The community-level variables included the scientific measurement of risk (wildfire hazard zone), socioeconomic characteristics related to physical characteristics (housing density), and social vulnerability to wildfire (poverty rate).

We applied the Cultural Theory typology (Schwarz and Thompson 1990) to wildfire management. Respondents were asked to rate the importance of possible causes of wildfires in their community, such as discarding cigarettes, burning debris and arson. The mean score of these ratings was used to determine the residents' opinions on the level of human responsibility for causing wildfires (human-related risk factor). According to Douglas and Wildavsky (1983), individuals do not necessary adhere into one cultural type. To test this assertion, cluster analysis was used to group respondents with similar responses on cultural adherence (Oltedal and Rundmo 2007). A *K*-means cluster analysis was conducted to classify respondents' views on nature. The results found a heterogeneous distribution of values which are not indicative of any particular cultural type. Factor scores of items measured to determine the view of nature were used in the analysis to minimize computational complexity and achieve iteration convergence. Although differences between the distributions of indicators were found, the pattern of distribution can be distinguished by the levels of homogeneity, accumulation, and concentration. The determination criteria for the number of clusters were based on the significant *F*-value of the cluster, minimum cluster size, and the unique characteristics with distinctive variables. The mean of each indicator within the final cluster plays a significant role within the different combinations of the other three worldviews (Fig.3). The clusters of the four views of nature are labeled based on the dominant indicators.

We can distinguish the dominant characteristics from preferred management style into three general degrees of risk: risk averse, risk taking/or tolerant, and risk neutral. The ephemeral view of nature is associated with risk aversion in the sense that adherents are concerned with the depletion of environmental and natural resources. The greater the loading on this view, the stronger aversion to risk will be. Clusters 1 and 2 have greater risk aversion than the other two groups, while cluster 1 is more risk averse than cluster 2. Those who hold to the *benign* view of

Fig. 3. Cluster of the view of nature



nature are likely to be closely associated with risk-taking due to a belief in a resilient ecosystem. Those of the *perverse* view share similar beliefs, but they perceive that resilience has limits. Cluster 3 represents a group of respondents who are more prone to risk taking than other worldview groups. Cluster 2 and 3 share a similar cluster which presents a risk-taking view. Lastly, the *capricious* viewpoint is the most prominent in cluster 4. Persons holding this viewpoint are not very concerned about erratic events because they believe one cannot be concerned about what one does not know is coming; therefore, cluster 4 is closely related to the risk neutral group (Fig. 3). To simplify the clusters of nature viewpoints, we group the risk clusters into three categories: risk aversion, risk taking, and risk neutral.

To scientifically measure wildfire risk, we applied a single standard measurement acquired from the Wildland Fire Potential map[A]. The WFP is a raster geospatial map that estimates burn probability and fire intensity levels for areas throughout the United States. The map represents the relative probability of five levels, very low, low, moderate, high, and very high, of experiencing an intense fire that may include torching, crowning and other forms of extreme fire behavior. We applied the majority filter and focal analysis[B] via ArcGIS 10.1 to obtain more specific raster which would only include larger and more generalized areas. As a result, three wildfire zones, (low= 0, moderate, and high=2), were created to simplify the analysis.

[A] The WFP map is produced by the USDA Forest Service, Fire Modeling Institute (2012), Online links: http://www.firelab.org/fmi/data-products/229-wildland-firepotential-wfp
[B] The majority filter operates five successive times with HALF replacement threshold and the Median statistics is used for generalized data in Focal Analysis.

Multilevel statistical analysis procedure

Multilevel statistical modeling is designed to handle hierarchically structured data. Variability at individual levels (lower level) can be partially explained by variation at the group level (higher level). Individuals in the WUI are members of their communities; therefore, we analyzed the risk perception of individuals by simultaneously considering variation within and between communities. Since we used categorical responses of wildfire risk perception from low, moderate, and high, ordinal regression models were ideal for minimizing underestimation and standard error bias within the parameters (Muthén and Kaplan 1985). In addition, the ordered categorical variables represent the difference in quantity for measuring variation from nominal outcomes (Azen and Walker 2011).

The functional form of this multilevel model was adapted from (Hedeker and Mermelstein 2011). If Y denotes the individual wildfire risk perception response with a probability of $\pi_{ijc} = P(Y_{ij} \leq c)$ for individual *i* within each community-level *j*, we have the ratio of the probability of risk perception being at or below the c^{th} category where $c = 1, 2, \ldots, C$. We applied cumulative probabilities to the applied complementary log-log link function to estimate the ordinal model:

$$\eta_c = \log[-\log(1-\pi_{ijc})] = \gamma_c - \mathrm{X}'\beta_c \qquad (1)$$

where c represents the c categories of risk perception outcomes from 1,2,…, c -1

X denotes the vector of explanatory variables, including the intercepts

γ_c refers to threshold which reflects cumulative odds when $\mathrm{X} = 0$.

A complementary log-log transformation is recommended for the ordinal model when categories are not equally distributed (Heck *et al.* 2013) yielding a very small or large probability (*i.e.*, most individual responses fit into specific categories). The odds ratio is simply the exponent of the estimate's coefficient.

The sequential modeling process begins with the unconditional model (no independent variables), which assumes that each community has a random average that may reflect the respondent's perception of wildfire risk. If a significant amount of variance in the random intercepts occurs, this suggests a total variance in risk perception as a result of differences in community means, the second level. Next, the independent variables, including the individual level (level-1), are introduced in the second model where the community intercepts are allowed to vary from each other, and the community-level variables (level-2) are introduced into the model. The sequential procedure was based on (Hox 1995), which consists of four progressive specifications:

1) Begin with an unconditional model, including only the intercepts and threshold coefficients

2) Add level-1 fixed individual explanatory variables

3) Add level-2 random community-level explanatory variables

4) Add cross-level interaction explanatory variable.

The intraclass correlation coefficient (ICC) is used to estimate the proportion of variance among group (higher) levels, ranging from 0 to 1. The ICC was calculated from a community-level variance ($\sigma^2_{between}$) relative to a total variance ($\sigma^2_{between} + \sigma^2_{within}$). The variance of a complementary log-log link function, σ^2_{within}, is equal to $\frac{\pi^2}{6}$, or approximately 1.645[C]. All analyses were performed using the IBM SPSS statistical package. The receiver operating characteristics (ROC) analysis was used to determine a goodness-of-fit of the subsequent models in this study. The ROC value, which varies between 0.5 and 1, is close to 1, indicating a model with an ability to discriminate between categorical cases of the outcomes, whereas a value close to 0.5 indicates that the group is classified randomly.

Results

Effects of multilevel driving factors on wildfire risk perception

Four models were produced, each of which measured two levels of risk perception: random effects and fixed effects for fire prone communities (Table 2). Model 1 is the unconditional (intercept only) constraint for examining the variations in subjective risk of wildfire, assuming that each community has a random community average that could reflect residents' perceptions about this risk. The variance of the random intercept was 1.01 (z-test = 4.912, $p < .001$), which suggests overall differences across communities.

Table 2. Multilevel statistical models for wildfire risk perception

	Model 1 Null model	**Model 2** Fixed Level-1 variables added	**Model 3** Random slope added	**Model 4** Cross-level interaction
Fixed effects				
Threshold 0: Pr(< 10%)	0.44^{***}	0.36^{**}	3.71^{***}	3.64^{***}
Threshold 1: Pr(~33-50%)[A]	-1.81^{**}	2.34^{**}	6.74^{***}	6.70^{***}
Level 1				
cluster 1- risk averse		-0.02	0.07	0.12^{*}
cluster 2- risk taking		-0.08	-0.27^{**}	-0.24^{**}
cluster 3- risk-neutral[B]		-	-	-

[C] http://data.princeton.edu/wws509/notes/c3s7.html#f:links.

Residents over age 65		0.50^{**}	0.57^{**}	0.54^{**}
Length of residency		-0.03^{***}	-0.03^{**}	-0.03^{**}
Human risk factors index		0.73^{***}	0.67^{***}	0.68^{**}
Preparedness		-0.20^{*}	-	-
Place-based influence vs. wildfire risk				
Community				
High probability of home burning > 60%		1.14^{***}	2.81^{***}	2.74^{***}
Moderate ^{C} ~33-50%		-0.13	1.16^{**}	1.07^{**}
State level				
High probability of home burning > 60%		-1.16^{***}	-0.15	-0.13
Moderate^{D} ~33-50%		-0.97^{**}	-0.04	-0.06
Level 2				
Wildfire risk zones				
High exposure			0.88^{**}	0.83^{**}
Moderate exposure^{E}			0.15	0.08
Density of housing^{F}			0.67^{**}	0.67^{**}
Poverty level			0.07^{**}	0.09^{***}
Interaction				
Poverty × cluster1 – risk aversion				-0.05^{*}
Poverty × cluster2 – risk taking				-0.07^{*}
Variance Component/ Random Effect				
Intercept variance	1.01^{***}	1.92^{***}	1.07^{***}	1.09^{***}
ICC	0.38	0.54	0.39	0.40
AIC	8,034.05	26,777.95	10,305.96	10,271.68
BIC	8,039.12	26782.98	10,310.98	10,276.70
ROC	.739	.770	.887	.890

Note that all continuous variables are grand-mean centered.
*** $p < 0.001$; ** $p < 0.05$; * $p < 0.10$;
$^{A\text{-}E}$ other = 0 responses used as reference including pr(burning > 60%), age < 65, pr(burning <10%), and low exposure; ^{F} the housing density is logarithm transformed.

Also note that due to the inverse relationship between the ordered outcome categories and the direction of the predictors; the software restores the direction of the regression coefficients such that the positive coefficients increase the likelihood of being in the highest category and vice versa (Hox 2010).

The total variance in wildfire risk perception is calculated by determining the differences in community means. This evidence confirms that the multilevel approach can explain the multilevel association of subjective risk and the location of the community where the respondents reside. The intraclass correlation coefficient (ICC) of model 2, the individual level variables, shows that 42% of the total variance can be attributed to the community level (level-

2), indicating higher clustering of risk factors associated with the threat of wildfire at the community level (Table 2). Controlling for the ICC, higher levels of risk perception in model 2 are significantly associated with most individual-level variables except for views of nature. In addition, preparedness and cluster 1 of nature views did not have independent effects on risk perception. The model was rerun without these two variables to yield model 3 and the subsequent analyses. The ICC of model 3 dropped from 54% to 39% at the community level, and it only was very slightly altered after the cross-level interaction between the cluster 2 view of nature and poverty level was introduced, which resulted in model 4. The ROC analysis indicated that the multinomial complementary log-log models are a very good fit (0.89).

The percentage of respondents over 65 years of age, the degree to which wildfire could be caused by human factors, risk perception at the community level, and risk perception of wildfire were found to be positively related by Model 2. Conversely in the same model, the length of residency, degree of preparedness, and risk perception at the state level were found to be negatively related. Specifically, when all other variables are held constant, the predicted odds of perceiving a high wildfire risk (versus perceived moderate or low risk) were lower with greater length of residency. The degree of preparedness for wildfire protection decreased with respondents' perception of moderate or low wildfire risk. This implies that the respondents who are long-term residents and are less prepared for a wildfire also have a low perceived probability of a wildfire damaging their home.

Perceived risk at the state level is associated with perceived risk at the local level. The negative relationship of perceived probability of wildfire at the state level supported the hypothesis that people are more optimistic about wildfire in their neighborhoods than broader areas. These effects (moderate and high chance of home burning) were reduced by a factor of exponent (-1.16 and 0.97), when other factors are constant. However, view of nature did not significantly explain the factor of risk judgments in the context of wildfire threats in model 2.

All three community-level variables in Model 3 were found to have a significant correspondence to the differences in community-level means. The estimated slopes associated with all variables were significantly positive, which implies a significant association between the average community perception of wildfire risk and housing density, poverty level, and the exposure proximity of wildfire hazard. This association supports the hypothesis that as housing density and poverty levels in the community increase, perceived risk of wildfire also increases. Similarly, residents' perceived risk was consistent with their proximity to hazard zones.

The incorporation of complex structures and the cross-level interaction between both levels are presented in the model 4. It explores the combined effects of poverty level and low risk-taking perception (cluster2) on the general perception of risk. Note that the risk-aversion group (cluster1), which had been statistically insignificant in models 2 and 3, became significant only when cross-level variables were examined in the more complex model. The results of cross-level effects indicate that the interaction of respondents adhering to a risk averse and risk taking perspective is statistically significant. This interaction is known as a moderating effect (Azen and Walker 2011), where the strength of a relationship between two variables is affected by a third variable. In this case, these interactive effects are associated with poverty level. It should also be noted that the average effects of views of nature upon being risk averse (B= -0.05, $p < .10$) or risk taking (B= -0.07, $p < .05$) are significantly negative. In other words, the direction and strength of the relation between perceived wildfire risk at local and views of nature adherents is affected by poverty level. For example, because poor individuals are less likely to mitigate wildfire risk due to reduced access to resources (financial and time), the effect of their views of nature on perceived risk is reduced when compared to higher-income individuals.

Discussion and conclusion

The findings confirm a majority of our hypotheses about individuals' perceptions of risk. The first model shows that a significant amount of variance (39%) in wildfire risk perception can be explained by community-level differences. In model 2, age, length of residency, attitude about risk factors, and level of preparedness were all found to be significant predictors of risk perception. The positive association hypothesized with regard to attitude about risk factors of wildfire hazards was supported. A person who is more concerned about the threat of wildfire is more likely to acknowledge higher risk factors caused by human activity. In contrast, length of residency and preparedness were found to have unexpected associations with risk perception at the household level. This could possibly be explained by the significant role of place attachment variables. Our findings extend those of Brenkert-Smith (2006) in the sense that the feeling of place attachment decreases perceived risk from wildfires for WUI residents. Wildfire risk perception is relatively higher at broader scales - community and state level than the perceived risk closer to home. Specifically, respondents perceived the probability of fire damage in the community similar to how they perceive it at the level of their home, whereas large differences were found between perceptions at the state level and the home level. In other words, relatively higher risk perception is reserved for wildfire damage on a broader scale (state-level) compared to the more local scale of (home and community). This discrepancy could be due to what risk researchers call optimistic bias (Weinstein 1989), or it may simply reflect the higher probability that a wildfire will occur somewhere in each state during any given year.

As the intra-community difference shows various levels of significance, all three community-level variables show the expected positive associations with perceived fire risk at the home level. Respondents' perception of risk was consistent with their level of hazard exposure. As housing density and poverty level increase, greater risk was perceived. The same relationship was found with poverty level. View of nature becomes a significant predictor when cross-level effects are considered, although it was not found to be significant at the fixed-effect level (model 2). Risk aversion and risk-taking have negative associations with perceived risk of fire. Another important finding appeared in Model 4, which examined evidence for cross-level interactions between the individual and community levels. This model confirms that random-slope variations can be accounted for by community-level effects. In this case, poverty level as an indicator of social vulnerability at the community level is significantly related to individuals' perception of wildfire damaging their homes.

In conclusion, this study illustrates that a WUI homeowner's perspective regarding nature, length of residency, place-based influence, and attitudes about risk factors are significant predictors for how residents of fire-prone areas perceive their risk. The variation in social and physical vulnerability associated with wildfire can explain, to a certain extent, the variation in individual perceptions of wildfire risk. Perception of risk is consistent with the level of exposure to fire hazards. These findings have useful implications in many aspects for public policy and improvement of hazard communication and education. For instance, given the significant associations indicated between attitude toward hazard mitigation and risk, environmental views, and individual characteristics, a 'one-size-fits-all' policy is likely to be less efficient to communicate the complexities of risk than a strategy of policy making and planning aimed at certain groups or residents. Additionally, acknowledgement of the differences in wildfire risk perception in terms of individual and community level will help fire-prone communities or adjacent states become motivated to play a part in implementing wildfire risk reduction strategies. Although the adjacent landscape shares geographic similarities, the same rules may not apply to each local social dynamic. The study of wildfire risk perception should inspire fire managers or community leaders to identify gaps between biophysical conditions and social values and awareness about wildfire risks in their areas.

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Suppression of forest fires by droplet water streams distributed in time and space

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Abstract

Experimental results of droplet water stream evaporation during passage through high-temperature gases (combustion products of typical liquid fuels) are presented. Experiments were carried out by using the panoramic optical non-contact methods of 'tracer' visualization (PIV, IPI, PTV, PLIF). We determined the influence of dimensions, speed and concentration of droplets in the water stream on its evaporation. The laws of droplet deceleration in a flame area, changes of characteristic forms of droplets, collisions, coagulation and splitting were revealed. Physical and mathematical models of the movement of droplets through the flames were developed on the basis of experimental data. Numerical values of droplet existence times in flames of different heights during droplet passage through them at various speeds and distances between droplets were established. The model allowed us to define the required concentration of droplets, their sizes and motion velocities, at which predetermined temperature decrease in the flaming combustion area and concentration of combustion products and an oxidant is possible.

We simulated suppression of flaming combustion and thermal decomposition of typical forest fuels (birch leaves, pine and fir-tree needles) by vapor-droplet water streams. The model allowed description of the processes of heat transfer under full water droplet evaporation in the flame and generation of only water vapor at the surface of forest fuel material. We were thus able to determine the required temperature of the vapor-gas mixture and thickness of forest fuel material that resulted in stopping thermal decomposition of forest fuel material. The system describing the heat transfer conditions under liquid film evaporation at the boundary with thermally decaying forest fuel material was also considered. The minimum liquid film thickness at which temperature in forest fuel material is lower than the temperature of thermal decomposition was established. The results of numerical simulation of the system in which the processes of heat transfer are considered when forming the heterogeneous system (water with solid inclusions) between the layer of forest combustible material and the trace of water array were presented. It was found that the possible increase of 'buffer layer' concerning 0.005 m doesn't practically influence cooling conditions of forest fuel material. We were able to describe the processes of heat transfer when the extinguishing liquid droplets were at a specified distance between each other on the surface of intensively pyrolyzing forest fuel material. We found that heat of phase transformation under the evaporation of two 'neighboring' water droplets is sufficient for the absorption of energy accumulated in a heated layer of forest fuel material. The model allows determination of the process of heat transfer during the passage of all water in the pores of a near-surface layer of forest fuel material as well as when a water film will form over the saturated forest fuel material layer. It was found that the speeds of the chemical reaction in this area inertially decrease owing to the cooling of adjoining saturated forest fuel layers.

Additional keywords: flames, suppression, water droplet streams, simulation, experiment, panoramic optical methods.

Introduction

In recent years the processes of formation, motion, disintegration of water nucleuses or missiles, and streams of atomized water or different water agglomerates have been studied due to development of droplet and polydisperse technologies of firefighting (Meshkov *et al.* 2011; Wu 2011; Strizhak 2013; Tang *et al.* 2013; Vysokomornaya *et al.* 2014). The physical and mathematical models of heat and mass transfer (e.g., Strizhak 2013; Kuznetsov and Strizhak 2014; Vysokomornaya *et al.* 2013)) were developed to investigate the phase transformations during evaporation of single droplets, or groups of them moving through the flame under conditions of complicated coupled convective, radiative and conductive heat exchange. It was a challenge to determine the characteristics of evaporation and the influence of sizes, motion speed and concentration of droplets in the stream on the characteristics using known theoretical approaches (conditions of significant nonstationarity of flame combustion area behavior and the presence of gas stream swirl occurrence).

Size of droplets in an atomized flow influence significantly the taking away of them with high-temperature combustion products (Volkov 2014). He established experimentally that a droplet radius from 200 to 500 μm is optimum to prevent a droplet splitting and minimize their being taken away by combustion products. Droplets with a radius less than 200 μm undergo a turn and are taken away by high-temperature combustion products as early as the approach to the flame, and therefore have little if any influence on the firefighting process, especially with large fires. The polydisperse firefighting – water supply distributed in time and space into the flame area seems expedient. Motion features of big water missiles (volume 0.1–0.5 l), atomized water (droplet diameters 0.1–1 mm), and single droplets (0.1–5 mm) moving through the flames were studied and their influence determined on simulated fire sources (including typical forest fuel materials, liquid fuels, gas-burners etc.) as described below.

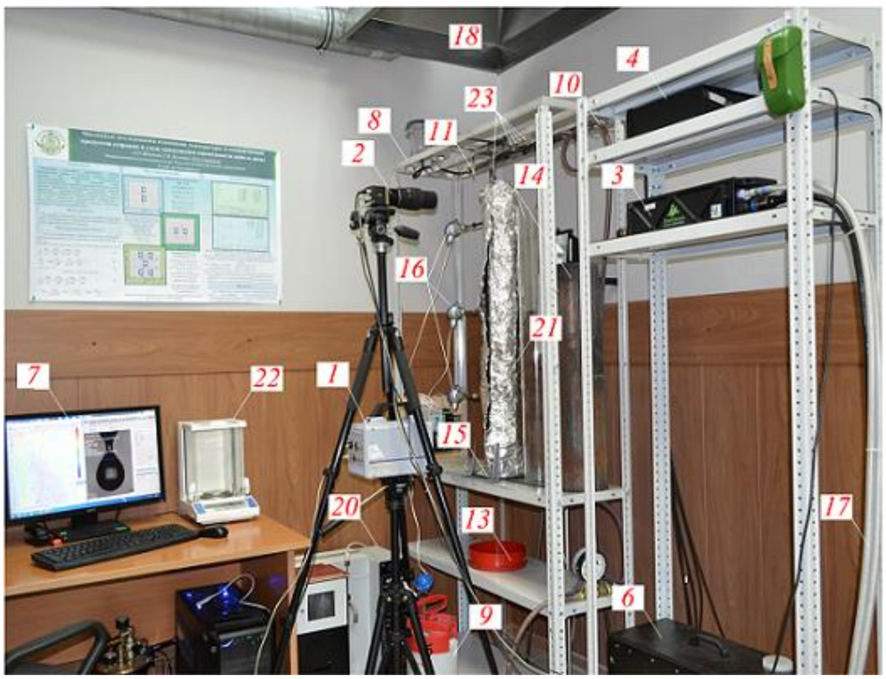
Experimental research

Five experimental setups were used to solve the listed research problems: 1) destruction of water missiles of large mass; 2) deformation of single droplets and their agglomerates in the flame; 3)examination of the processes of heat and mass transfer and phase transformations during the passage of single droplets, groups of them and droplet flows through the flames at various temperatures and speeds of combustion product motion (by ensuring the possibility of combustion substance phase change to a liquid or solid); 4)study of the evaporation processes of water droplets and emulsions on its base in an air flux with various temperatures, as well as on the heat of selected surfaces and constructions, and; 5)study of the processes of heat and mass transfer and phase transformation with suppression of thermal decomposition of common forest fuel materials.

The experiments were recorded with cross-correlation cameras, high-speed video cameras, and pulsed lasers using software packages to optimize optical 'tracer' visualization (PIV, Stereo PIV, PTV, IPI, SP) (Chagovets and Van Sciver 2011; Simo *et al.* 2013;Damiani *et al.* 2014) , and with high-speed video recording 'Tema Automotive' (Janiszewski 2012a, b). Special spotlights, reflectors, 'light conductors' and corresponding 'tracer' particles were used for each setup according to the applied panoramic optical method of 'tracer' visualization and type of the channel (made with heat-resistant translucent glass, stainless steel, or rolled steel with special holes) with droplets and high-temperature gases.

Fig. 1 illustrates one of the setups used to analyze evaporation processes of water droplets and emulsions on its base in the high-temperature gas fluxes corresponding to flames of kerosene, alcohol and common forest fuel materials (FFM) – birch leaves, needles and twigs of pine and fir-trees. Water with 'tracers' was applied. The 'tracers' were an admixture (0.5%) of particles of titanium dioxide nanopowder for refining the videograms obtained with the cross-correlation camera. The speed, size, weight, form and concentration of water droplets in the flame were studied.

Fig. 1. External appearance of the experimental setup: *1* – high-speed video camera; *2* – cross-correlation camera (according to the problems of the experiment, it was used up to 3 cameras simultaneously); *3* – double pulsed solid-state laser; *4* – synchronizer of PC, cross-correlation digital camera and laser; *5* – light 'pulse'; *6* – laser emission generator; 7 – PC; *8* – rack; *9* – container with water; *10* – channel of water supply; *11* – dosing devise (or atomizer); *12* – droplets (or their flux) of water; *13* – trap device; *14* – hollow cylindrical channels; *15* – 'burner device' (the group of such devices was used to burn kerosene, alcohol and forest fuels); *16* – thermocouples; *17* – motion channel of cooling liquid of laser; *18* – pressure system; *19* – turn-on/ turn-off unit of the pressure system; *20* – heating installation; *21* – thermal insulating layer; *22* – analytical weighing system; *23* – water atomizer.



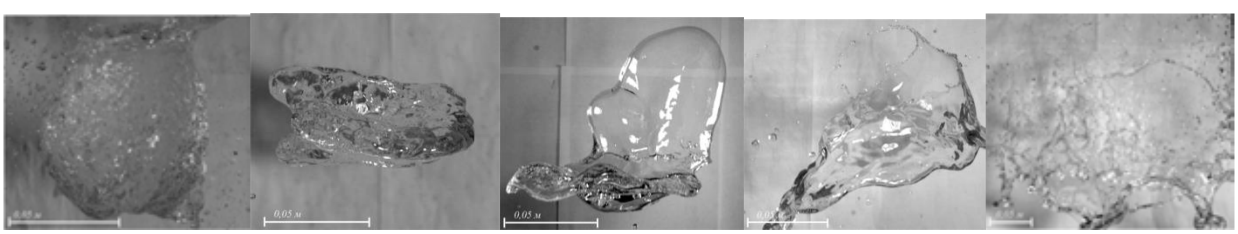
The cycle of experiments included two series of ten experiments each. The video frames of atomized water being directed into the cylindrical channels with the flames were fixed during the first series. The images of droplets after passing through the flame zone were recorded during the second series. The kerosene, alcohol and FFM were used to form the flame. An additional point is that the similar experiments were conducted during passage of the air heated to required temperatures (special fan heaters, tubular heating elements, thermal insulating layers and other assisting elements were applied) instead of the combustion products in the operating cylindrical channel.

Each series of experiments consisted of several stages. A vessel with a capacity of 5 L (7, 10 and 20 L vessels were also used) was filled with water and emulsion on its base. An atomizer (in the case of single droplets – a dosing device with appropriate atomizer) was connected to the vessel's outlet. The atomizer was tuned according to necessary parameters of liquid atomization.

The height of racks for a group of cameras as well as the height of the laser beam were chosen so that an optical axis of cameras and a plane of the laser's light 'pulse' intersected at a 90 degree angle with the point of their intersection in the operating area. The camera was calibrated (with the scale coefficient calculated on a personal computer (PC)) and 'reclasping' of the laser's light 'pulse' tuned. The special sublayer of the setup was filled with liquid or solid substance which was fired later. After 3–5 minutes (the time necessary to heat the intracavity of operating vertical cylindrical channel up to the desired temperature) the special software ('Actual Flow', 'DaVis' or 'Tema Automotive' were applied in accordance to the type of camera, laser and synchronizer used) was started on the PC, the atomizer (or the dosing device) was turned on and videogram recording begun in the operating area. Velocity fields of 'tracer' particles of atomized water were constructed and the speed of the separate droplets calculated in the operating area from the video frames taken.

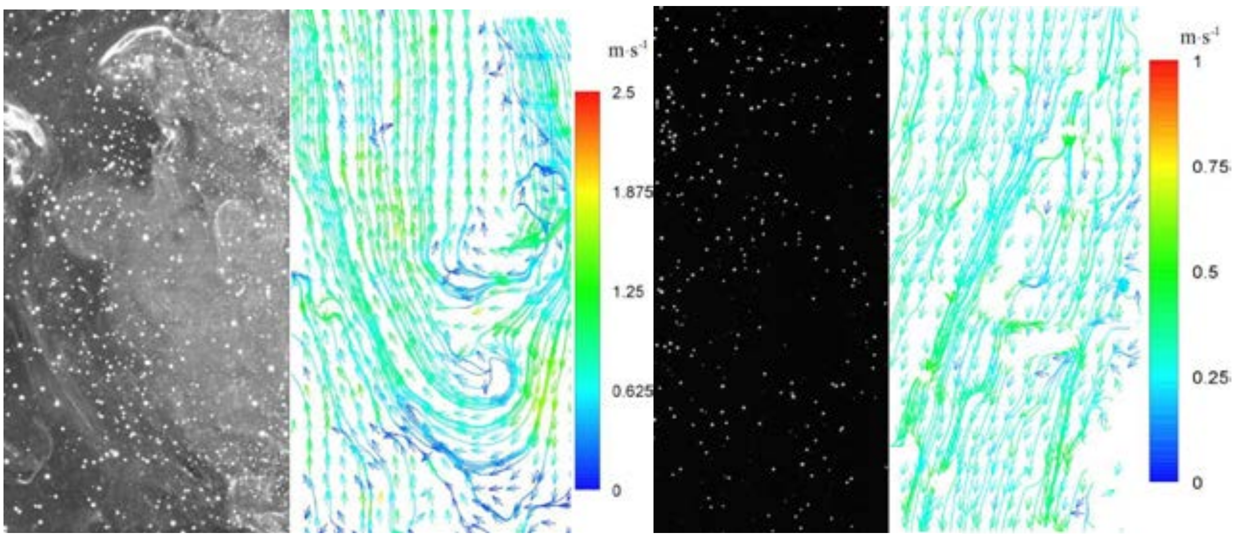
The integral characteristics of motion, evaporation and taking away of water droplets and emulsions on its base were determined using these setups for different suspensions applied in firefighting systems. The main results (typical evaporation speeds, concentrations of droplets in combustion products, fraction of liquid passing through the flames, forms of droplets and agglomerates of them in the flame, etc.) are presented in Kuznetsov *et al.* (2015) andVolkov *et al.* (2015a, b). Figs. 2 and 3 illustrate typical configurations of big water missiles during the destruction, speeds of droplets of atomized streams and combustion products in the flame zone.

Fig. 2. Video frames with the images of missile (initial volume 0 0.3 l) at different stages of destruction (when the fixed dimension of missile motion trace *S*): *a* – formation of a nucleus, *b* – 'flattening' of the missile (*S*≈0.5 m), *c* – formation of bubbles ('parachutes') (*S*≈1 m), *d* – destruction of the 'parachutes' and formation of 'chains' (*S*≈1.25 m), *e* – formation of small droplet cloud (*S*≈1.75 m).



a *b* *c* *d* *e*

Fig. 3. Typical videograms of the aggregate of the liquid droplets and velocity fields of "tracer" particles at the inlet (*a*) and outlet (*b*) from the flame at initial speeds of gases U_g=1 ms^{-1} and droplets U_m=1 ms^{-1}.



a *b*

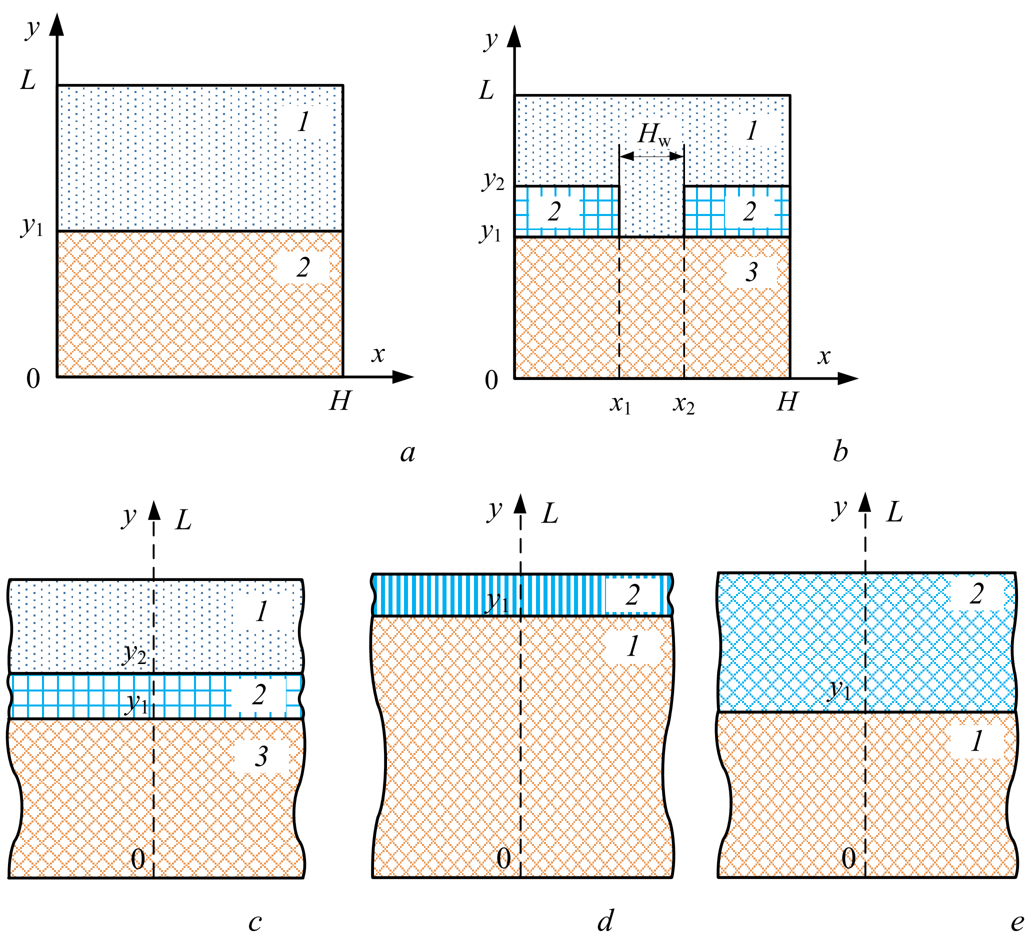
Experiment results using simulated combustion sources established that single water droplets, a group of them of sufficiently large mass to form a film with motion into the boundary layer of FFM can prevent thermal decomposition of forest fuel material (Fig. 4).

Fig. 4. Typical videogram of experiment with the suppression of thermal decomposition reaction of FFM (birch leaves) by the vapor-water mixture: *1* – metal sublayer; *2* – hollow cylinder; *3* – forest fuel material; *4* – vapor-water mixture.

Theoretical research

Experiment results allowed placing individual models into groups of similar heat and mass transfer that suppressed thermal decomposition of FFM when applied vapor-water streams reached their surfaces under conditions corresponding to typical forest fires. Fig. 5 illustrates the most typical schemes.

Fig. 5. Schemes of the developed models of heat and mass transfer: *a* – for the vapor-gas mixture above FFM (*1* – mixture of combustion products and water vapors, *2* – boundary layer of FFM); *b* – for two droplets at the surface of FFM (*1* – vapor-gas mixture, *2* – water droplets, *3* – FFM); *c* – for homogeneous film of water at the surface of FFM (*1* – vapor-gas mixture, *2* – water, *3* – FFM); *d* – for water film with solid inclusions (*1* – FFM, *2* – water with solid inclusions); *e* –at penetration of water into pores of FFM (*1* – layer of FFM with $T>T_d$, *2* – layer of FFM with the pores full of water).



Tables 1and 2, and Figs. 6–8 illustrate the main results of the research using the models presented in Fig. 5.

Table 1. Dependence of evaporated layer thickness of liquid film (L_e, mm) on characteristic size of FFM for the model 'homogeneous water film – FFM'

Characteristic size of FFM, (m)	0.020	0.030	0.040	0.050	0.060
birch leaves	0.0517	0.056	0.0649	0.09	0.1349
pine needles	0.044	0.047	0.052	0.068	0.0985
fir-tree needles	0.0385	0.041	0.0463	0.058	0.0832

Fig. 6. Dependence of time of thermal decomposition suppression of systems 'water with solid inclusions – FFM' when FFM $L_{w\text{-}f}$=0.01 m, γ=0.5, α=20 W/(m^{2}K) (*1*–*3*) and 'homogeneous water film – FMM' (*4*–*6*) on thickness of the sensitive boundary layer of FFM: *1*, *4* – birch leaves, *2*, *5* – pine needles, *3*, *6* – fir-tree needles.

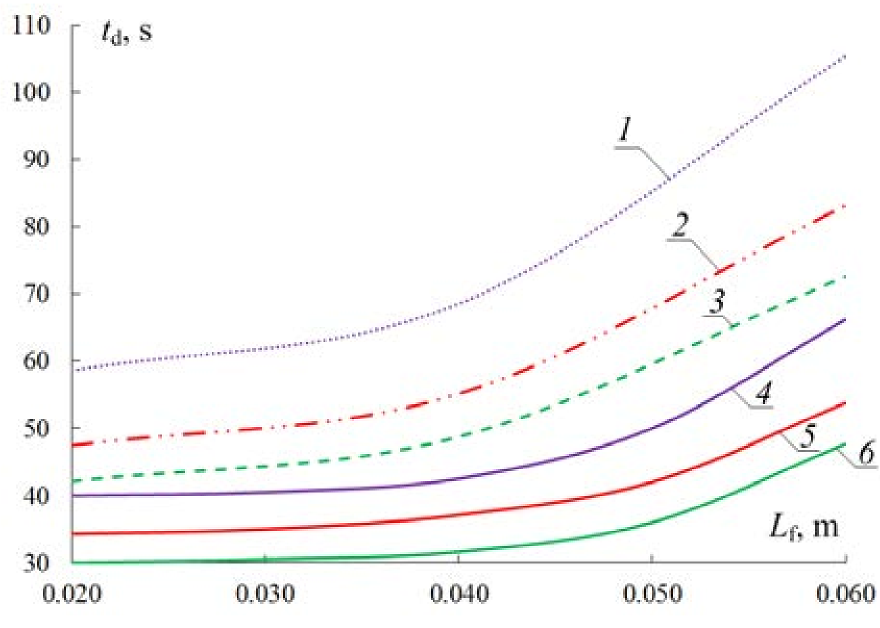


Fig. 7. Dependence of time of thermal decomposition suppression on thickness of 'buffer layer' of the model 'water with solid inclusions – FFM' when L_f=0.04 m, γ=0.5, α=20 W/(m^2K): *1* – birch leaves, *2* – pine needles, *3* – fir-tree needles.

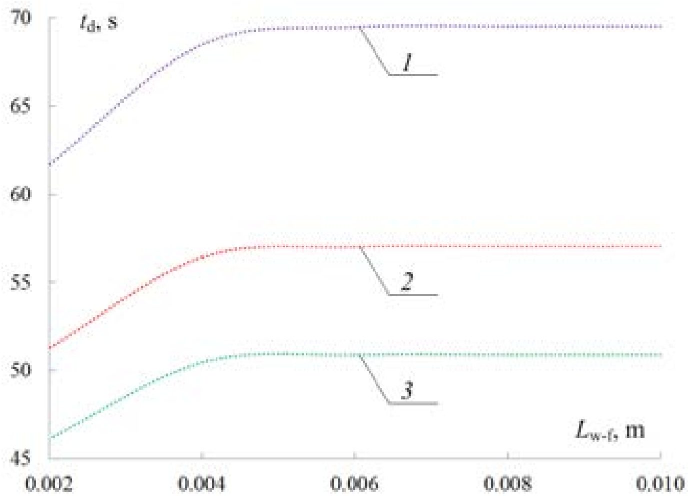
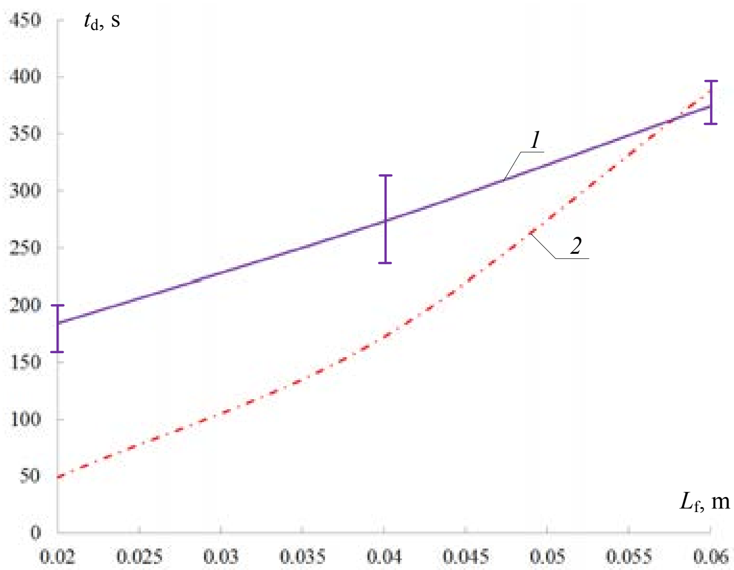


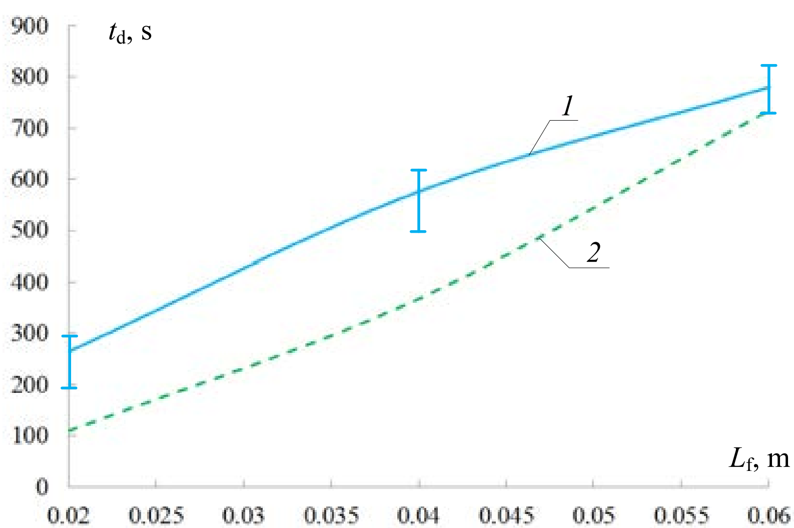
Table 2. Dependence of time of thermal decomposition (t_d, s) suppression of FFM (pine needles) on parameter H_w at various temperatures in the trace of water array and L_f=0.04 m for the model 'group of water droplets – FFM'

Distance between droplets (H_w), (mm) / Temperature In the trace, (K)	0.004	0.008	0.012	0.016	0.0241	0.0402	0.0643
300	42.6	55	68.9	82.3	105.5	136.7	159.9
350	42.6	55	69	83	107	139.9	166.1
450	42.6	55	69	83	109	146.6	180.7
550	42.6	55	70	85	113	154.3	199.5
650	42.6	56	71	87	116	162.9	227.6
800	42.6	56	71	87	116	162.9	227.6

Fig. 8. Characteristic periods of the suppression of thermal decomposition reaction of FFM (a – birch leaves, b – pine needles) at the temperature of the vapor-gas mixture T_f=300 K: 1 – experimental data, 2 – results of numerical simulation.



a



b

Conclusion

Results of experimental and theoretical research suggest it is unreasonable to use large volumes of water for forest firefighting. Using more water than needed results in only a minor improvement in halting the thermal decomposition reaction. We conclude that firefighters can reduce the water used in fire suppression by utilizing the results of the research described in this paper to more efficiently distribute the water applied to the flame zone in both time and space. .

Acknowledgements

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Wildland firefighter safety and fire behavior prediction on the fireline

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Abstract. Using the 2013 Yarnell Hill fatality fire in Arizona as a backdrop, this paper considers whether the global wildland fire community has failed on-the-ground firefighters. To begin answering this question two specific lines of inquiry are addressed: (i) was the fire behavior during the major run beyond what would be predicted by currently available guidelines? and (ii) what fire behavior knowledge and tools are available to allow wildland firefighters to assess their 'margin of safety'? A set of three recommendations are offered in light of our findings.

Additional keywords: fire behavior field guide, fire rate of spread, firefighter travel rate, flame length, Granite Mountain Interagency Hotshot Crew, margin of safety, Yarnell Hill Fire

Introduction

In his seminal work on *Fire Behavior in Northern Rocky Mountain Forests*, Jack Barrows (1951, p. 1), considering the subject of fire behavior and wildland firefighter safety said:

> An important reason for understanding fire behavior is to provide safety for the firefighters. Every fire behavior situation calls for specific safety measures. Experience gained from fighting thousands of fires has shown that the suppression job may be accomplished with a reasonable degree of safety. To achieve safety it is highly important that all firefighters have a general knowledge and the leaders of the firefighting forces have a high degree of knowledge of fire behavior. … Many risks can be eliminated from firefighting if each man knows what to expect the fire to do. The average firefighter need not be an expert on all phases of fire behavior, but he should have a working knowledge of ignition, combustion, and rate of spread of fires burning in forest fuels. Equipped with such basic fire behavior "know-how" the individual firefighter can approach his job without fear and with confidence that he can perform required duties in a safe and efficient manner.

Despite these general recommendations by Barrows, numerous entrapments and burn-overs have occurred that were directly related to an under appreciation or misjudgement of fire behavior potential (e.g. rapid changes in fire spread and intensity) involving both new and experienced firefighters. In an effort to learn from each of the tragedies, the wildland fire community has developed recommendations or lessons learned which have in turn led to a whole host of firefighter safety guidelines starting with the *Ten Standard Fire Fighting Orders* in 1957 (Alexander and Thorburn 2015). Similarly, many advances in fire behavior research and fire behavior training have taken place that have exposed wildland firefighters to a much more rigorous understanding and evaluation of fire behavior potential (Scott *et al.* 2014; Cruz *et al.* 2015). Yet in spite of these advances firefighter fatalities due to entrapments and burn-overs continue to occur. Such incidents are sometimes of disastrous proportions and are not restricted to just North America but are in fact global in nature (Alexander *et al.* 2012).

The circumstances surrounding the Yarnell Hill Fire tragedy of June 30, 2013, in which 19 members of the 20-person Granite Mountain Interagency Hotshot Crew (GMIHC) perished, are documented in Part 1 of the serious accident investigation report of this unfortunate incident (http://www.wildfirelessons.net/yarnellhill). In Part 2 of the report, the investigators raise over 35 questions for ground and air crews, incident and agency managers, and researchers to consider as part of a 'learning discussion'. The wildland firefighter fatalities associated with the Yarnell Hill Fire is one more in a long list of similar tragic incidents from all over the world that prompts us to ask a more general question that should be of concern to the entire wildland fire community: Have decades of wildland fire research, training and administration failed to give firefighters the knowledge, skills and tools to assess potential fire behavior and implications for their safety? The purpose of this paper is to hopefully deepen the learning discussion.

The case of the 2013 Yarnell Hill Fire

According to the Yarnell Hill Fire serious accident investigation report (p. 78), the flame front in the vicinity of the entrapment area/deployment site advanced at a rate of around 270 to 320 m min^{-1} with flame lengths of 18 to 24 m, an extreme level of fire behavior by any account.

Was the fire behavior during the major run beyond what would be predicted by currently available guidelines?

Barrows (1951) outlined the general process of predicting wildland fire behavior that are as valid today as they were nearly 65 years ago (Fig. 1). Most of the operational fire behavior guidelines and modeling systems presently used in the US are founded on the framework as illustrated in Fig. 2. In addressing the question raised above, let us assume that the following environmental conditions prevailed during the major run of the Yarnell Hill Fire based on data and information contained in the serious accident investigation report and Rothermel's (1983) guidelines:

- Fire Behavior Fuel Model 4 – Chaparral (1.8 m) as per Anderson (1982)
- 0% slope steepness
- Fine dead fuel moisture contents of 3%
- Live woody fuel moisture content of 75% (cf. Davis and Dieterich 1976)
- Mid-flame windspeeds of 32-40 km h^{-1} given forecasted 6.1-m open winds of 64-80 km^{-1}

The BehavePlus fire modeling system (Andrews *et al.* 2008) predicted the head fire rate of spread (ROS) and flame length (FL) to vary from 248 to 340 m min^{-1} and 18 to 21 m, respectively. This is a good match with the reconstructed values for the major run.

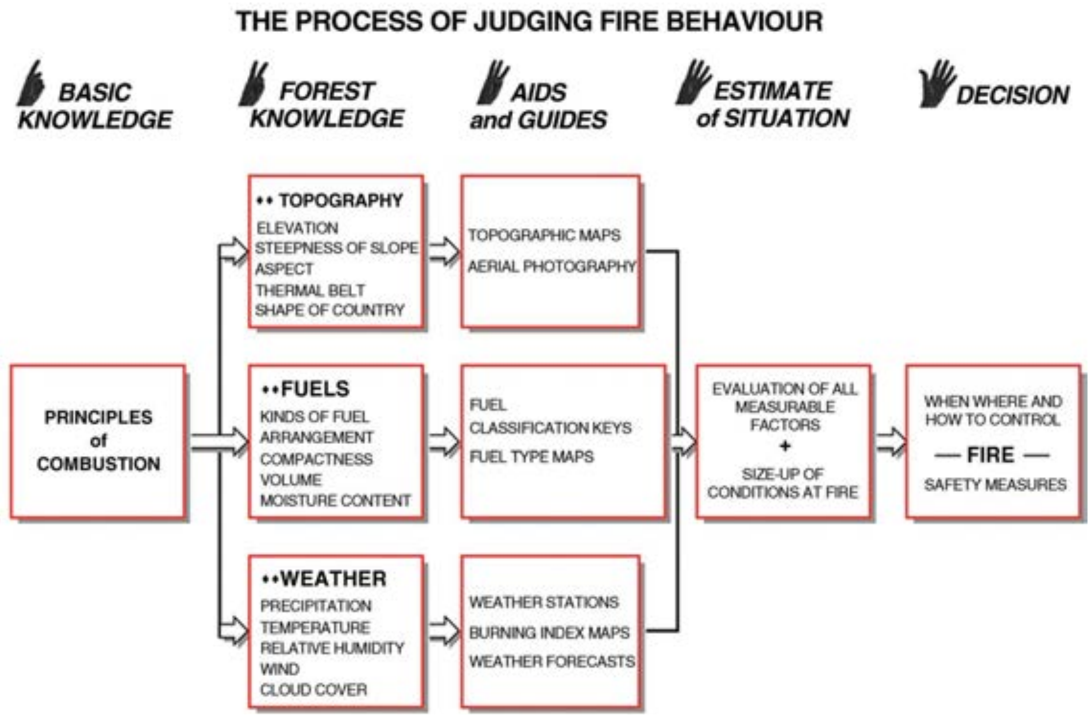

Fig. 1. Judging and interpreting predictions of wildland fire behavior requires the systematic analysis of many factors and considerations (from Barrows 1951).

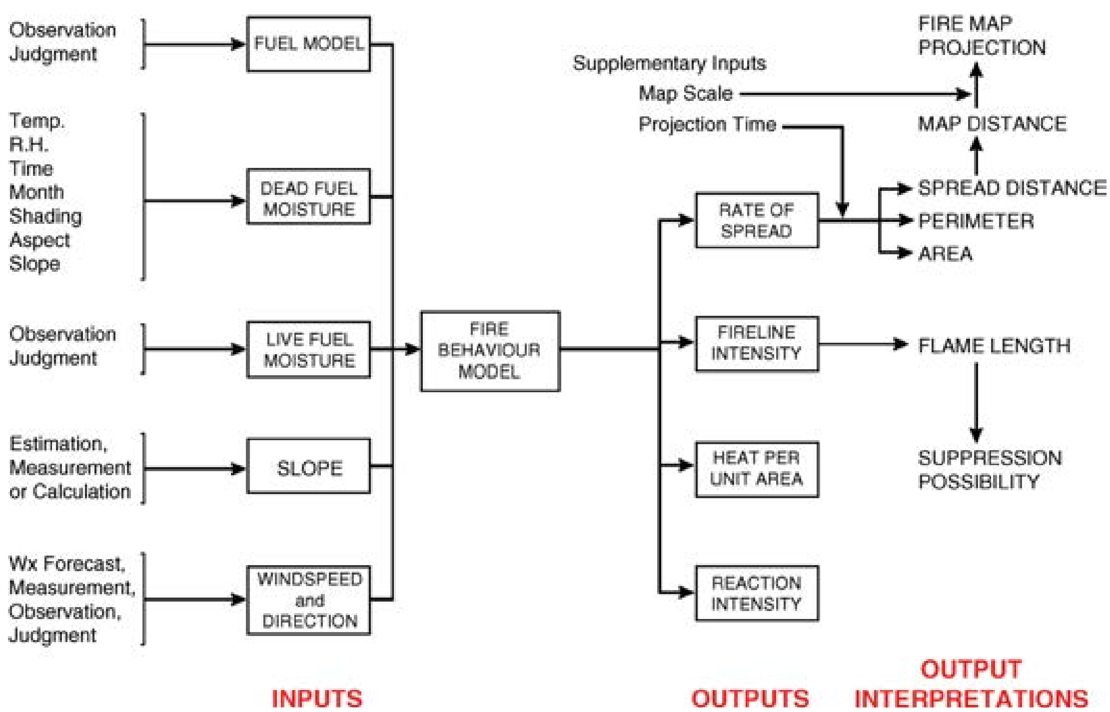

Fig. 2. General information flow involved with the underlying framework of most operational fire behavior guides and modeling systems used in the US (from Rothermel 1983).

For lack of computer access the GMIHC was unable to perform BehavePlus fire modeling system computations on the fireline. The National Wildfire Coordinating Group (2014a) *Incident Response Pocket Guide* (*IRPG*) doesn't include methods to predict or estimate ROS or FL. However, the National Wildfire Coordinating Group (2006) *Fireline Handbook Appendix B: Fire Behavior* supplement does. Table 30 on p. B-74 from that publication is reproduced here as Fig. 3. The tabulation is limited to a maximum mid-flame windspeed (MFW) of 19 km h^{-1} and live woody fuel moisture (LWFM) of 90 to 120%. The maximum predicted ROS and FL are 84-105 m min^{-1} and 11-12 m, respectively, still a very extreme level of fire behavior.

TABLE 30: FUEL MODEL 4—0% SLOPE

Fuel Moisture % (1-Hour)		Midflame Wind, mi/h 0.	2.	4.	6.	8.	10.	12.
		Rate of Spread/Chains per Hour						
3.0	120-90	5	24-29	56-70	97-120	143-178	195-243	252-313
6.0	120-90	4	21-25	49-61	85-104	126-155	171-211	221-272
9.0	120-90	4	19-23	46-56	79-96	117-143	160-194	206-250
12.0	120-90	4	18-22	43-53	74-90	110-134	149-183	192-235
15.0	120-90	3	12-19	28-46	47-78	70-116	96-158	124-204
18.0+	120-90	1	6	11-13	19-23	29-34	39-46	51-60
21.0	120-90	0	0	0	0	0	0	0
		Flame Length/Feet						
3.0	120-90	5.7	12-13	18-20	23-25	27-31	32-35	35-40
6.0	120-90	5.1	11-12	16-18	20-23	25-27	28-32	32-35
9.0	120-90	4.8	10-11	15-17	19-21	23-26	27-30	30-33
12.0	120-90	4.6	10-11	14-16	18-20	22-24	25-28	28-32
15.0	120-90	3-4	6-10	10-14	12-18	15-22	17-25	19-28
18.0+	120-90	1	3	4-5	6	7	8	9
21.0	120-90	0	0	0	0	0	0	0

Fig. 3. Tabulation for Fire Behavior Fuel Model 4 – Chaparral (1.8 m) for zero percent slope contained in the National Wildfire Coordinating Group (2006) *Fireline Handbook Appendix B Fire Behavior* supplement. This tabulation is not available in SI units. Conversion factors: mi/h × 1.61 = km h^{-1}; chains per hour × 0.335 = m min^{-1}; feet × 0.305 = m.

Fire behavior nomograms (Albini 1976; Rothermel 1983; National Wildfire Coordinating Group 1992) were another potential field tool available in 2013 that do allow for higher windspeed values to be considered (Fig. 4). The nomogram for Fire Behavior Fuel Model 4 – Chaparral (1.8 m) gives a predicted ROS and FL of 251 to 335 m min^{-1} and of 18 to 21 m, respectively. Nomograms and also nomographs (Scott 2007), however, are not commonly employed outdoors in fireline situations by fire suppression crews but they are used by a fire behavior analyst (FBAN) at an incident command post, for example.

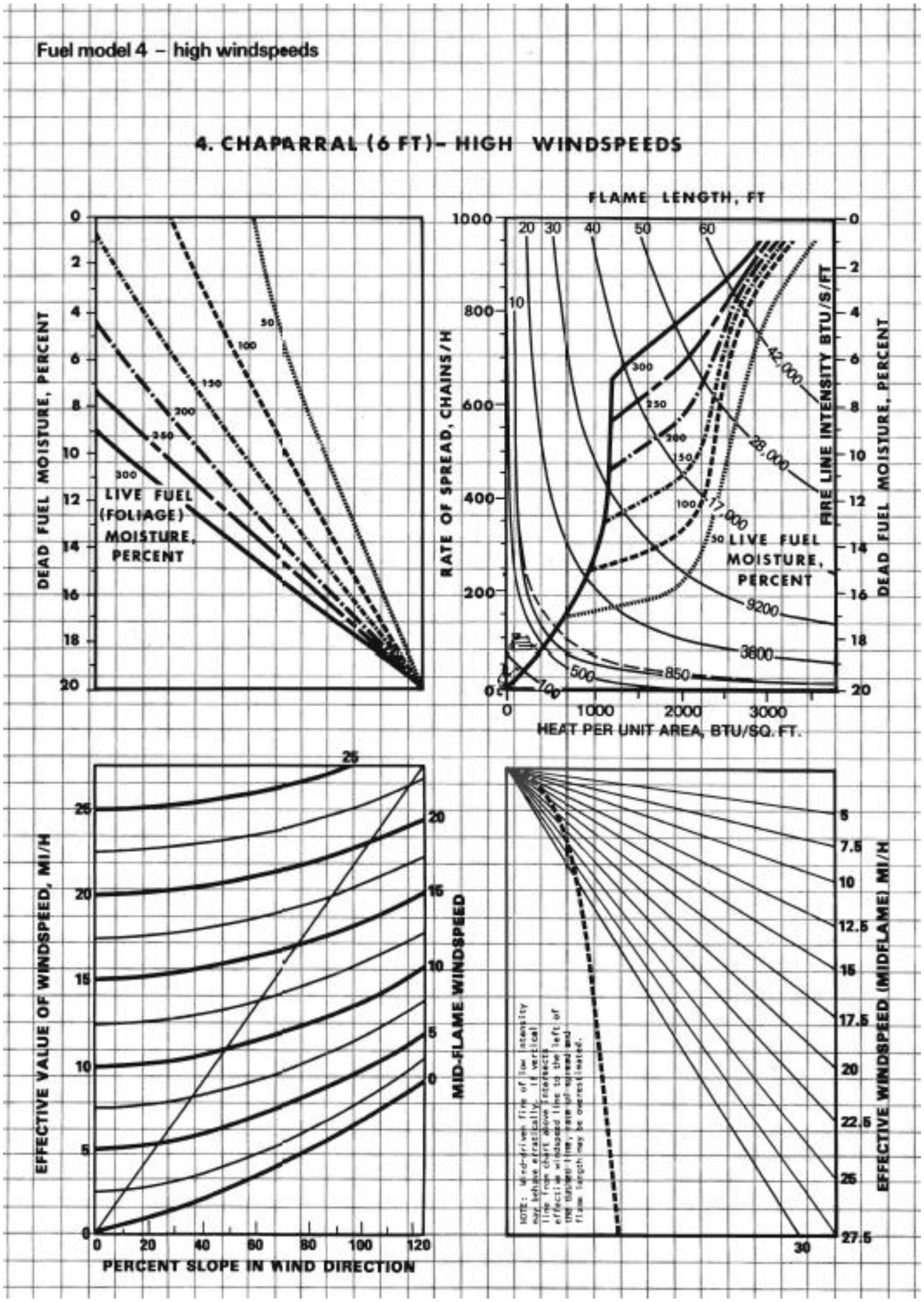

Fig. 4. The National Wildfire Coordinating Group (1992) fire behavior nomogram for Fuel Model 4 – Chaparral (1.8 m) for high windspeeds. This graphic is not available in SI units. Refer to Fig. 3 caption for conversion factors.

The latest edition of the *Fire Behavior Field Reference Guide* allows for a maximum MFW of 32 km h^{-1} for Fire Behavior Fuel Model 4 – Chaparral (1.8 m) (National Wildfire Coordinating Group 2014c, p. 117). Combined with the fuel model, slope steepness, and fuel moistures stated previously, this gives a predicted ROS and FL of 173 to 235 m min^{-1} and 15 to 18 m, respectively. (Note: at some 200 pages in length it is unlikely this guide would be carried on the fireline by an IHC superintendent or assistant superintendent.)

In addressing the question poised at the start of this section, from the perspective of hindsight, one would have to say 'no'. The ROS and FL observed during the major run of the Yarnell Hill Fire on June 30, 2013, was not beyond what could be predicted by the Rothermel (1972) surface fire model in the form of the BehavePlus fire modeling system (Table 1). Some limits imposed on live fuel moisture and windspeed with the three manual methods or tools for fire behavior prediction do restrict the ROS and FL values that are possible (Table 1). However, in real time, decisions can only be made with foresight (Sutton 2011). Whether fire behavior is predictable in practice may also depend on the accuracy and availability of model inputs, appropriate training, whether fire behavior assessment is part of work protocols and operating procedures, and having sufficient time.

Table 1. Summary of after-the-fact predictions of fire rate of spread (ROS) and flame length (FL) by various fire behavior predictive tools for Fire Behavior Fuel Model 4 – Chaparral (1.8 m), including their live fuel moisture and windspeed limits, in comparison to the ROS (270 to 320 m min^{-1}) and FL (18 to 24 m) experienced during the major run of the Yarnell Hill Fire on June 30, 2013

LWFM, live woody fuel moisture; MFW, mid-flame windspeed

Fire behavior predictive tool	ROS (m min^{-1})	FL (m)	LWFM range (%)	MFW maxima (km h^{-1})
BehavePlus fire modelling system (Andrews *et al.* 2008)	248-340	18-21	30-300	64
Fireline Handbook Appendix B: Fire Behavior (National Wildfire Coordinating Group (2006)	84-105	11-12	90-120	19
Fire Behavior Nomograms (National Wildfire Coordinating Group 1992)	251-335	18-21[A]	50-300	38
Fire Behavior Field Reference Guide (National Wildfire Coordinating Group 2014c)	173-235	15-18	80-120	32

[A]The upper FL value was estimated on the basis of the maximum MFW (i.e. 38 km h^{-1}) that could be used given the boundary limitations of the Fire Behavior Fuel Model 4 – Chaparral (1.8 m) nomogram for high windspeeds (Fig. 4).

We do not know, even with the benefit of hindsight, whether a prediction of potential fire behavior was made prior to the crew leaving the safety of the "black" sometime after 1604 h on June 30. However, we do see in several digital images sent out by members of the GMIHC from their cell phones that they did take time to observe the Yarnell Hill Fire's behavior prior to the major run and their relocation. Furthermore, the US Department of Interior and US Department of Agriculture Forest Service (2011) require IHC superintendents and assistant superintendents are required to have taken the course *S-390 Introduction to Wildland Fire Behavior Calculations* which includes instruction in both the *Fireline Handbook Appendix B: Fire Behavior* supplement and the *Fire Behavior Nomograms* (National Wildfire Coordinating Group 2015).

On the basis of an interview (http://www.youtube.com/watch?v=-4hR5annS_Y) conducted by Dave Thomas with Steve Little (Superintendent, Asheville IHC) during the Fire Management Deep Smarts Project (Thomas *et al.* 2012, 2015), it is apparent that some firefighters do in fact utilize the *Fireline Handbook Appendix B: Fire Behavior* supplement to make estimates or predictions of wildland fire behavior in relation to escape routes and safety zones considerations, although it is unknown how widespread and rigorous this practice is at present.

An additional field tool also available in 2013 was the *FireLine Assessment Method FLAME Field Guide* (National Wildfire Coordinating Group 2007). The *FLAME Field Guide* is not used to predict ROS and FL directly, rather it is used to assess dramatic changes in fire behavior (Bishop 2007), particularly in ROS based on changes in windspeed, fuel type, topography, and other fire environment characteristics. All senior firefighters on an interagency hotshot crew (IHC) are required to have taken the course *S-290 Intermediate Wildland Fire Behavior* (US Department of Interior and US Department of Agriculture Forest Service 2011) where instruction in the use of the *FLAME Field Guide* is given (National Wildfire Coordinating Group 2015).

Using the *FLAME Field Guide* for the Yarnell Hill Fire and assuming an increase in windspeed and a change from a backing fire to a head fire with an effective windspeed-ratio of 56 to 64X, the ROS-ratio was on the order of 110 to 140X. That is, a 100 to 140X increase in ROS was predicted given the increase in windspeed and change in wind direction, a value well above the threshold of 60X noted in the *FLAME Field Guide* where past firefighter fatalities have occurred.

What fire behavior knowledge and tools are available to allow wildland firefighters to assess their ‘margin of safety’?

FL values of 18 to 24 m suggests that separation distances of 72 to 96 m are needed (Cohen and Butler 1998), assuming that FL is equivalent to height of the flames. This represents a sizeable area (i.e. 1.6 to 2.9 ha). In any event, a good safety zone is of no use to firefighters if they cannot reach it in time.

The motivation for firefighters to evaluate fire behavior potential is to assess risks to their safety posed by rapid fire spread and (or) intense heat. In his landmark textbook on forest fire control and use, Davis (1959, p. 404) pointed out that:

> Good scouting, communication, knowledge of fire behavior, fire weather forecasting, training, and leadership are the best insurance of safety. If these things are well handled, there is little reason for fire suppression to be more dangerous than any other kind of woods work … There have been instances where there was underappreciation of the danger of a situation and of allowing too narrow a margin of safety.

While Davis’s statement regarding working in the woods may hold in many cases, it is clearly not the case under extreme burning conditions, particularly in open wildland environments.

The margin of safety with respect to wildland fire behavior and firefighter safety was first enunciated in print by Beighely (1995). The concept is graphically illustrated in Fig. 5.

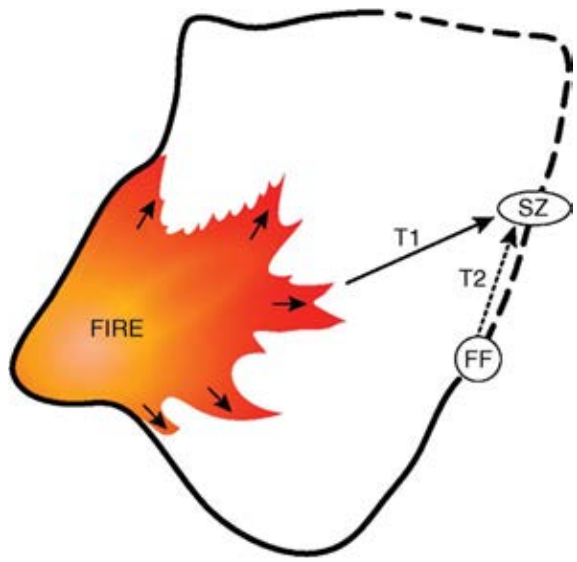

Fig. 5. Illustration of the 'margin of safety' concept involved during indirect and parallel attack wildland fire suppression situations (adapted from Beighely 1995). FF = firefighter(s); SZ = safety zone; T1 = the time taken for the fire to reach the safety zone; and T2 = the total time taken for firefighter(s) to reach the reach the safety zone.

Mathematically, the margin of safety is defined as follows (from Beighely 1995):

$$\text{Safety Margin } (\pm) = T1 - T2 \quad (1)$$

where T1 is the time for a fire to reach a safety zone and T2 is the time for a firefighter(s) to reach the safety zone (Fig. 5). T1 is dictated by the distance involved and the fire's ROS. T2 depends not only on the fire crew's rate of travel (ROT) but other factors such as the delay in recognizing the need to use an escape route as a result of a change or anticipated change in fire behavior, and the time required to communicate this decision to the other crew members (Baxter *et al.* 2004). Equation (1) can also be expressed as:

$$\text{Safety Margin } (\pm) = D1/ROS - (D2/ROT + T) \quad (2)$$

where D1 and D2 are the distances between the fire front and firefighter(s) and the safety zone, respectively, and T is the time taken for the firefighters to initiate travel along the escape route to the safety zone.

A positive (+) safety margin from either equation (1) or (2) implies that the firefighter can reach the safety zone before being overtaken by the fire, whereas a negative (-) safety margin implies that the fire can overtake a firefighter before the firefighter can reach the safety zone. The greater the positive difference between T1 and T2, the greater the margin of safety.

While the margin of safety concept is regarded as useful, application can be difficult in practice. Information on the four key variables shown in equation (2) can be challenging to assess, especially ROS and ROT, partly because they require direct observation, which may be difficult under extreme burning conditions and because they are constantly changing over time and space. ROS and D1 are likely often under-estimated (McLennan 2009). The fire's movement across the landscape requires a constant re-evaluation of both the fire's ROS and position relative to firefighters and safety zones as well as the fire crew's ROT and position relative to an escape route and safety zone. To cope with some of these challenges, firefighters often identify 'trigger point' locations on the fire that will give them, if the fire reaches that location, adequate amount of time to move to an identified safety zone. (Greenlee and Greenlee 2003; Campbell 2005). Although we believe the margin of safety concept to be quite useful in fire suppression operations, we know of no practical guides or tools to assist firefighters with such assessments as documented in the global wildland firefighter safety and fire behavior literature.

Hard data on firefighter travel rates is limited to a few published studies (Rothermel 1993; Butler *et al.* 1998; Ruby *et al.* 2003; Alexander *et al.* 2013). While some existing research is being applied (e.g. Fryer *et al.* 2013), much more observational data needs to be collected in order to cover a wider range of conditions.

While the Lookout(s) – Communication(s) – Escape route(s) – Safety zone(s) *(*LCES) wildland firefighter safety system checklist on p. 6 of the *IPRG* does indicate the need to 'evaluate escape time vs. rate of spread', no mention is specifically made of the need to undertake a margin of safety calculation in the new *Wildland Fire Incident Management Field Guide* (National Wildfire Coordinating Group 2014b).

Wildland fire behavior prediction: slow or fast?

While there have been advances made in fire behavior prediction since Barrows (1951) observations, advances have also been made in the understanding of decision making and human error. Considerable research has been done on decision making under time pressure. Klein (1999) found that many experts rely on intuition informed by experience or 'recognition primed decision-making' (RPD). Rule-based approaches are also used (McLennan *et al.* 2003). While these approaches are effective in many situations, they are not infallible; RPD relies on extensive experience which may not encompass extreme events. What fire behavior prediction provides is access to information that is beyond one's personal experience.

While no fire behavior prediction is perfect (there is inherent uncertainty related to weather forecasts and model error), accuracy can be in the order of 60 to 80% (Cruz and Alexander 2013). However, assessments of fire behavior and margins of safety require the explicit, systematic analysis of many factors. This kind of rational thought process (sometimes called 'System 2') is inherently hard and slow, as opposed to the quick, intuitive judgements of 'System 1' (Kahneman 2011). Even the most basic fire behavior prediction takes some time, perhaps a few minutes. Klein *et al.* (2010) estimated that urban fire department commanders made 78% of their decisions in less than one minute. Just as we often require structured processes and external aids for many rational thought processes, such as a pencil and paper to do mathematics (Heath 2014), work processes, decision aids and training are as essential to operational fire behavior prediction and as deserving of attention as the science itself.

In a general sense one has to wonder just how often, if at all, are current fire behavior guides utilized by field going personnel, and if they are not being used, why not? Is there a lack of confidence in the models upon which they are based? Is it a case that the existing field tools are not convenient to use on the fireline? Could the margin of safety implications be simplified (e.g. Cheney *et al.* 2001)? Is too much reliance placed upon experienced judgement (Burrows 1984) over systematic, model based assessments? Is the main obstacle to full use of fire behavior models and guides under fireline conditions the fact that there appears to be no standard operating procedure on how to use them? Is there not enough time in the day to undertake the calculations of ROS and the margin of safety (Fig. 6) to aid anticipatory thinking (McLennan *et al.* 2009) ?

Element	**Daily fire behavior prediction**	**Fire behavior concern**	**Imminent threat**
Fire personnel	Fire Behavior Analyst	Fire crew leaders –	Crew
Decision time	Days to hours	Hours to minutes	Minutes to seconds
Thought process	Rational	Intuitive/Rational	Intuitive
Tools	Fire behavior models, training, experience	Fire behavior guides, training, experience	Training, experience, mental models
Decision/Plan	Daily incident action plan	Re-evaluate strategy & tactics or disengage tactics	Disengage or seek out survival zone

Time wedge

Fig. 6. Illustration of fire behavior assessment and decision making- during a critical day. As fire behavior and the tempo and urgency of events escalates, the ‘wedge of time’ available to evaluate fire behavior decreases.

The time available for fire behavior assessment during a firefighter’s work day may be seen as an arrow or wedge of time (Fig. 6); the broad end often begins with a morning briefing on the daily plan and on a large incident may include discussion of fire behavior potential with a FBAN. During the day the time available for decision making may narrow with increasing fire behavior and the tempo and urgency of events; on a critical day the sharp end may narrow to mere seconds if firefighters are confronted with an imminent threat. The sharp end of the time wedge is clearly too late for fire behavior prediction, but the question arises as to what point(s) should updated fire behavior predictions be used to reassess or ‘replan’ current tactics? In part this requires overcoming the tendency to continue with an existing plan (Sutton 2011; Frye et al. 2014).

Current approaches to understanding the human contribution to accidents emphasize that, while safety is not inherent to systems, human error is connected to the tools, tasks and operating environment we regularly utilize. Progress in safety will be made by understanding and influencing these connections (Dekker 2002, 2014). The issue is undoubtedly multi-faceted. There is an overriding need for wildland fire and human factors researchers to work together with firefighters and managers to better understand decision processes, tasks and the operating environment in order to improve the connections between decision aids, training, communications and protocols – to better connect human behavior and fire behavior. Nevertheless, the creation of a 'fire behavior pocket guide' with the on-the-ground firefighter in mind would appear to be in order, not just in the US or Canada but globally using as a starting point ideas from existing field guide formats (Taylor *et al.* 1997; Sneeuwjagt and Peet 1998; National Wildfire Coordinating Group 2006; Gould *et al.* 2007; Pearce *et al.* 2012). and interpretive guidelines and threshold values that aim to reduce risk by managing exposure to extreme fire behavior (i.e. risk = hazard x exposure x vulnerability); see, for example, the Operational Safe Work Standard 5 discussed by Beck *et al.* (2002). Perhaps it is now time to consider the application of a mobile device for use on the fireline (Broyles and Verania 2006; Anderson *et al.* 2008) as part and parcel of one's personal protection equipment.

Implications for wildland fire science and management

In light of the Yarnell Hill Fire and similar tragedies on other continents in the past, we believe the following steps should be undertaken:

(1) Undertake a comprehensive literature review/annotated bibliography related to the subject of fire behavior and firefighter safety (e.g. firefighter travel rates on escape routes, safety and survival zones, fire behavior guides, thinking under uncertainty, decision making, organizational safety, risk management) including how such information is incorporated in wildland fire training and standard operating programs.
(2) Undertake interviews with selected individuals in the wildland fire community along the lines of the Fire Management Deep Smarts Project as to: (i) how they are currently using fire behavior information in the field in regards to firefighter safety and what they think should be done to improve field applications of it, including knowledge gaps, and (ii) how and why responders successfully withdrew from incidents that resulted in entrapment of others.
(3) Convene a working group to analyze the information gleamed from steps 1 and 2 to make recommendations regarding management actions and address research needs in the form of an international workshop and symposium, complete with compendium.

Potential organizations that should be involved in such an undertaking include the Australasian Fire and Emergency Service Authorities Council, Bushfire & Natural Hazards Cooperative Research Centre, Canadian Interagency Forest Fire Centre, Fire Management Study Group of the North American Forestry Commission, Food and Agriculture Organization of the United Nations, Forest and Rural Fire Association of New Zealand, International Association of

Wildland Fire, Joint Fire Science Program, National Interagency Hotshot Crew Steering Committee, National Wildfire Coordinating Group, Pau Costa Foundation, and Wildland Fire Lessons Learned Center, just to name a few.

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Using Historical Photograph Collections to Identify Indigenous Burning Patterns

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Abstract

Identifying historic disturbance patterns is a critical prerequisite before undertaking any ecological restoration or for that matter, planning for landscape or ecological management. Of equal or greater importance, is understanding how those disturbance patterns came into being or were maintained. Indigenous fire has been recognized as a principle tool for a variety of multiple resource uses and benefits. While the scale of use has been debated, there is increasing consensus that frequent fire maintained certain ecosystems.

In latter stages of ecological succession, the historical use of frequent fire is very difficult to ascertain. There are ecological indicators that can be found through careful assessment and interpretation. Identifying low intensity fire patterns is difficult as it does not leave significant markers on the landscape. These are often lost over time thru successive vegetative types or expansion of coniferous forests. Historic and repeat photographs often provide some insight but are usually, only a single image or a few images that may or may not represent the landscape. and as such have limited usefulness.

Early Canadian surveyors took systematic glass plate photographs as they surveyed the mountain regions of western Canada. Through the Mountain Legacy Project, these collections are being identified, digitized, and retaken in effort to explore change in Canada's mountain environments. MLP researchers seek to re-photograph these images as accurately as possible and make the resulting image pairs available for further investigation. With careful interpretation, these collections could represent the equivalent of the Rosetta Stone in understanding patterns and scale of indigenous fire use prior to European settlement as well as providing a baseline for landscape management and change.

Introduction

The use of fire by humans has been credited as being a major factor in human evolution. So much in fact that its use has been identified as one of the defining characteristics of the human species. Darwin had considered that the development of languages and the use of fire were the two most significant achievements of humanity (a). Evidence recently found in caves like Wonderwerks and Swartkrans has determined that the control and use of fire by early hominids may have occurred as early as 1.5 million years ago, much earlier than originally believed (b).

With the passage of time, the knowledge of the use of fire and its benefits was gained through trial and error and observation over generations. Fire, the significance of its use and its adaptation by humans, became much more that warmth, cooking, and protection from predators.

Humans learned to use fire to change and shape the surrounding ecosystems to suite their needs. “The most significant type of environmental change brought about by Pre-Columbian human activity was the modification of vegetation. … Vegetation was primarily altered by the clearing of forest and by intentional burning. Natural fires certainly occurred but varied in frequency and strength in different habitats. Anthropogenic fires, for which there is ample documentation, tended to be more frequent but weaker, with a different seasonality than natural fires, and thus had a different type of influence on vegetation. The result of clearing and burning was, in many regions, the conversion of forest to grassland, savanna, scrub, open woodland, and forest with grassy openings.” (c)

From there, the knowledge and use of fire continued to grow. Its research, discoveries, and breakthroughs came through generational research, not two or three generations but hundreds, perhaps thousands. The knowledge gained was passed on the next generation mostly through oral tradition, practical application and use. Within nomadic hunter gather societies around the world, concepts related to the use of fire such as when to burn, what to burn, reasons for burning, etc. all became embedded within day to day activities with barely a thought of its use or value. At the same time, European agrarian societies, as well as others, while still using fire, lost the understanding of many of those concepts.

With the discovery and colonization of North America came a significant shift in land management. The use of fire as practised for millennia by Indigenous peoples prior to European settlement was all but stopped as settlement expanded across North America. Until recently, anthropologists, failed to recognize the use of fire, the extent of its use, as well as its cultural roots as part of the indigenous societies using it. As such, the knowledge known by indigenous peoples related to the use of fire, its expanse, and its effects, was never recognized, especially in respect to creating and maintaining biodiversity in North American ecosystems.

In addition, a somewhat mythological pattern has persisted from early European settlement onwards, with the belief that North America was a pristine wilderness, a New Eden, a paradise lost, etc.. As well, the indigenous peoples were considered to be a primitive stone age peoples who did not possess either the knowledge nor the tools to create and maintain landscape level changes on ecosystems. By not recognizing the incredible knowledge used by Indigenous peoples in landscape management and maintaining the notion that “they were a benign people treading lightly on the land” (d) has resulted in convoluted understanding of ecological management in North America and practises bordering on mismanagement.

In recent years, a greater understanding of the complexity of Indigenous cultural knowledge and practises are being recognized. The use of fire is now being acknowledged as a critical cultural tool (amongst others) that was used to both change and maintain ecosystems. The use of fire is recognized as being much more widespread than ever understood or believed. In recent years, works by Stewart, Lewis, Anderson, Ferguson, Pyne, etc. have been changing perspectives and our understanding of Indigenous practises and their impacts on shaping our landscapes.

While there are many references to the use of fire, recent fires, etc. in journals from early explorers, fur traders, settlers, etc., the extent of the use of fire as a tool for creating and maintaining ecological change is not understood nor easily substantiated. "Evidence for the purposeful use of fire by American Indians (also termed Native Americans, Indigenous People, and First Nations/People) in many ecosystems has been easy to document but difficult to substantiate. Commonly, many people, even researchers and ecologists, discount the fact that the American Indians greatly changed the ecosystems for their use and survival." (e)

The Mountain Legacy Project

Even with the use of historic photos, evidence of Indigenous burning patterns is difficult to determine. Few photos were taken with the intent of capturing landscape vegetative patterns. Those that were taken are often single in nature as opposed to capturing the entire landscape with multiple photographs and stations. Critics would suggest that bias may have been brought into the location of the camera station and/or the framing of the photograph to select the landscape being photographed. Other images for other purposes sometimes captured the landscape in the background but only incidentally.

During the surveying of the mountainous regions of Western Canada, Canadian surveyors developed a unique "Photo Topographic Survey System" in which, in addition the the regular survey equipment, they brought glass plate cameras and used them to capture a series of panoramas from each of their camera stations. The photographs were used with a focal plane technique and in conjunction with the collected survey data to draw the first topographic maps of the areas being surveyed. Between the early 1860's to the early 1950's, an estimated 145,000 systematic landscape photographs were taken. The surveyors captured entire regions in one season, with stations that often looked back into the same area from different perspectives allowing for better interpretation as well as broader landscape perspectives due to the numbers of images taken.

As the lead for the Mountain Legacy Project, the School of Environmental Studies, University of Victoria, is leading research in respect to the various collections. Project members are utilizing archival research, digitization of the glass plates, repeat photography, as well as scientific, historical, and cultural analyses of repeated historical survey photographs to assess landscape change in the Canadian Rocky Mountains over the last century. There is considerable evidence within these collections that much of the change relates more to fire exclusion (the decline of Indigenous use of fire) rather than modern fire suppression as is often expounded.

The Mountain Legacy Project maintains strict scientific standards for repeating the historic imagery. Wherever possible, the repeat camera is located sub-meter to the location of the original camera. In many cases, this will mean moving the camera and resetting several times at a single station as the original camera was moved to obtain the best view for that specific image. Care is taken in selecting camera/lens combinations to ensure that they are comparable with the original cameras field of view, have appropriate resolution, as well as compatibility. Detailed field notes are kept of each image taken including weather conditions at the time, GPS location, site description, access, etc. These are used as reference during follow up research as well as for future return trips to the same station for "third views". Third views are follow repeats of the same station in advent of time or major disturbances such as fire. This provides opportunities for tracking ecological or landscape change over time.

Evidence of Indigenous fire at both a localized as well as landscape levels become apparent when comparing the historic images to those from surrounding stations as well as to the more recent repeat photography taken by the Mountain Legacy Project. In some cases, the original surveys plus subsequent surveys of the same region along with modern repeat images are documenting pre-European disturbance patterns, early European settlement, and more recent disturbances and ecological change.

The Mountain Legacy photographs provide an excellent tool for research in a variety of disciplines. They were taken in a very systematic fashion, are well documented, have exceptional resolution, and cover entire landscapes in the same season. In the same image, often both historic disturbance patterns as well as early European incursions can be identified.

Analysis

Evidence of Indigenous burning patterns including specific localized sites (yard burning), travel corridors (corridor burning) (f), or broader landscape burning can be readily seen on many images from the earlier surveys. As a general rule, most of the Indigenous burning practises were done outside of the more severe burning conditions found in mid summer or the peak of “fire season”(g). This practise generally resulted in low intensity fires with much less severity. The frequency of this type of burning, over the same areas, created a very short term fire return interval. Over time, possibly millennia, these frequent fires coupled with bison herbivory created and maintained rich open grassland ecosystems. Due to the short return intervals, these sites can often be identified in the historic images, in part due to the open nature of the repeated disturbance patterns and also through location (ie valley bottom) aspect, the lack of larger dead and down woody material, etc. These same sites can often be differentiated from natural openings such as sub-alpine meadows, wet land sites, etc. on the repeat imagery. Most often, those areas in which Indigenous burning had historically occurred have grown back in with forest cover once the frequent disturbance regime stopped. In addition, photo analysis and interpretation can be supported through references from other disciplines as well as historical documentation.

The following is a brief sample of an interpretation of select image pairs (historic and repeat) from various surveys from the Mountain Legacy Project Collection. (All photos are used with permission from the Mountain Legacy Project.)

Castle West, Bridgland 1914, repeated 2006

Castle Mountain located above the South Castle River is critical Mountain Sheep habitat. The west facing slopes of the Castle were maintained through frequent indigenous burning. The use of fire by Indigenous peoples stopped shortly after the signing of Treaty 7 in 1877. Magnification of the high resolution historic image shows light woody vegetation ingress onto the lower and mid-slope of the mountain. Isolated Douglas Fir, surviving years of low intensity fire, are evident on the slopes. Isolated draws have some coniferous growth particularly on north facing aspects. The South Castle valley burnt in 1932. Heavy snow damage, occurred with an unusually late snow event in early June 2002, resulting in considerable stand damage.

Bellevue, Bridgland 1914, repeated 2006

The hamlet of Hillcrest was established below and east of Turtle Mountain, In the early 1900's it was known as "Stump Town", the stumps being left from the large scattered Douglas Fir that survived the frequent spring fires that burnt through the area. To the west, the Crowsnest Pass, was a main travel corridor for Indigenous peoples crossing over the Great Divide. In the middle left, the edge of the Byron Hills can be seen. In both images, burnt trees provide evidence of less frequent fire events, in this case; the area burnt in 1910 and 2003 respectively.

Lusk Creek, McArthur 1889, repeated 2012

The Lower Kananaskis River, adjacent to the Bow Corridor, was subject to frequent fire used to maintain grass lands for bison. It was also part of 2 major travel corridors used by Indigenous peoples. The Bow Corridor carried on beyond Banff as a travel route to the present day Shuswap Lake area. The Kananaskis valley, Elk Valley, and finally the Flathead provided a travel corridor well down through the Western United States. Aspect played a key role in early spring burning limiting which fuels would respond.

Summary

Systematic photograph collections created by early Canadian Surveyors provide a unique opportunity for research in a number of unrelated disciplines. The repeat photography of those same images completed to a scientific standard as provided by the Mountain Legacy Project further enhance those opportunities by providing the ability to complete comparative analysis of those landscapes. The use of fire by Indigenous peoples is clearly evident in numerous surveys across the Mountain Regions of Western Canada.

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The Sounds of Wildland Firefighting in Action: A Communication Research Study

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Abstract:

Although radio communication is common in wildland firefighting our research has shown that the current training in radio communication best practices tends to be mostly informal and inconsistent across fire organizations. Our poster focuses on the research process involved in studying this safety issue and the goals of our grant funded research.

Additional Keywords: radio communication, communication research design, high-reliability organizing mindfulness

Introduction

The goal of this poster presentation was to share what we have learned about the process of conducting research on radio communication practices in wildland fire. How people talk to each other using radios and other communication devices during an incident to maximize principles of high-reliability organizing mindfulness is not well understood. Furthermore, the current training in radio communication best practices tends to be mostly informal and inconsistent across fire organizations. By focusing attention on how interactions and sensemaking in the field are shaped by available technologies, this study, funded by the Joint Fire Science Program, seeks to benefit members of the inter-agency wildland fire community and the human factors research community.

Specifically, our research project seeks to accomplish the following goals: (a) to understand how people make sense of radio messages on an incident while distributed geographically; (b) to understand opportunities as well as practical and cultural constraints within current radio and other practices for communicating risk; and (c) to understand how interactions in the field are shaped by the available technologies.

Although our overall goal may seem straightforward, the process of researching radio communication in wildland fire is complex and presents several obstacles. Our study involves observing communication in multiple contexts (active fire incidents, training simulations, and dispatch centers) as well as conducting follow-up interviews, and analyzing actual radio transmissions. This poster reveals the steps that have been taken to accomplish this type of research with the intent of producing research articles and conference presentations that contribute to both theory and practice and increase firefighter safety. We discussed developing project goals, interviewing people in the field, navigating human subjects review processes, and producing materials such as “Informed Consent Forms,” “Interview Protocols” and “Observation Protocols”, etc.). Additionally, we engaged IAWF conferences goers in a conversation about our project in order to learn from their experiences communicating on wildland fires. By introducing this study to the IAWF community during the combined Safety Summit and Human Dimensions Conferences, we gained feedback on our methods and support for our study.

We all play a part- Bushfire Ready Neighborhoods

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Bushfire season after season, emergency services agencies urge householders in bushfire prone areas to plan and prepare. Yet, despite increasing investment in risk awareness and education campaigns, agencies and research bodies continue to report that many people do not do either. Typically, according to post-fire studies, many householders do not have a plan of action, and wait until the last minute to leave1. This conundrum has continued to vex and confuse agencies. What might it take to get people to prepare to survive, protect their properties and safeguard their livelihoods?

In 2009, against a backdrop of calls for shared responsibility for disaster resilience, the Tasmania Fire Service (TFS) set out to investigate. In partnership with the Bushfire CRC and University of Tasmania researchers, they started researching and developing a more effective and sustainable approach to their own community bushfire education programs. Their main aim was to understand how householders interpreted risk and what influences drove their decisions on whether to plan and prepare. These new insights would, in turn, helped TFS refine and target messaging, resources and interventions. Over the next few years (2009-2013), from that initial concept, the agency-research partnership co-developed, piloted and refined a new practical community engagement model, which ultimately transformed TFS's thinking and approach to bushfire mitigation.

Under the new approach, the agency takes on a facilitator role, connecting, supporting and enabling communities and householders to take the necessary steps to plan and prepare. TFS provides guidance, tools and templates, as well as resources and targeted interventions. But in many cases they remain in the background so that the community can lead and drive the action. In this context (Paton 2006), agencies "act as consultants to communities rather than orchestrate the change".

By 2015, the new TFS community education approach, entitled Bushfire Ready Neighbourhoods, had been integrated into operations and rolled out to over 40 communities across Tasmania. Along the way, TFS earned the support of the three tiers of government for the initiative, and was recognised by the Australian Government in 2014 with a State and National Resilient Australia Award for its contribution to promoting and building disaster resilient communities. In 2015, TFS's Community Development Coordinator, Peter Middleton, detailed the program at the International Association of Wildland Fire Conference in the United States. This case study describes how TFS contextualised, piloted, implemented, adopted and evaluated research, from the initial concept through an adoption pathway to integration within its core operations.

Bushfire Ready Neighbourhoods, TFS's community development program, has been built on the premise that there is no one-size-fits-all solution to community resilience and preparedness. Shared responsibility for community resilience, says Peter Middleton, is a complex challenge that aims to change behaviour. "And while we at TFS have come a long way, we know there is still a long road ahead," he explains.

TFS's clear objective has been to help develop, support and grow community resilience to bushfire by empowering communities to plan and prepare. In order to make that happen it has had to re-engineer its practices and operations to engage at-risk communities fully in bushfire preparedness.

Conclusion

The use of evidence and research to support decision making and evaluation, together with the application of best practices in community engagement, project management and organisational learning have been critical to the agency's success to date.

Critical factors include:

- Collaborating with and actively involving all stakeholders (internally and externally);
- Being innovative, flexible and creative in their approaches, such as considering different modes of learning by developing a suite of various resources and ways of presenting information;
- Training and development of TFS staff and volunteer brigade members to expand their skills and knowledge;

- Investigating and applying sector research findings, peer benchmarking and presenting the program at sector, state, national and international conferences (e.g. Human Dimensions of Wildfire Conference 2015 – USA), and publications (e.g. http://wildfiremagazine.org/article/bushfire-ready- neighbourhoods-we-all-play-a-part/);
- Reinforcing the brand of the program "Bushfire Ready Neighbourhoods. Individuals, TFS, Communities. We all play a part."

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Climate Wise Communities: enhancing traditional bushfire risk management using a community multi-hazard resilience program in Sydney, Australia

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Abstract:

Recently increasing extremes in fire weather and events have highlighted deficiencies in traditional bushfire hazard management. Australian policy has yet to effectively apply social dynamics into bushfire resilience which may explain why traditional approaches fail to sufficiently protect communities. Ku-ring-gai, NSW, Australia has a history of bushfire impact due to climate, extensive urban-bushland interface and population density. To better prepare for bushfire, Ku-ring-gai Council adopted a shared responsibility approach using the Climate Wise Communities (CWC) program. Interactive exercises and scenarios facilitate assessment of extreme weather vulnerability and planning for improved resilience. In collaboration with emergency services, Government, and not-for-profit agencies Council delivered targeted workshops to highly vulnerable sectors and localities. Over 220 have participated including families, neighbourhoods, community groups and social services. Aged care and early childhood businesses also trialled a multi-hazard approach successfully. Participation guides timely evacuation, property resilience and realistic stay and defend assessments. Outcomes include better household preparedness and decision-making. Continuing program refinements will develop networks to build independence and aid recovery that will also integrate small business, property owners, women's groups and non-English speaking residents. The authors propose that social dynamics adds much needed latitude and flexibility to traditional bushfire risk management.

Additional Keywords: bushfire, CWC, climate adaptation, resilience, shared responsibility, preparedness, social dynamic

Introduction

Climate

A comprehensive evidence base demonstrates that the global climate is changing (IPCC, 2014). The scale of the warming has often been unprecedented for millennia and the most recent decades have been some of the warmest observed on record. The risks emerging from these changed weather patterns feature more frequent and intense extreme weather events that put communities, environments and economies at risk and demand a response from decision makers into formulating actions to reduce vulnerability by strengthening preparedness.

In New South Wales, Australia the rate of the warming has accelerated in recent decades. The period of 1997-2013 was an unprecedented series of warm years with some of the hottest on record (NSW OEH, 2015). The NSW and ACT Regional Climate Modelling (NARCliM) project has generated downscaled projection models using the IPCC high emissions scenario A2 to map temperature, rainfall and Forest Fire Danger Index for twelve regional areas of South-east Australia (Evans et al., 2014). For the Sydney region maximum and minimum temperatures are projected to increase with more hot days (above 35°C) and fewer cold nights. Rainfall variability is projected to shift seasonally, increasing in Autumn and decreasing in Spring. These projections exacerbate the fire weather risk which is expected to increase as a result, mainly during spring and summer – the typical prescribed burn periods and peak fire risk seasons (NSW OEH, 2014).

Locality, choices, vulnerability

These projections present challenges for local government areas such as Ku-ring-gai on Sydney's upper North Shore. Ku-ring-gai is a typical example of Sydney's complex topography intersecting with dense residential development. The municipality covers 8400 ha with a population of 120,978 (ABS, 2014). Past land use planning decisions have resulted in urbanised ridgetops often accessed by a single road and enveloped by extensive tall dry eucalypt forest on steep slopes. Much of this bushland is contiguous with larger natural areas in National Parks to the north, south-west and east, making it one of the most bushfire-prone areas in Greater Sydney and Australia-wide (Chen, 2005).

Despite, its bushfire-prone status, living in Ku-ring-gai is often described as a lifestyle choice. Amongst other things the areas proximity to transport, services and good schools, historic homes, sense of community and physical setting are a drawcard. Peoples choices of where to live do not necessarily acknowledge potential risk from natural hazards. This may be a result of their priorities, lack of knowledge or experience of a natural disaster or social-demographic characteristics (Solangaarachchi et al., 2012, Morrison et al., 2014, Winter and Fried, 2000 cited in Cottrell, 2005, McCaffrey et al., 2011). These elements may effect a person's risk perception which can ultimately influence their choice on where they reside (eg. the urban bushland interface) and whether they take specific precautionary actions.

Traditional management
Ku-ring-gai has experienced a range of extreme weather events in the past and has a history of destructive fires impacting the urban-bushland interface. Large scale and intense bushfires impact the area on average once every 10 years (HKBFMC, 2010). To assist in reducing the risk and impact of bushfire on life, property and environment, land managers have statutory obligations and are committed to undertaking fuel management. However, recent fire events across Australia have demonstrated that traditional hazard reduction measures are inadequate in the face of large scale, catastrophic fires (VBRC, 2010). This is compounded by reduced opportunities to undertake prescribed burning and decreased effectiveness of hazard reduced areas to provide protection under extreme conditions (Lucas et al., 2007, Hennessy et al., 2005, McCarthy and Tolhurst, 2001 cited in Fernandes and Botelho, 2003).

Consideration of a resilience focus
In a national inquiry into bushfire mitigation and management following the 2002/03 fire season, Ellis, et.al (2004) concluded that we need to adapt the way we plan and respond to changed fire regimes. Although policy developments continuously demand more intensive fuel management treatments, it is evident communities remain at significant risk if they solely rely on land managers and fire agencies to protect them. The situation demands consideration of community and residential scale adaptation measures to encourage individuals to contribute to their own personal protective measures. Local governments have a duty of care under law and a moral responsibility for the welfare of their communities. Understanding this, Ku-ring-gai Council has invested in research to develop a program that assists residents to assess their vulnerability to extreme weather events and build resilience to bushfire and other natural hazards. According to the regional climate modelling such events are more likely to impact the Ku-ring-gai area in the future (NSW OEH, 2015, Taplin et al., 2010).

Features of bush fire vulnerable communities

Every year extreme weather events disrupt human and natural systems. These events tend to be viewed as disasters when they interact with a vulnerable human population and in doing so disrupt the function of the community beyond its normal adaptive capacity (Blaikie et al., 2004, Smith, 2013). A community's vulnerability may be generated by social, economic, political and environmental processes that influence how hazards, in this case bushfire, affect people and their connectivity to norms (Blaikie et al., 2004). What causes the vulnerability may not simply be the geophysical characteristics of a location and hazard exposure but a complex interaction of socio-economic and psychological elements. For example, a resident may perceive their risk as low and fail to adequately prepare as a consequence. Studies undertaken within various fire-prone communities relate this to the diversity of people living in these areas. Variations may be as a result of diversity in trusted information sources, perceptions of local fire behaviour and direct fire experiences. Diversity in perception may also relate to gender, ethnicity, length of time in the area, education, age and economic capacity (Erikson and Prior, 2011, Champ et al., 2013). In a study by Cheney (1996), in which the use of prescribed fire to reduce bushfire risk was generally supported, the author acknowledged that prescribed burns can promote a false sense of security and over-reliance on the efforts of others leading to a failure to undertake their own pre-fire preparations (Cheney, 1996 cited in Fernandes and Botelho, 2003). It is generally accepted that people need to perceive a risk in order to be motivated to address it (McDaniel, 2014). However, in some cases, even if the perceived risk is high this does not necessarily lead to better household preparedness(Cottrell et al., 2008). This suggests that the usual methods employed to distribute, communicate and motivate bushfire preparation need to be tailored to suit a specific audience and to empower them to take responsibility for action. These messages need constant reinforcement as complacency in people's behavior towards bushfire risk mitigation often occurs and an ability to deny or discount hazard potential is recognised as an ongoing issue for bushfire managers (Clode, 2010, Beebe and Omi, 1993 cited in Champ et al., 2013).

The way bushfire preparation messaging is communicated is a critical component in vulnerability assessment. In the context of community engagement and bushfire preparedness mass communication of standardised messages do not accommodate the variability within and between communities and often lacks local context. Prior and Patton (2008 p. 11.) suggest that approaches which encourage the community to interact with each other and emergency services are more likely to generate:

'*…a higher level of collective preparedness and a stronger sense of community'*.

This kind of communication can be facilitated by the presence of interconnected networks and trusted relationships between people where information is exchanged on shared risks. This can lead to critical collective action enabling communities to cope with extreme weather events (Akama and Chaplin, 2013). Akama et.al. (2012) conducted research into the way people utilise their social networks to increase bushfire awareness and preparedness. The researchers found that some participants had many social connections which demonstrated reciprocal community support whereas others had a very insular network which left them socially isolated and vulnerable as they were completely reliant on a single individual for information and local knowledge.

Strong community networks and sense of community acts to support services and economic characteristics vulnerable to disaster impacts particularly the ongoing stress of recovery. An example can be found in small village settings or local neighborhood shopping precincts servicing small communities. When affected by a bushfire, residents are often temporarily displaced. This has flow on effects to local economies as the market size reduces forcing the business to cope with lower cash flows and in turn reducing local employment opportunities (Regional Australia Institute, 2013). Often this results in a further population exodus as some businesses become unviable which can increase the vulnerability of the entire community and reinforces the impact of the disaster (Vigdor, 2008 and Dalhammer and Tierney, 1998 cited in Regional Australia Institute, 2013).

Improving resilience

Fire managers are facing increasing complexities regarding the effectiveness of management decisions as our climate continues to influence erratic and challenging fire weather conditions. As a result, effective strategies for reducing exposure to loss need to be multi-dimensional (Simmons and Adams, 2004). There is increasing momentum for the facilitation of agency-community networks to strengthen resilience in communities facing extreme bushfire risks. Key objectives of the Australian National Strategy for Disaster Resilience are to foster resilient communities through partnerships and cooperative effort to improve understanding and appropriately prepare for extreme events (COAG, 2011). But how do we know what a resilient community looks like when standardised messaging focuses so heavily on properly preparing homes for the bushfire season ahead and writing a bushfire survival plan?

Resilience is a complex suite of factors that the US National Academy of Sciences defines as:

"*…the ability of local communities with support from all levels of government and the private sector to plan and prepare for, absorb, respond to, and recover from disasters and adapt to new conditions*". (National Research Council, 2012 p.1.)

Resilience also relies on a behavioural psychosocial element that may, for example influence an individual's capacity to choose whether to stay and defend or the way they respond to disruption and displacement (Bosomworth and Handmer, 2008, KMC, 2012). The authors of this paper contend that resilience is a combination of all these elements at personal, property and whole of neighbourhood levels (KMC, 2012).

Social research suggests that individuals who feel they belong in their community are more likely to be involved in that community and take preparation actions (Paton and Wright, 2008). Solangaarachchi et.al. (2012) found in Ku-ring-gai that community interactions help people to share their experience, knowledge and resources about bushfire. Traditionally, the community has not always had the opportunity to be a part of their own education. Message creation and delivery was the responsibility of the emergency services. These agencies typically function in a command and control manner leaving the community to assume they don't play a role (Overton, 2015). In order to share the responsibility for bushfire or other disaster preparedness, emergency management agencies need to break down the 'them' and 'us' silos by participating in trusted networks.

McLennan and Eburn (2015) consider that 'real world' wildfire management is a hybrid system in which control, choice, public values and private interests are prioritised and that there are trade-offs between all of these. These trade-offs can be reflected in the way agencies undertake community engagement. Instead of a top-down approach, agency-community relationships can be about facilitating an understanding of bushfire or other extreme weather risks and fostering knowledge exchange to enable people to make more informed decisions regarding triggers for timely evacuation, property resilience and their capacity to stay and defend.

Following the devastating Black Saturday fires in Victoria 2009, fire managers across Australia reviewed the way they approached community engagement (VBRC 2009). In response, Akama et.al. (2012) developed a community engagement methodology which looked at improving the way preparation messages are formulated and distributed. Their research suggested that the command and control method represented in standardised messaging was seen as disempowering by the community. In response, Akama et.al. developed a series of activities to encourage a dialogue between agencies and at risk communities. The 'design methods' developed used a combination of visual objects and 'flash' cards to assist participants to interpret and articulate collective knowledge about strengths and vulnerabilities within their neighbourhoods, define their social networks and heighten their awareness to emotive response in unexpected scenarios (Akama et al., 2012). These methods enable individuals to comprehend the complexities surrounding bushfire impact. Importantly such methods also reveal how informed contingency planning can play a vital role in potentially life or death scenarios.

Implementing Climate Wise Communities

In 2012, Ku-ring-gai Council, having completed a climate change adaptation strategy was considering options for implementing a community networking program to build neighbourhood capacity to prepare for and recover from extreme weather events. Ku-ring-gai Council worked with RMIT to adapt their design methods to suit the Ku-ring-gai context and implemented the Climate Wise Communities initiative (CWC).

The Climate Wise Communities program designers worked with emergency services, NGOs and other Government agencies working in the field of disaster resilience and in particular bushfire to ensure consistency with their messaging. While a gradual shift was occurring toward education of 'at risk' groups to improve resilience, most other resilience programs were still on the drawing board as CWC activities commenced. A pilot program consisting of three locality based workshops was undertaken in 2012 in areas where the bushfire technical officer assessed the risk was 'extreme' for the coming fire season. The three locations selected were very different contexts in which to test the model for its flexibility and applicability to diverse scenarios.

The first workshop was situated in a neighborhood with an active fire history. Residents had formed a community fire unit (CFU) who were well equipped and trained in defending homes in the event of a fire. This neighborhood was somewhat divided into two, those in the CFU and those who were not. The CFU members generally lived on the bushland interface while the 'others' lived in homes on the other side of the street so deemed themselves to be less at risk even though recent history had demonstrated this was not so.

The second group lived in an area that had not seen a major fire for several decades. Complacency was evident with those who attended commenting that others in their street needed to be there but would not make the time to attend. Those attending were a mix of long-term residents and others who had come more recently. Non-English speaking background people were very interested in how to communicate the risk and plan resilience to others in their cultural and linguistic groups.

The third group consisted of residents located close to a primary school and many of those who attended were parents of students in the school. These families were unaware of the level of risk of bushfire in their area and hadn't given much thought to how vulnerable their homes and lives were to this risk. Several retired residents had experienced bushfire in the area and were very concerned about how they would cope now being less physically capable in the face of a fire such as they had experienced in the past.

Reviewing the pilot program assisted Council staff to better understand how to target at risk groups. Council then decided to roll out the CWC program following a bilateral strategy. The first strategy would continue to target residents in high risk locations for bushfire. The second strategy would target sectors of the community deemed 'at risk' and included aged care services, early childhood businesses, seniors living alone, cultural and linguistically diverse residents, small businesses and women particularly those with small children living at home.

Each workshop is structured according to the specific needs of each target group. Locality based workshops focus in the physical, social and to an extent the financial characteristics of the context. By using aerial photographs of the area Council staff working with the emergency management agencies can point out good and bad features that have influenced fire behavior in the area and how different weather characteristics could influence future fire behavior. The maps also serve to help residents better understand the logistics of evacuation with police explaining how they handle emergencies and why evacuations sometimes go wrong.

Sector based workshops also use the aerial maps to enable people to better understand how their business, clients or service might be impacted. Again with the assistance of the emergency services they can better appreciate the practicality of their emergency management plans they have in place or gather data to create or review emergency plans in the future.

As workshop participants delve down to the level of their property and determine how vulnerable it is to bushfire they build a picture of the reality of their circumstances, particularly in relation to:

- How vulnerable their home is to ember attack;
- How vulnerable their home is to radiant heat;
- How defendable is their home to bushfire;

- How will they cope personally in the event of an emergency that requires physical resilience and an ability to organize and focus;
- Who can they call on for assistance if needed;
- Who might call on them for assistance;
- What are appropriate triggers for them to use to decide whether to stay or leave;
- Has their emergency management plan taken into account the full range of variables that might affect the way their plans work;
- What alternatives exist to their first option if that option is no longer open to them;
- What contingencies can be taken in advance to reduce the range of variables that could occur.

These workshops build up an appreciation of the personal circumstances of a family or business and a neighborhood. Emergency management agents explain that in the case of a large scale fire, it is likely people will be on their own to make decisions and not to expect a fire tanker to be present.

As the program developed, the importance of understanding the context of the audience became increasingly relevant. For example one workshop was for a community group that had long insisted that Council or State Government needed to construct a second road as a supplementary evacuation route in the event that the main road access was cut in bushfire. This community group had received many explanations over the years to justify why a supplementary evacuation route wasn't likely to help solve any evacuation dilemmas in this location. However, the group persisted with the notion that this wasn't so. When the CWC workshop was planned for this group it was deemed a different approach again was needed.

In this workshop, the Council officers designed a 'scenario' for a possible bushfire event to 'walk' the workshop attendees through the processes occurring amongst the fire and land management agencies during a typical fire event. As each stage of this fire scenario unfolded, each agency explained what action they would be taking at that point. The community members were also asked the same question, what would you be doing at this point, under these circumstances.

The hypothetical exercise worked very well as it demonstrated that agencies were communicating effectively, their messaging was consistent and their actions precautionary. The same could not be said for the readiness, knowledge and communication between the residents. With the logistics of how events unfolded in the scenario, it became very evident to the residents that the safest option to prevent an issue from occurring around the evacuation route was for them to leave early. The lesson learned here was that if people have retrofitted their home to be more resilient to ember attack and radiant heat without the need for them being present, they are more likely to be confident in making a timely decision to leave early.

The significance of all workshops trialed to date focused on the concepts of building trust, sharing responsibilities, and fostering conversations which are often driven by the participants themselves. Apart from learning from lived experience of bushfires, participants also started connecting with others to discuss neighborhood resilience. It is hoped connections may lead to future networks developing and help these communities become more effective in preparation and recovery in bushfire events.

Conclusion

Global warming is increasing the risk of extreme bushfire events. Despite policy developments demanding more intensive fuel management treatments as a risk abatement strategy, it is evident that communities remain at significant risk if they solely rely on land managers and fire agencies to protect them. The dependence on hazard reduction burning as the primary risk management tool has a range of unintended consequences including creating a false sense of security in vulnerable communities. The result is that communities are generally under-prepared for the current level of fire risk experienced, let alone an increase.

There is a need to balance operational bushfire risk management strategies with community oriented capacity building around the personal, property and neighborhood scale in order to increase resilience to bushfire impacts. The momentum is building for the facilitation of agency-community networks to foster resilient communities through partnerships and cooperative effort. New bushfire engagement methods are challenging more traditional strategies that have been based on a command and control approach that struggles to engage the community. The goal of strengthening community resilience through shared responsibility requires a more contextually specific program that can demonstrate a positive cost benefit result from household investment in resilience. The CWC program has successfully adapted a range of tools developed by RMIT University that engages localities and sectors at risk of extreme events in resilience capacity building. The CWC program aims to improve psychological preparedness and decision making capacity, allowing residents to make more informed decisions regarding strengths and weaknesses of their home and their bushfire survival plans. At the neighborhood or sector level, CWC starts conversations and strengthens networks as the facilitated activities encourage sharing of local knowledge.

The next steps in this program are to analyse the potential for building more formal relationships between community networks and local emergency operators to strengthen lines of communication before, during and post extreme weather events. The authors propose that a focus on social dynamics, through programs like CWC adds much needed latitude and flexibility to traditional bushfire risk management. By developing or strengthening the social dimension, more effective outcomes should evolve for communities living with bushfire risk.

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Methods for visualization and classification of fire risk in Brazil

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Abstract:

[The occurrence statistics of forest fires are the tools to define the profile of the fires for more efficient control based on knowledge of local and seasons of higher occurrence. Despite the importance of the matter there are no updated statistics enabling to know the profile of forest fires in the states of Brazil. An alternative the difficulties presented is identify the distribution of hot spots on the surface that persist over time. The challenge in analyzing these data sets is develop techniques to facilitate analysis, visualization and interpretation of results. This study presents the use of a principal component analysis (PCA) to extract the high dimensionality of the input variables and design the data set over a 2-D space and a self-organizing map (SOM) for data visualization and subsequently, to create a classification system of fire risk through the clusters in the SOM map. The results indicate that the first two principal components account a large percentage of cumulative variance for explaining the data patterns. SOM is suitable to visualize the distribution of fire risk in the states and the correlation between the input variables on a monthly basis. This visualization is also used to create an understanding which states are related to each cluster]

Additional Keywords: [Hot Spots, dimensionality reduction, multivariate analysis, neural network]

Introduction

The author is graduated in Forest Engineering by the Federal University of Espirito Santo, Brazil (2011). Masters in Forest Science by the Federal University of Espirito Santo (2014). Is currently PhD student in Forestry Sciences by the Federal University of Espirito Santo. His research covers the areas of geotechnologies, forest fires and intelligent methods. In essence, this work provides the science and technology to meet the needs of fire management agencies for prediction and management of forest fires in Brazil. This study allows to institutes establish protection measures of natural resources by knowledge of local and seasons of higher occurrence of forest fires in the states of Brazil.

A proposed experimental methodology for assessing the effects of water and dry matter content on live fuel flammability

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Additional keywords: forest fire, fire modeling, frontal fire, frontal flame, flame propagation, heat transfer, fuel particle, heating rate, ignition delay time, residence time, flaming duration, incomplete combustion, convective heating, radiative heating, oxygen consumption calorimetry, heat release rate, effective heat of combustion, shoots, white spruce

Extended abstract

Introduction

Fire management effectiveness and the safety of firefighters strongly depend on accurate predictions of fire behavior. The most common cause of fire-related accidents is failure to predict changes in the behaviour of the propagating fire front (Viegas 1993). When moderate simultaneous changes in the three main groups of factors determining fire behavior (fuel, weather, and topography) become 'aligned', fire behaviour can rapidly switch from apparently harmless to devastating (Campbell 1995). Accurate prediction of changes in fire behaviour is impossible if all of these important factors are not fully taken into account. While weather and topography are well-studied and sufficiently represented in the fire modeling systems that are currently used operationally, fuel-related variables are only partially considered. Currently the potential rate of simultaneous combustion of live and dead vegetation is evaluated using mostly water content of dead fuel. Species-specific changes in water content, dry matter content, chemical composition, density, and hence in flammability of live plant tissue are determined by physiological state of individual species composing a forest stand according to their phenology, growth conditions, and level of natural disturbance. Due to unique biophysical and chemical properties and characteristics of combustion of live plant tissue, the existing methods designed for dead fuel flammability assessment may not properly represent live fuel or combinations of live and dead fuel. The aim of this study is to resolve this issue and to improve the understanding of live fuel flammability which was examined in relation to water content, dry matter content, and density using the test conditions which are more representative of a frontal flame than existing techniques.

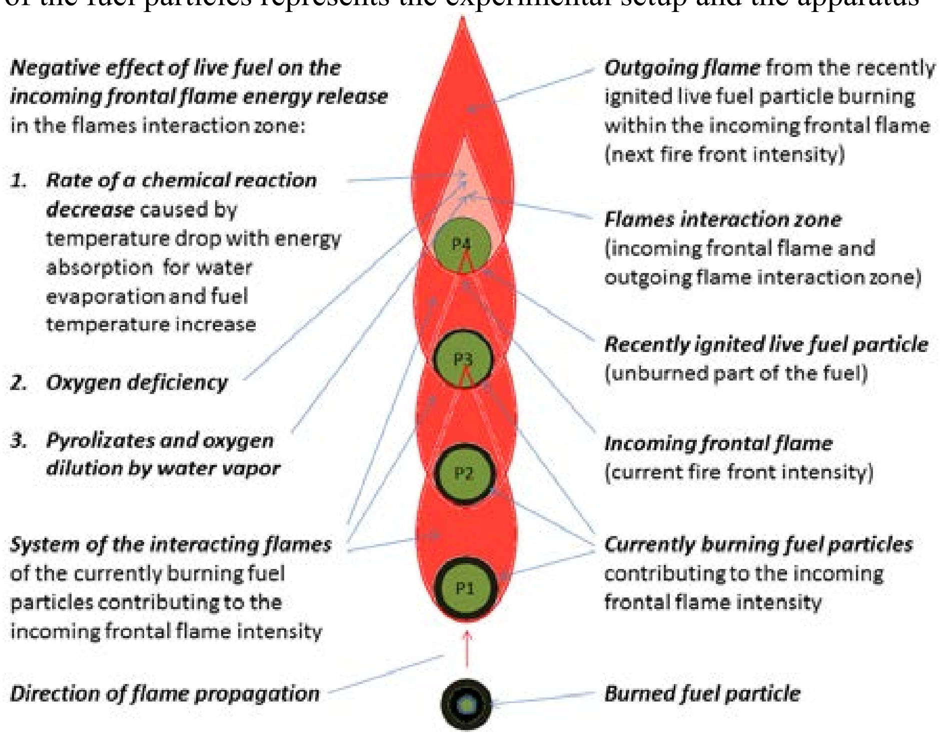
Background

Issues associated with the combustion of live fuels are among the most important factors limiting the use of physically-based fire modeling (Finney *et al*. 2012). There is no commonly accepted definition or measure of live fuel flammability which leads to large variety of methods and variability in results. Live fuel is usually represented by testing foliage only; however the live plant material consumed by the frontal fire consists of shoots which include twigs (roundwood) less than 1 cm in diameter and the attached foliage (Stocks *et al*. 2004). Oxygen bomb calorimetry determines the heat of combustion of oven-dry plant material in pure oxygen environment. Differential scanning calorimetry is characterized by small sample size, low heating rates, and efficient removal of pyrolysis and combustion products; this can lead to misrepresentation of fuel properties and the conditions of live fuel combustion in the atmospheric air.

Oxygen consumption calorimetry using a cone calorimeter (Babrauskas 1984) allows a more detailed evaluation of live fuel flammability by measuring heat release rate from the chemical reaction of the fuel with atmospheric oxygen (Babrauskas and Peacock 1992) and estimation of effective heat of combustion (Babrauskas 2006; Weise *et al*. 2005; White and Zipperer 2010). However, the radiant ignition flux of 25-50 kW m^{-2} of the cone calorimeter usually used is totally insufficient to provide the conditions of the flaming front reported (over 300 kW m^{-2} combined radiative and convective ignition flux, 5-15 seconds ignition delay time, 50-70 seconds flaming front residence time, and over 30°C sec^{-1} heating rates) (Frankman *et al*. 2013; Wotton *et al*. 2012). Consequently in many cases, tested green samples exposed to the 25 kW m^{-2} radiant ignition flux did not sustain ignition, and if ignition occurred, ignition delay time was on average 120-150 sec (Weise *et al*. 2005).

It has been suggested that the combustion of live fuel occurs simultaneously with water evaporation (Finney *et al.* 2010). The endothermic process of water evaporation and the presence of considerable concentrations of water vapor in the resulting gaseous mixture (Ferguson *et al.* 2013) as well as oxygen deficiency in the flames interaction zone of neighboring fuel particles (Pickett *et al*. 2009) strongly affects all stages of live fuel combustion causing incomplete combustion (Byram 1959). While these energy release losses are well-estimated by oxygen consumption calorimetry for live fuel burning separately, there is little information on the possible effect of high water content of burning live fuel on the incoming frontal flame. The hypothesis of this study is that energy release losses due to incomplete combustion are significant not only for outgoing flame from the recently ignited live fuel particle, but also for incoming frontal flame (Fig. 1). Due to this hypothetical energy release drop for the incoming frontal flame in the flames interaction zone, the resulting energy release growth caused by the introduction into the frontal flame of the new live fuel particle can be less than energy release of this burning particle if measured separately. Thus the traditional oxygen consumption calorimetry method likely overestimates the energy contribution of the burning live fuel to frontal flame intensity and propagation.

Fig. 1. Hypothetical energy release losses for the incoming frontal flame due to incomplete combustion caused by high water content of live fuel and oxygen deficiency in the incoming and outgoing flames interaction zone. Vertical orientation of the fuel particles represents the experimental setup and the apparatus



Methods

Linear propagation of the frontal flame can be presented as the consequent gradual transition of the system of the interacting flames of the currently burning fuel particles (for example P1, P2, and P3) (Fig.1) to the unburned part of the fuel (a recently ignited live fuel particle, P4). The recently ignited live fuel particle is involved in the two simultaneous interactions. (1) It is exposed to the radiative and convective heating of the incoming frontal flame created by the currently burning particles while it simultaneously causes a negative effect on the incoming frontal flame energy release in the flames interaction zone. (2) It produces an outgoing flame and heat release which will be further used for the ignition of the next fuel particles. In this study, the flammability of live fuel, defined as its energy release contribution to the frontal flame intensity and propagation, was evaluated using a paired linear flame propagation model which considers both interactions (1) and (2) presented above:

[Incoming frontal flame = current fire front intensity] ⇄ [**Recently ignited live fuel particle]** → [Resulting outgoing flame = next fire front intensity*]* (1)

These conditions were experimentally simulated using the flame from a 100×100-mm calibrated open methane burner placed underneath a 100×100-mm sample of new, 1-year, and 2+ year old shoots of white spruce *(Picea glauca)* (Fig.2). Heat release rate (HRR) and effective heat of combustion (H_{eff}) during the first 60 seconds of combustion (average frontal fire residence time) were measured using an oxygen-consumption calorimetry method developed for the study which provides the test conditions which are more representative of a frontal flame than either bomb calorimetry or radiant heating from a cone calorimeter. The common opinion that radiative heat transfer is the dominant form of heat transfer with flame propagation (Albini 1985) has been questioned by many authors (Anderson 1969; Van Wagner 1977; Beer 1991), while a study by Frankman *et al*. (2013) concluded that convective heating is as important as radiative heating. The nominal energy release 500 kW m^{-2} of the calibrated methane burner provided high-intensity combined convective and radiative external ignition flux, extremely high heating rates, a consistent ignition at several seconds ignition delay time, and on average 60 seconds flame residence time.

Fig.2. Experimental setup (from bottom to top): load cell, methane burner, incoming methane flame, wire-mesh sample holder, burning live fuel sample, outgoing flame (methane flame with the burning sample within the flame**)**

HRR of the incoming flame (open methane burner) was measured with separate test runs with an empty sample holder before and after each test set; the incoming flame HRR baseline was calculated as the average of these two test runs. This measured baseline heat release rate was compared to the measured mass flow rate of methane to confirm the result. Differential Heat Release Rate (dHRR) was calculated as the difference between outgoing flame intensity (HRR of the methane flame with the burning sample within the flame) and incoming flame intensity (baseline HRR of the methane flames alone). The flammability of the fuel sample was defined and evaluated as its energy release contribution to the incoming methane flame and calculated as Differential Effective Heat of Combustion (dH_{eff}): difference between heat release of the methane flame with the burning sample within the flame and heat release of the methane flame alone during the first 60 seconds of combustion (integral of the dHRR) divided by sample mass loss.

Results

The high water content of shoots and substantial losses of energy for water evaporation caused increased ignition delay time. Flammability, defined as an energy release contribution of burning fuel to the frontal flame intensity and experimentally measured as differential effective heat of combustion (dH_{eff}), is strongly affected by water content of live fuel. The water content of 1-year and 2+ year old shoots caused a notable decrease in shoot flammability. For new shoots, with water content over 180%, the calculated energy release contribution of the burning live fuel to the incoming methane flame (dH_{eff}) was negative, meaning a substantial reduction in the energy release rate for the incoming methane flame. This supports the hypothesis that high water content of live fuel has substantial negative effect on the energy release of the incoming frontal flame. According to these results, new shoots actually suppress the combustion process of the incoming flame of the approaching fire front. The flame front constantly emits large amounts of energy into the environment (depending on weather/ fuel/ flame characteristics) in the form of convection and radiation. For the frontal flame to propagate (to sustain equilibrium state or growth), it requires a constant positive energy release contribution at or above a threshold value from each burning fuel particle. Hence, low-positive and negative values of the energy release contribution (with water content of live fuel above a certain value) will mean frontal flame intensity decreases, eventually extinguishing the frontal flame.

Conclusions

The conditions of frontal fire are much better represented in the proposed experimental method than in existing techniques. In this study a combined radiative and convective energy transfer was used, providing heating rates, ignition delay time, and flaming duration time comparable to those measured in natural fires. The range of live plant material consumed during the tests was the same as consumed by frontal flame (twigs {roundwood} less than 1 cm in diameter with the attached foliage). Unlike other studies, flammability is defined and measured as a potential energy release contribution of live fuel to frontal flame intensity and propagation. Both for the outgoing flame from the burning sample and for the incoming methane flame, the test method accounts for water content and oxygen deficiency-associated energy release losses due to incomplete combustion, allowing more realistic estimations of flammability. The results of the study showed the strong negative effect of water content on the energy release of the incoming frontal flame and flammability of live fuel. The proposed method can be used for estimation of live fuel flammability conditions for prescribed burn planning; evaluation of flammability of new fuels, such as disease and insect damaged stands; comparative estimation of flammability of different fire-resistant species; choosing optimal species composition and spatial structure for stand tending; reforestation; and fuel treatments in the wildland-urban interface. Further development of the proposed method will allow quantification and reliable prediction of the flammability of live fuel and eventually inclusion of this important variable in the fire modeling process providing higher accuracy of fire behavior prediction, and therefore higher level of fire management efficiency and fireline safety.

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Applying the ISO 31000:2009 Risk Management – Principles and Guidelines for improved Risk Management Decision Making

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Abstract:
Managing risk in the wildland fire management business is seldom, if ever, managed to zero risk. Presented is the application of the International Organization for Standardization, ISO 31000:2009 Risk Management – Principles and Guidelines for informing wildland fire, risk management decision making. This international standard provides a consistent framework for systematically defining the effects of uncertainty on organizational objectives, understanding that risk can result in positive and/or negative outcomes.

In combination with a consistent risk profile structure and the application of decision making psychology it provides an improved science based method for improving the delivery of preferred outcomes and defendable due diligence decision making. The objective, to implement a system that acknowledges and adapts to the strengths and limitations of intuitive and logic decision making.

This in turn provides a point of application for the existing wildland fire and social science research while providing an operational feedback mechanism for identifying research gaps and weaknesses. Its organization wide application also provides a monitoring and review cycle that tracks the changing risk environment and provides for the continuous improvement of an organization's risk management processes and ultimately its risk management culture.

Additional Keywords: [risk profile, risk assessment, controls, safety, severity, likelihood, exposure, values, vulnerability, decision making, economics]

Introduction

The business of Wildland Fire Management is a complex operating environment of ongoing risk management decisions that strives to achieve an acceptable balance of social, economic and environmental considerations. Managing the risks and making risk management decisions associated with the wildland fire operating environment is the very substance of what the Wildland Fire Manager does. In this context Wildland Fire Management is synonymous with Wildland Fire Risk Management. By extension the Wildland Fire Manager is the Wildland Fire Risk Manager (Risk Manager) and the International Organization for Standardization, ISO 31000:2009 Risk Management – Principles and Guidelines (ISO 31000) provides the principles, a framework, and a process for managing wildland fire risk.

Good risk management contributes to the achievement of an organization's objectives through the systematic and repetitive application of risk management processes and systems. These processes and systems assist risk managers to identify, analyze and evaluate the risk components and the contributing risk drivers. By systematically assessing the effects of uncertainty on their organization's objectives, risk managers can identify priorities, implement controls and make informed decisions on a course of action to maximize the chance of gain while minimizing the chance of loss. To be effective it is important to consider and understand all available intelligence relevant to a business activity and to be aware that there may be limitations or uncertainties in that intelligence.

Risk management is a proactive and ongoing process and should be integral to management and decision-making at all levels, integrated into practices and the very culture of the organization and its business activities. To be truly effective it needs to be applied as an organizational doctrine across all business sectors to ensure efficiency, consistency and the reliability of results. Ongoing monitoring and review is equally important for tracking real-time changes in the risk profile and taking corrective action, plus committing to continuously refining their risk management processes and systems.

The ISO 31000 was developed for this purpose.

The Psychology of Decision Making

The application of the ISO 31000 is not particularly complicated nor is its processes entirely foreign to most people. Most people have well developed risk management instincts from years of living in and adapting to an assemblage of societies and cultures abundant with health, safety, socio-economic and environmental risks. Each day a person unconsciously makes dozens if not hundreds or more risk management related decisions for achieving their personal objectives as well as relatively fewer but more thoughtful, conscious assessments and decisions (Kahneman 2013). The ISO 31000 formalizes the latter, logic decision making process but its application must not ignore the dominant influence of the former, intuitive decision making process.

Nobel Prize winning psychologist Dr. Daniel Kahneman, in his 2013 publication Thinking, Fast and Slow (Kahneman 2013) uses the analogy of two systems (System 1 and System 2) to explain how people assess situations and make decisions. This analogy is a simplification of reality and editorial license has been taken by the author of this document for brevity and operational risk manager comprehension and application.

System 1:

System 1 represents the intuitive decision making process. It is developed experientially and operates unconsciously with little or no realization that it is constantly evaluating the environment, making decisions and producing reactions[1]. Sometimes expressed as the involuntary or automatic system, it operates rapidly and requires little mental resources, concentration or energy. It is very efficient in what it does.

While System 1 (Intuitive Decision Making) is mostly in control, and usually correct in its day-to-day judgements, it is substantially influenced by numerous bias producing processes[2]. It has little capacity for statistical analysis and can be prone to drawing conclusions from little information or information of little accuracy.

The intuitive mind can be trained to some extent with practice and repetition in a consistent and stable environment that includes rapid, unequivocal feedback about the correctness of the assessment(s) and action(s). It however remains susceptible to the previously mentioned bias producing processes. It is also impaired by such things as stress, fatigue, drugs and/or alcohol, even hunger.

System 2:

System 2 operates in the voluntary, conscious reasoning environment but mostly in the background to System 1 where it executes an analytical and validating role. Kahneman (2013) identifies System 2 as being slow, lazy and resource (mental energy) demanding. While System 1 is mostly in control, System 2 is activated by cognitive strain when a simple, intuitive solution is not readily available and statistical or probabilistic reasoning (logic) is required. Multi-tasking

[1] No two people have identical experiences, education and training.

[2] The bias producing processes are substantial and critical to the functioning and understanding of System 1. It is however not within the scope of this document to detail these processes.

is effectively impossible while System 2 (Logic Decision Making) is engaged because it is so resource demanding. Maintaining an accurate and coherent logbook requires System 2 cognitive effort that cannot be accomplished simultaneous with other tasks requiring even minimal cognitive effort.

The assessment of an optimum mortgage amortization period as it relates to interest rates and debt service capacity cannot be accomplished by System 1, Intuitive Decision Making. It is a task requiring System 2, Logic Decision Making, requiring deliberate and effortful thought and attention.

The author provides the following examples of driving a motor vehicle under very different conditions of complexity. The driver has 46 years of extensive driving experience of left-side drive vehicles, driving on the right-hand side of the road (North America).

Experience 1:
Driving an economy sized, automatic transmission car during daytime, good summertime road conditions on a traffic-less and familiar street in Whitehorse, Yukon Territory, Canada (population ~25,000). This was a simple task where the author could drive, have a casual conversation, observe the scenery, listen to the radio, sing along, etc.

System 1 was in control and the entire operation was relaxed.

Experience 2:
Driving a manual transmission, right-side drive, utility vehicle driving on the left-hand side of the road in unfamiliar downtown Melbourne, Victoria, Australia (population ~4.4 million), at night. This commanded the driver's total attention and made even navigating instructions from the passenger/navigator difficult to process. There was no casual conversation, singing along to the radio or observing the scenery, no multi-tasking. Simple mental calculations of travel distance, speed and arrival time were a strain.

System 2 was required and it was a stressful and exhausting experience for both the driver and passenger/navigator.

Mistakes happen when System 1 makes decisions that would be better made by System 2 yet this is not necessarily a voluntary action. Kahneman (2013) concedes that "Even in modern humans, System 1 takes over in emergencies and assigns total priority to self-protection actions". System 1 is very good at distinguishing changes in the immediate environment but requires System 2 to validate if the changes are threatening or not. With respect to the bias producing processes that System 1 is prone to and the background experiences of initial attack resources operating at success rates of better than 95%, it is the author's contention that System 1 is ill prepared to manage the dynamics of blowup wildfire conditions. Yet it may well be the evolutionary default condition.

Research applying Kahneman's Thinking, Fast and Slow may provide some insight into the trend of fatalities, injuries and near-hits associated with initial attack or the transition period from initial attack to sustained attack (Putnam 1995, Mangun 1999). It certainly raises questions over the applicability of the 1957 Standard Fire Order "Be Alert, Keep Calm, Think Clearly, Act Decisively" (McArdle 1957) which asks for System 2 decision making in a System 1 survival situation. Or the plethora of orders, watchouts, guides, common denominators, acronyms, and checklists that require System 2 effort of situational validation.

This highlights an even greater concern over the decision making impairments of the public in wildland urban interface situations who have had little or no experience with what they may be exposed to. Or the context, fairness and utility of fire reviews, inquiries, commissions, etc. Hours and even months of individual and group System 2 cognitive effort examination is frequently applied to moments or possibly a few hours of System 1 decision making in physical and cognitive environment conditions not conducive to System 2 function.

It begs the question, "for all of these years and all of the losses, have we been engaged in a struggle against the relentlessness of nature plus eons of human evolution"? "Have we been asking people to act counter to their evolutionary will?"

Kahneman himself admits to being unable to override the bias producing processes in spite of his many years of research and recognized expertise in this field of research. His only advantage over the layperson is his knowledge to better identify the conditions where these processes will apply and how they function. In this respect it may be thought of as a known uncertainty that should be accounted for in the application of the ISO 31000.

There is clearly a fertile and demanding need for further research in this comparatively overlooked field of study in the wildland fire risk management business.

That said, the application of the ISO 31000 with an adaptation of Crichton's Risk Profile (Crichton 1999) and even a rudimentary application of Kahneman's Thinking, Fast and Slow principles forms a process for the improved application of Logic Decision Making (System 2) and better adapting Intuitive Decision Making (System 1).

ISO 31000:2009 Risk Management – Principles and Guidelines

Applying ISO 31000 can help Wildland Fire Risk Management Organizations increase the chances of achieving objectives by improving the identification of opportunities and threats and effectively allocate and use resources for risk treatment. A key feature of the ISO 31000 over its predecessor (AS/NZS 4360:2004) is that it defines risk as "the effect of uncertainty on objectives". This feature recognizes that risk can produce both positive and/or negative outcomes to objectives, plus the intelligence, tools and systems for assessing risk can have considerable uncertainty.

Because it purposefully assesses the effects of uncertainty on objectives the application of the ISO 31000 framework and processes systematically links the organization's objectives through to risk treatment strategies and tactics plus monitoring and review for supporting adaptive management and continuous improvement.

The ISO 31000 specifies that the process should be integral to management and decision making at all levels, integrated into practices and the business culture and introduces the following eleven principles of risk management.

1. Risk management creates and protects value;

   Good risk management contributes to the demonstrable achievement of an organization's objectives through the continuous and repetitive review of its processes and systems.
2. Risk management is an integral part of all organizational processes;

   Risk Management needs to be integral to management and decision-making at all levels, integrated into practices and culture and tailored to the organization or application and its risk profile. It is to be established as the organization-wide doctrine.

3. Be part of decision making;

   The process of risk management assists decision makers to make informed choices, identify priorities and select the most appropriate action.

4. Explicitly address uncertainty;

   By identifying potential risks, organizations can implement controls and treatments to maximize the chance of gain while minimizing the chance of loss.

5. Be systematic, structured and timely;

   The process of risk management should be consistent across an organization to ensure efficiency, consistency and the reliability of results. It should receive wholesale application for anything that requires a decision on course of action.

6. Be based on the best available information;

   To effectively manage risk it is important to understand and consider all available information relevant to an activity and to be aware that there may be limitations on that information, it is then important to understand how all this information informs the risk management process. And what doesn't or has minimal utility.

7. Be tailored;

   An organization's risk management framework needs to include its risk profile, as well as take into consideration its internal and external operating environment.

8. Take human and cultural values into account;

   Risk management needs to recognise the contribution that people and culture have on achieving an organization's objectives.

9. Be transparent and inclusive;

   Engaging stakeholders, both internal and external, throughout the risk management process recognises that communication and consultation is key to identifying, analysing and monitoring risk.

10. Be dynamic, iterative and responsive to change;

    The process of risk managing risk needs to be flexible. The challenging environment we operate in requires organizations to consider the context for managing risk as well as continuing to identify new risks that emerge, and make allowances for those risks that no longer exist.

11. Be capable of continual improvement and enhancement;

    Organizations with a mature risk management culture are those that have invested resources over time and are able to demonstrate the continual achievement of their objectives.

The ISO 31000 risk management framework systematically processes the effects of uncertainty on objectives through seven interacting elements (Figure 1) where communication and consultation is a fundamental and enabling element. Communication and consultation is particularly important in stakeholder engagement for better understanding the uncertainties of the risk environment and identifying risk and control owners for improved risk sharing.

Controls are the means by which Risk Managers seek to modify risks. Control owners are those organizations or individuals who are accountable for ensuring that those controls remain adequate and effective. It would seem self-evident that proposed controls do not become actual controls until they are activated or implemented. Until application, controls retain the distinction of being little more than statements of good advice or good intentions.

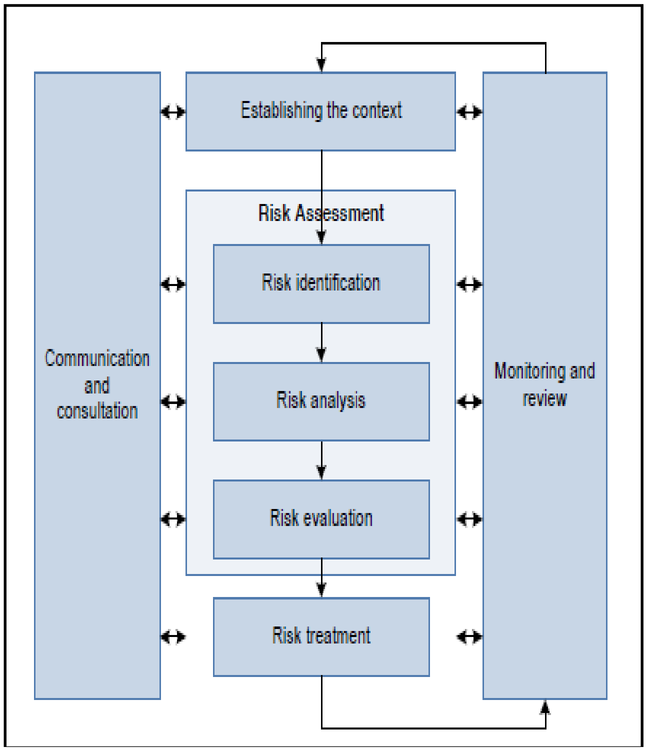

Figure 1. ISO 31000:2009 Risk Management – Principles and Guidelines

The application of ISO 31000 is central to the development of a comprehensive "Risk Profile". It is the risk profile that frames the risk components and risk drivers along with assessing the uncertainties of data, processes and systems. From this the Risk Manager develops and/or modifies existing controls, strategies and tactics and makes better informed risk management decisions.

Risk Profile

The Risk Profile is introduced at this stage to provide the reader with a familiarity of where and how the ISO 31000 Risk Assessment intelligence is systematically processed and compiled.

Risk managers will likely be familiar with the risk equation Likelihood x Consequence = Risk (Equation 1) and the risk matrix depicted in Figure 2. This equation and matrix may have some utility for expressing relative risk but by themselves are of low utility for informing risk management decision making.

$$Likelihood\ x\ Consequence = Risk$$

Equation 1. Rudimentary Risk Equation

RISK MATRIX					
CONSEQUENCE / LIKELIHOOD	1 Insignificant	2 Minor	3 Moderate	4 Major	5 Extreme
A - Almost certain (frequent)	M	M	H	E	E
B - Likely (probable)	L	M	H	H	E
C - Possible (occasional)	L	M	M	H	H
D - Unlikely (uncommon)	L	L	M	M	H
E - Rare (remote)	L	L	L	L	M

Figure 2. Common Risk Matrix

For the purpose of providing the minimum required detail that a risk manager will require for systematically assessing the respective risk drivers plus potential controls and control owners a modified risk profile from Crichton (1999) has been applied. This is based upon the premise that if you don't understand what is truly driving the risk then you can't possibly develop immediate and long-term controls to manage the risk.

The adapted profile, regardless of scale or threat, is established by the interactions of the components of Likelihood x Severity x Exposure x Value(s) x Vulnerability (Equation 2). When applying the property of multiplication by zero if any of these risk components can be managed to zero then the risk will be zero. Zero risk is seldom achievable in the wildland fire risk management business and where this is not achievable the aim is to reduce each component to as near zero as is practical, economical and commensurate with objectives.

The question of which component is most important is not greatly dissimilar to the question "which is the most important leg on a three legged stool"? It is the one that is missing. Effective risk management requires all five risk components to be assessed and assigned controls for optimal risk reduction. Applying Risk Equation 2, the control of ten additional fire trucks can be easily negated by people ceasing to apply proper building construction and maintenance controls. Fire suppression controls in the absence of meaningful fuel management controls will produce an escalating risk. The silver bullet solution that only served to bringing certainty to the very consequences that fire suppression controls were meant to eliminate.

Equations 3 and 4 then provide the formula for deriving Likelihood x Consequence (Equation 1 and Figure 2) with improved operational detail and clarity.

$$Likelihood\ x\ Severity\ x\ Exposure\ x\ Value\ x\ Vulnerability = Risk$$

Equation 2. Risk adapted from Crichton 1999

where:

$$Likelihood = Likelihood$$

Equation 3. Likelihood

and:

$$Severity\ x\ Exposure\ x\ Value\ x\ Vulnerability = Consequence$$

Equation 4. Consequence

Value and Vulnerability have sometimes been expressed together simply as Vulnerability (Crichton 1999) that then assumes there is an associated value. This was rejected as been insufficient for assessing wildland fire economic risks and defining potential controls and control owners. I.e. most wildland fire management programs are funded from the public treasury. This comes with an opportunity cost to other publicly funded programs. There has been no shortage of criticism over fire management operations expending public funds and risking the health and safety of fire suppression resources, in fire suppression efforts that are nowhere near commensurate with the economic value(s) under so called protection (Beaver 2003).

Likelihood: Can be driven by a variety of sources depending upon the level and scope of the risk management assessment and profile.

- Strategic level risk profiles (Table 1) would assess more historic likelihood data, ignitions and frequency of destructive climatic and fire behaviour related thresholds.
- Readiness level risk profiles (Table 2) would assess the presence of active fires, recent lightning occurrence (wet? or dry?), lightning prediction models (wet? or dry?), human caused ignition trends, probability of ignition models and prescribed fire ignition schedules.
- Incident level profiles (Table 3) would assess the location, construction and the breaching potential of fire control lines (the place where the fire is most likely to escape).

Severity: Is largely driven by direction and rate of fire spread, fireline intensity, ember production and spotting distance, type of fire (surface/crown), convection column development, perimeter and area growth rate, flame depth, fuel consumption, radiant heat flux, suppression difficulty, diurnal pattern, heat stress, smoke, terrain, slope, dangerous trees and other fire resource health and safety drivers. Severity is very much, but not entirely, driven by fire behaviour characteristics.

Fire ecologists may recognize Likelihood and Severity at the Strategic Risk Profile level as having many of the characteristics comprising a fire regime (Table 1).

Exposure: Is the seasonal and diurnal time and duration that a Value that is Vulnerable to the assessed Likelihood x Severity may be Exposed. It is very much determined by the proximity of the value to the Likelihood, the topography, direction and rate of spread, embers and smoke production and dispersion and what the severity of the fire will be upon arrival.

Value: Represents Social, Economic and Environmental, intrinsic and/or extrinsic values as determined by stakeholder and public Communication and Consultation. Much of this intelligence would have been compiled from strategic level risk management planning and then cascaded/networked though to readiness and incident risk management.

Vulnerability: Relates to how predisposed to damage a particular value is to the assessed Likelihood x Severity. It may be determined by interacting social-economic, physical, and environmental factors or processes. I.e. a fire adapted forest ecosystem may be vulnerable to high intensity crown fire but have a beneficial relationship with low intensity surface fire. Public and firefighters are far more vulnerable to radiant heat flux and smoke than is a properly constructed and maintained structure.

ISO 31000 – Application

Establish the Context:

Much of the context for operational wildland Fire Readiness and Incident Risk Management (Tables 2 and 3) would have been established over the years at the Strategic Risk Management Planning level (Table 1). It is this planning level that establishes Values and Vulnerability through stakeholder and public Communication and Consultation. The strategic level risk management planning is also where the high level organizational objectives (goals) are established, setting the stage for a cascading/networking of objectives through to the operational strategies and tactics (Figure 2).

This is the stage where the scope of the risk assessment is determined. I.e. will it be a strategic level all-inclusive risk assessment for a multiuse park or a community wildland urban interface specific risk assessment. Or, a total incident to extinguishment risk assessment, or a risk assessment on a particularly high priority portion of an incident for a defined period such as the passage of a cold front. This also helps to define what persons and/or stakeholders are required for Communication and Consultation.

Strategic risk management planning is clearly important to the overall corporate risk management. It is imperative to the cascading/networking of objectives plus risk drivers and potential controls that the frameworks of the ISO 31000 and the Risk Profile described are maintained throughout an organization's risk management decision making. It also provides for Decision Support System development efficiency plus operator and end user familiarity for all levels of decision making.

One of the greatest difference between Strategic Level Planning (Table 1) and Readiness and Incident Risk Management (Tables 2 and 3) is the degree of public and stakeholder Communication and Consultation that takes place at the strategic level. In a hierarchy risk management context, Readiness and Incident Risk Management are potential controls of Strategic Risk Management Planning, no different than fuel management or building construction controls. Strategic level Consultation and Communication will have detailed these controls.

Simply, there are risks within controls and further controls within those risks.

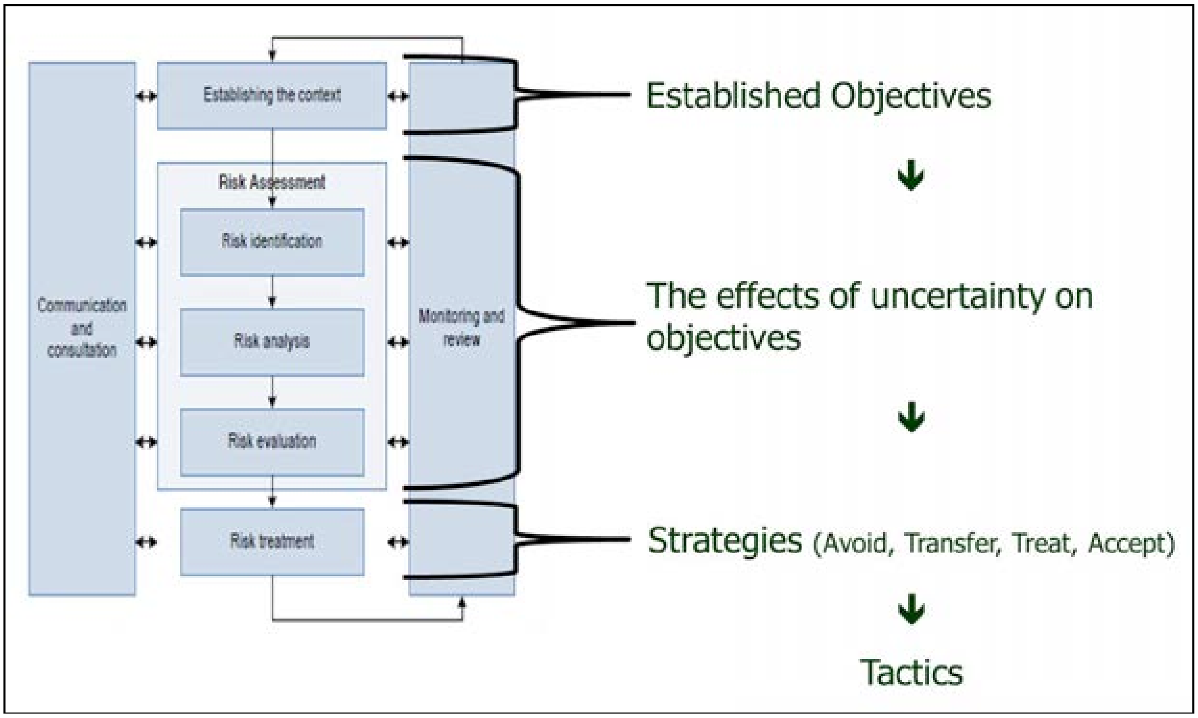

Figure 2. ISO 31000:2009 Risk Management – Principles and Guidelines (annotated)

Risk Assessment:
The Risk Assessment process stage encompasses the systematic process steps of risk identification, risk analysis and risk evaluation (Figure 2). Risk assessment is where the Risk Manager in collaboration with team members and technical specialists identifies, analyzes and evaluates the effects of uncertainty on the established objective(s) for developing a comprehensive risk profile (reference examples, Tables 1, 2 and 3). This is an indispensable stage from which informed strategies and tactics can be developed, linking objectives to controls and actions.

Risk Identification:
On the basis of the best quality information and science (intelligence), the Exposure of Values that are Vulnerable to the assessed Likelihood and Severity are identified and described. Sources of risk drivers, current controls, events and their possible causes, areas of impact and potential consequence are considered. A systematic and comprehensive approach is taken to ensure that no significant risk is inadvertently omitted. This might involve considering historical information or projections on similar events. Identifying these scenarios may prove useful, because they may lead to reasonable predictions about current and evolving issues. Strategic Level Wildland Fire Risk Management Planning is a valuable source for informing readiness and incident risk identification.

Historical information should however be assessed with caution. Standard Operating Procedures (SOP's) are largely controls that are frequently developed from Standard Operating Conditions of Likelihood x Severity. They work well for managing risk under the conditions that underpin their development. The uncertainty in the wildland fire risk management business is that some of the greatest wildland fire disasters have occurred under risk Likelihood and/or Severity conditions far beyond standard. And have we yet to see the worst that nature can deliver?

It is equally important to avoid an over simplification of the intelligence. The more you simplify the intelligence the less intelligent it becomes.

Risk Analysis:
Risk analysis is the activity in the process through which the level of risk and its characteristics are determined and understood. Information from the risk analysis is vital to understand the magnitude and seriousness of risks and to help decide whether risks need to be treated or not. The analysis involves consideration of possible consequences, the likelihood that those consequences may occur, including the drivers that affect the consequences, and any existing control(s) that tend to reduce the risk drivers and components. During this activity the degree of confidence in the analysis is assessed by considering factors such as the level of expertise, uncertainty, quality, quantity and relevance of data and information, and limitations of the modelling and Decision Support Systems.

Fire behavior prediction and occurrence systems play a key role in analyzing and populating the Likelihood and Severity components of a Risk Profile. The uncertainty and limitations of these systems needs to be fully understood or the Likelihood and/or Severity components could be misrepresented in the Risk Profile (Cruz and Alexander 2013). Of the five Risk Profile components it is the components of Likelihood and Severity that are the most dynamic in wildland fire with the greatest uncertainty.

Risk Evaluation:
During risk evaluation the level of risk is evaluated in relation to the established objectives. The desired outcome of the evaluation is a decision concerning which risk drivers need to and can be treated, treatment priorities, potential controls and who is the owner of each potential control? Risk evaluation may also lead to a decision to undertake further analysis. Another outcome might be that no further analysis or treatment is required, so that the relevant risk will merely be subject to a continuation of existing controls and ongoing Monitoring and Review. Always ask the question "does this support the established objective(s)"?

It is during the Risk Evaluation activity where the technical specialist(s) interact and communicate with the Risk Manager(s)[3] to inform them in their respective specialist areas

[3] During the initial attack and/or transition from initial attack to sustained attack stages there is little or no opportunity for interacting with technical specialists for the development, execution or Monitoring and Review of an incident risk management plan.

(meteorology, fire behavior, fire ecology, vulnerable communities, cultural resources, health services, etc.). This intelligence is processed and compiled in the Risk Profile, progressing to the Risk Treatment stage.

Risk Treatment:
Risk treatment is the process of selecting and assessing controls to mitigate risk from what the respective Risk Profile processed and compiled. This then moves to the preparation of Risk Management Strategies and Tactics which may prescribe for new controls and/or modifying existing controls. More than one option may be considered and adopted either separately or in combination. Actions to manage risk can include avoiding, retaining or increasing risk in order to pursue an opportunity, removing or modifying the risk component and/or driver. It identifies opportunities for managing wildland fire on your terms over nature's terms.

This is the step where the individual or organizational risk tolerance is determined in relation to the objectives and residual risk. How much risk is too much? How much uncertainty is too much?

The Risk Manager(s) assesses the appropriateness of the risk uncertainties to the established objectives and may request additional Risk Assessments for Strategy and Tactics considerations. I.e. do the suppression controls expose fire suppression resources to unacceptable Likelihood x Severity with only limited effectiveness to reduce the exposure of other Values and Vulnerabilities?

Strategy:
A strategy as it relates to wildland fire risk management is a big picture overview for which a comprehensive Risk Assessment and precipitating Risk Profile is instrumental to strategy development. It is the Risk Assessment that brings context to the effects of uncertainty on objectives. It is important that the Strategy addresses both the positive and negative outcomes that the risk might present.

Describing the diurnal variations in fire behavior related Severity is an example of a key output of a comprehensive Risk Assessment that would feed into a strategy statement. What may be an unmanageable Severity component during the peak burning period may give way to tactical opportunities later in the day or early mornings. It also helps define the period of Exposure to which a Value that is Vulnerable to the specified Likelihood and Severity might be exposed.

Tactics:
Tactics are the actions that lead to the execution of the strategy. Every tactic must suit the strategy. If you can't explain how a tactic helps you achieve the preferred strategic outcome, then it may not be the best choice and needs to be rethought. This could lead to an additional Risk Assessment and revised Risk Profile.

All tactics require a purpose, schedule (who, what, when, where, how) and a measurable output (SMART Objectives – Specific, Measurable, Achievable, Realistic, Timely). This helps to achieve the strategic outcome and reduce the likelihood of wasting time on tasks that are unlikely to deliver a suitable return on investment or even exacerbate or produce another risk.

Monitor and Review:
Monitoring and Review in the wildland fire risk management business functions on multiple timescales. Real-time or near real-time fire environment reality updates that would compare how the fire/fire-day is developing in relation to how it was predicted to unfold are invaluable to informing situational awareness (Putnam 1995). Are the controls that were established on the predicted fire environment and all of its uncertainties still adequate, do they require modification or new controls? One need only reference the evening news to witness the continued application of ineffective Suppression Controls when it is Exposure Controls that require attention and application.

"Situational awareness is the understanding of what the fire is doing and what you are doing *(Controls)* in relation to the fire and your objectives *(Context)*. It involves an understanding of fire behaviour and terrain and the ability to predict where the fire *(Likelihood x Severity)* and you *(Value x Vulnerability)* will be in the future *(Exposure)* (Putnam 1995)."

Ongoing monitoring and reviewing is used for confirming the effectiveness of existing controls and accounting for changes in context, risk components or risk drivers. These activities provide the feedback mechanism to the ongoing risk management cycle so that assumptions, methods, data sources, results and rationale for decisions are subject to regular checks and balances. The process should also provide consolidation of further information to improve risk assessments, analysis of lessons learned from events, trends in changes of Exposure and Vulnerability, detection of these changes and changes in Likelihood and Severity.

After action reviews, debriefs, reviews and enquiries in this context are important practices for continuous improvement of the entire risk management process. It is essential to examine all of the components, drivers and controls of the risk management process, what worked well so that it can be repeated, what needs improvement and/or new research or improved decision support tools and systems.

Decisions that lead to positive outcomes need to be understood so they can be repeated. Was it a good decision from a sound application of the processes or simply a circumstance of good luck? Without a comprehensive understanding of the conditions that produced the good luck it can and has had substantial, adverse, downstream effects to Risk Management Decision Making. Whereas sound decisions from a sound process that did not deliver the desired outcomes in the face of the dynamics and uncertainties in the wildland risk management business are still sound decisions based upon the available intelligence.

While it is easy for debriefs and reviews to fixate on outcomes it is the commitment of organizations to continuous improvement of their risk management processes and systems that will deliver long-term results. Debriefs and reviews would now have a true focus and purpose.

Risk Profile Examples:
Tables 1, 2 and 3 are not comprehensive Risk Profile examples nor were they intended to be. Organizations may share similar objectives and risk profile drivers but it is unlike that any two will be identical. The ISO 31000 recognizes that a "one size fits all" risk management solution does not exist and the process needs to be tailored to each organization's risk profile. These examples are meant to provide an illustration of the minimum detail, in a framework, that Risk Manager(s) require and should come to expect for developing comprehensive and defendable Risk Management Strategies and Tactics. It also provides an illustration of how and where Applied Science and technical specialists fit into and inform the ISO 31000 process and where in turn the process helps to inform research needs.

What also should become evident is the cascading effect from strategic level risk management to readiness risk management planning to incident risk management planning. Applied in this manner it provides a networking of organizational objectives through to controls and operational strategies and tactics. Also evident is that wildland fire risk management organizations do not have authority over many of the risk drivers and controls, yet history has shown that many of these organizations have too frequently been assigned all of the risk and all of the blame when the controls have proven to be inadequate.

It would be remiss to Kahneman's 2013 Thinking, Fast and Slow not to point out that the application of the ISO 31000 and the resulting risk profiles in the manner illustrated in Tables 1, 2 and 3 predominantly applies and enhances System 2, Logic Decision Making. As previously described people cannot be trained to override the bias producing processes of System 1, Intuitive Decision Making. It is therefore imperative to identify situations where System 1 is likely to dominate and develop suitable controls for this known uncertainty. This is all achievable within the frameworks described, the available research and science and decision support system technology.

A caution provided by the author is that for the initial attack phase, dispatch to control, System 1, Intuitive Decision Making is likely making the majority of the decisions. For the large majority of initial attacks this is likely a safe and effective situation. The majority of initial attacks would have provided the consistent and stable environment with the immediate feedback required for educating the System 1 experiential memory base. Standard operating procedures developed under standard operating conditions.

Strategic Level Planning – Risk Profile (Components, Drivers, Potential Controls)

Objectives: (all risk management starts from well framed and stated objectives)

- To minimise the impact of major bushfires on human life, communities, essential and community infrastructure, industries, the economy and the environment. Human life will be afforded priority over all other considerations.
- To maintain or improve the resilience of natural ecosystems and their ability to deliver services such as biodiversity, water, carbon cycling and forest products.

Likelihood x	Severity x	Exposure x	Value(s) x	Vulnerability
Risk Assessment • Ignition History -Lightning? -Human? • Seasonality • Topography • Fuel Hazard • Climate	Risk Assessment • Fine Fuel Moisture Content • Rate of Spread • Fuel Consumption • Depth of Burn • Fireline Intensity • Embers / Spotting • Surface / Crown • Perimeter / Area • Flame Depth • Radiant Heat Flux • Fire Cycle / Interval • Heat Stress • Smoke • Terrian • Slope • Dangerous Trees • Other FF Safety Drivers	Risk Assessment • Proximity -Direction -Distance -Topography • Property Density • Smoke • Severity Duration	Risk Assessment • Public -Health -Safety -Wellbeing • Response Resources -Health -Safety -Wellbeing • Infrastructure • Property • Industry – Economics • Cultural • Environment • Agency Reputation	Risk Assessment • Human Physiology • Property Construction • Property Maintenance • Subdivision Design • Socio – Economics • Resilience • Biodiversity • Fire Ecology • Litigation
Potential Controls • Education • Engineering • *Spark Arresters* • *Power Grid Mgnt* • Enforcement • *Fire Bans* • *Area Closures*	Potential Controls • Fuel Management *-Protection Burning* *-Ecological Burning* *-Mechanical* • Fire Response	Potential Controls • Building Controls • Subdivision Design • Area Closures • Warnings • Evacuations	Potential Controls • Education • Land Use • Salvage	Potential Controls • Building Controls • Land Use • Training • Experience • Education • Warnings • Advice • Mosaic Burning

Table 1. Strategic Level Planning - Risk Profile Example

Readiness – Risk Profile (Components, Drivers, Potential Controls)

Objectives: (all risk management starts from well framed and stated objectives)

- Reduce the exposure of public and firefighters to smoke and damaging fire intensity.
- Manage the exposure of firefighters to debilitating levels of heat stress.
- Control 90% of all fires before they exceed 5 hectares in size.
- Prioritize response activities to agency priorities and values.
- Protection of residential property as a place of primary residence.

Likelihood x	Severity x	Exposure x	Value(s) x	Vulnerability
Risk Assessment • Ignition Sources -Going Fires? -Recent Lightning (dry/wet)? - Forecast Lightning (dry/wet)? -Human Caused? -Other? • Ignition Trends? • Prescribed Fire?	Risk Assessment • Fine Fuel Moisture Content • Direction and Rate of Spread • Fireline Intensity • Ember Production • Spotting Distance • Crown Fire? • Surface Fire? • Convective Column? • Perimeter Growth Rate • Area Growth Rate • Flame Depth • Fuel Consumption • Radiant Heat Flux • Suppression Difficulty • Diurnal Pattern • Heat Stress • Smoke • Terrian • Slope • Dangerous Trees • Ash Pits & Other FF Safety Drivers	Risk Assessment • Proximity -Direction -Distance -Topography • Property Density • Smoke Dispersion • Diurnal Duration	Risk Assessment • Public -Health -Safety -Wellbeing • Response Resources -Health -Safety -Wellbeing • Infrastructure • Property • Industry – Economics • Cultural • Environment • Agency Reputation	Risk Assessment • Human Physiology • Property Construction • Property Maintenance • Subdivision Design • Socio – Economics • Resilience • Biodiversity • Fire Ecology
Potential Controls • Total Fire Bans • Fire Restrictions • Area Closures • Patrols • Media Campaigns	Potential Controls • Early Detection • Rapid Dispatch • Resources (numbers and mix) • Size-up and engagement	Potential Controls • Warnings • Advice • Area Closures • Relocation • Access & Egress • Responder Briefings • PPE • Escape Routes • Safety Zones • Non-engagement (avoidance) • Strategies -Foot-in-the-black -Anchor, Flank & Hold	Potential Controls • Communicate & Consult • Salvage	Potential Controls • Warnings • Advice • Experience • Responder Briefings

Table 2. Readiness – Risk Profile Example

Incident – Risk Profile (Components, Drivers, Potential Controls)

Objectives: (all risk management starts from well framed and stated objectives)

- Manage the exposure of public and firefighters to smoke and damaging fire intensity.
- Manage the exposure of firefighters to debilitating levels of heat stress.
- Control Division "E" by 0900 October 12th.
- Secure communications infrastructure on Mount Granger by fuel managment using ground and aerial ignition before next burning period.

Likelihood x	Severity x	Exposure x	Value(s) x	Vulnerability
Risk Assessment • Control Line Status? -hotspots? -weak spots? • Fuel Burning • Fuel Adjacent • Wind Speed & Direction • The place the fire is most likely to escape?	Risk Assessment • Fine Fuel Moisture Content • Direction and Rate of Spread • Fireline Intensity • Ember Production • Spotting Distance • Crown Fire? • Surface Fire? • Convective Column? • Perimeter Growth Rate • Area Growth Rate • Flame Depth • Fuel Consumption • Radiant Heat Flux • Suppression Difficulty • Diurnal Pattern • Heat Stress • Smoke • Terrian • Slope • Dangerous Trees • Ash Pits & Other FF Safety Drivers	Risk Assessment • Proximity -Direction -Distance -Topography • Property Density • Smoke Dispersion • Severity Duration	Risk Assessment • Public -Health -Safefy -Wellbeing • Response Resources -Health -Safefy -Wellbeing • Infrastructure • Property • Industry – Economics • Cultural • Environment • Agency Reputation	Risk Assessment • Human Physiology • Property Construction • Property Maintenance • Subdivision Design • Socio – Economics • Resilience • Biodiversity • Fire Ecology • Litigation
Potential Controls • Containment Priorities • Mop-up Priorities • Mop-up resources • Patrols	Potential Controls • Direct Attack • Indirect Attack • Resources • Shifts	Potential Controls • Warnings • Advice • Area Closures • Relocations • Evacuations • Responder Briefings • PPE • Escape Routes • Safety Zones • Non-engagement (avoidance) • Strategies & Tactics -Direct Attack -Indirect Attack -Foot-in-the-black -Anchor, Flank & Hold	Potential Controls • Communicate & Consult • Salvage	Potential Controls • Warnings • Advice • Experience • Responder Briefings

Table 3. Incident - Risk Profile Example

Implementation

Risk management needs to be a continuous process that enables organizations to anticipate and respond well to internal and external changes and uncertainties. For this to happen effectively the organization must embed and integrate risk management into its everyday thinking, ongoing business processes, systems and business culture.

The benefits of applying the ISO 31000 as described are many. It promotes a consistent framework for improving logic decision making. Through the continuous and repetitious exposure to its terminology and processes it assists in also adapting intuitive decision making, further promoting a risk management culture.

Personnel would be exposed to this framework and processes from their first day on the job when decisions are relatively easy and then well-practiced in its application as they advance to decisions of more significance and complexity.

Most organizations already have risk management processes in place for a variety of activities. A Wildland Fire Situation Analysis sometimes referred to as an Options Analysis or Escaped Fire Analysis is a form of risk assessment. “Size Up”, taught in basic wildland fire suppression is a risk assessment. Many of these will require little more than minor restructuring, consolidating and terminology modifications.

There is also an order of efficiency for applying a single common framework for all decision making. Information technology clearly has a role, and like the ISO 31000 itself, a corresponding Decision Support System structure could be adapted to all decision making requirements regardless of scope or complexity. It could be developed incrementally and improved in unison with the emerging science (Adaptive Management), incorporating a type of complexity loading used successfully in athlete development. The benefits in resource sharing would seem obvious.

Some initial implementation activities follow.

- Introduce the application of ISO 31000 frameworks and processes into operational policy. Establish effective risk management decision making as the corporate doctrine.
- Edit/re-format all policy, Standard Operating Procedures and Decision Support Documents to the frameworks described. A reader of these documents should be able to easily and expressly see this framework.
- Implement Risk Management Terminology (i.e. change Size Up to Risk Assessment).
- Establish the “continuous improvement of risk management processes and systems” as a Term of Reference for Debriefs, Reviews, etc. This will assist in system development and capture corporate knowledge for future generations of risk managers.
- Invest in decision support tools and systems that conform to the prescribed framework with user interfaces that expressly displays the risk profile components.
- Invest in technology transfer

Summary

Good risk management is fundamental to organizations achieving their objectives in a business environment with an abundance of uncertainties. So much so that risk management should be a way of business life, threaded through every facet of a business that requires decisions on a course of action regardless of the real or perceived importance. Applying the describe risk management framework process on decisions of lesser importance and complexity provides operational practice for when the decisions are more critical.

Wildland Fire Risk Management should be promoted with equal or greater vigor as the enthusiasm given to 1935, 10am Fire Control (Pyne 1982), underpinned by relevant research and science.

It also provides the minimum detail required for targeting risk drivers and developing potential controls plus the identification of potential control owners. This in turn assists in promoting risk sharing and apportioning risk management contributions. Managing risk in this way helps improve an organization's logic decision making which in part, provides an evidence of due diligence.

By improving an organization's logic decision making (System 2) it can work to better manage the known uncertainties related to intuitive decision making (System 1). By better understanding the when, where and how of the bias producing processes that Kahneman attributes to intuitive decision making, risk managers can better assess the effects they may have on objectives and implement appropriate controls.

This framework also provides a structure and process for implementing the existing science plus through ongoing application, Monitoring and Review, it provides a mechanism for identifying and informing research needs. It also establishes a foundation for improved wildland fire economics.

Programs such as Community Protection Planning should be informed by nothing less than what has been described here.

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Is the whole greater than the sum of its parts? Homeowner wildfire risk mitigation and community heterogeneity

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Topic Area: Mitigating fire risk to communities

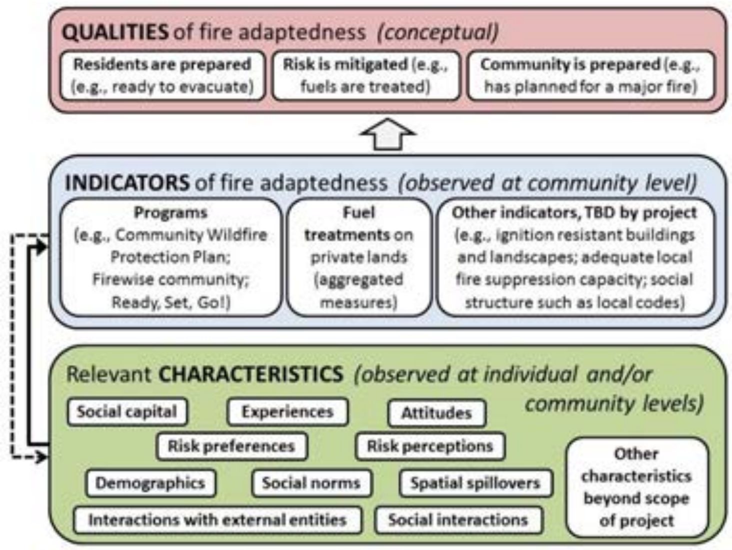
Adaptation to a fire-prone landscape requires action to mitigate the risk. Homeowner decisions to mitigate wildfire risk are complex, influenced by many factors, and are not made in isolation but are made within the context of a broader community. Many potentially relevant characteristics vary across communities, including: programs and approaches to wildfire risk mitigation, capacities to facilitate action (e.g. social capital, financial resources), social norms shaping the acceptability of different wildfire risk mitigation activities and programs, and histories with wildfire events. In this project, we use a framework the research team developed to investigate the conceptualization, measurement, and implementation of the concept of community fire adaptedness to focus on and expand an on-going data collection effort across multiple diverse communities in fire-prone areas of western Colorado. The research expands on previous efforts to characterize the wildfire risk mitigation choices of homeowners by shifting the analytical focus from individual-level characteristics to community-level characteristics.

The framework in Figure 1, presents three levels of fire adaptedness. The top level corresponds with conceptual **qualities** of fire adaptedness, such as residents being prepared for wildfire or risk being mitigated. These qualities are assumed to manifest as emergent properties of the **indicators** of fire adaptedness, which describe observable, community level aspects of being adapted to fire. Examples of indicators include the presence of a Community Wildfire Protection Plan, the existence of a local wildfire organization, or maintenance of a certain aggregate level of defensible space on private lands. In turn, community level indicators are driven by the decisions of the individuals who reside in the community and the interactions among them. Numerous parcel, household, or community level **characteristics** are either known or hypothesized to influence the indicators of fire adaptedness in a community. Examples of potentially relevant characteristics include risk perceptions, risk preferences (e.g., risk aversion), demographics, experiences with wildfire, and social norms. The model recognizes the potential for feedbacks from indicators to characteristics as well as for interactions amongst indicators.

The research examines three interrelated questions based on the conceptual model in the figure below: *1) What is fire adaptedness? 2) How do individual and community characteristics relate to indicators of fire adaptedness?* and *3) What are the impacts of community programs intended to enhance fire adaptedness on individual mitigation efforts on private property?*

Toward the broad goal of linking individual **characteristics** and **indicators** of fire adaptedness while controlling for community heterogeneity, the project addresses gaps in the literature described in the previous section by examining concepts and potential indicators of fire adaptedness to facilitate development of empirical models of fire adaptedness. We build on the existing "Living with Wildfire in Colorado" project, an interagency collaboration involving the US Forest Service, Rocky Mountain

Research Station; the University of Colorado, Institute of Behavioral Science; the Bureau of Land Management Southwest District Fire Management and the West Region Wildfire Council (WRWC). The proposed research expands the current project to also include FireWise of Southwest Colorado (FSC) communities. The WRWC and FSC are wildfire mitigation and education councils tasked with encouraging homeowners to mitigate their wildfire risk. The WRWC covers six counties (Delta, Gunnison, Hinsdale, Montrose, Ouray, and San Miguel) while FSC covers five counties (Archuleta, Dolores, La Plata, Montezuma and San Juan).



To date, the project has paired parcel level wildfire risk assessments with social data in four counties in western Colorado that fall under the purview of the WRWC. The dataset has allowed for an examination of the gap between perceived wildfire risk ratings and the assessed wildfire risk ratings, impediments to wildfire mitigation actions, and the role of a WRWC cost share program, as well interdependent behaviors among homeowners called "spillover effects" (Meldrum et al. 2013a, 2014, 2015(a,b,c,d)). We are expanding the current dataset to include another WRWC county and three counties within the purview of the FSC. Specifically, we are pairing professional wildfire risk assessments with social data in all of the new data collection communities. We also augment the existing and newly collected data with data on community characteristics and indicators of fire adaptedness. These two activities will facilitate analysis of the relationship between community characteristics and wildfire risk mitigation on private land and allow for aggregation of the parcel level data to facilitate community level analysis with sufficient variation on key community level variables.

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Transfer of Knowledge, Skills and Abilities from Leadership Development Training

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Abstract:

Leadership development training represents a form of human resource intervention, the fundamental purpose of which is to improve organizational performance. However, leadership development training represents a useful intervention only when participants transfer what they learn into enduring workplace practices. Both researchers and training practitioners use the term *training transfer* to describe the process by which training participants extend learned knowledge, skills and abilities into the workplace beyond the training environment and sustain those learned knowledge skills and abilities over time. The researcher's qualitative investigation examined lived training transfer experience by interviewing 17 participants in the National Wildfire Coordinating Group's *L-380* leadership development training intervention. The author identified eight factors that motivated the study's participants to transfer the knowledge, skills and abilities (KSAs) they had learned in their leadership development training. In this paper, the author explored the importance of two of those factors, (a) *framework for self-understanding and self-improvement* and (b) *resonance*. Understanding these motivations will prepare, both training practitioners and academics to improve the aptitude of organizations for providing training participants with the capacity to transfer their training into the workplace as a significant driver of training effectiveness.

Additional Keywords: abilities, knowledge, KSA, leadership development, experience, motivation, resonance, self-improvement, self-understanding, skills, training, transfer

Introduction

The researcher's qualitative investigation examined lived training transfer experience by interviewing 17 participants in the National Wildfire Coordinating Group's *L-380* leadership development training intervention. The author identified eight factors that motivated the study's participants to transfer the knowledge, skills and abilities (KSAs) they had learned in their leadership development training. In this paper, the author explored the importance of two of those motivating factors, (a) *self-understanding and self-improvement* and (b) *resonance*.

Training as Human Resources Intervention

The researcher defines human resource (HR) interventions as planned actions including training, mentoring, coaching, counseling and consulting; designed to drive changes in individual behavior and performance to accomplish clearly defined organizational goals (Rowold, 2008; Scott, 2003). Training is a nearly universal HR intervention. One may define training as a systematic process intended to transfer or obtain knowledge, attitudes and skills needed to carry out a specific activity or task (Society for Human Resource Management [SHRM], 2010). The reason training is so common in organizations is because training represents a reliable technique for enhancing the performance and productivity of both individuals and organizations.

Leadership development training constitutes a form of HR intervention (Nguyen & Klein, 2008; Rowold, 2008) the fundamental purpose of which is to improve organizational performance (Day, 2000; Riggio, 2008). However, like all training, leadership development training represents a worthwhile intervention only when participants transfer what they learn into lasting workplace performance (Burke & Hutchins, 2007; Chiaburu & Lindsay, 2008; Hawley & Barnard, 2005; Nikandrou, Brinia, & Berei, 2009; Scaduto, Lindsay, & Chiaburu, 2008; Velada, Caetano, Holton, & Bates, 2009; Yamnill & McLean, 2001). Researchers inquiring into training effectiveness contend that training participants, including participants in leadership development training, typically transfer a relatively small percentage of what they learn from training into actual workplace performance (Burke & Collins, 2005; Chiaburu & Lindsay, 2008; Gilpin-Jackson & Bushe, 2007).

Training Transfer

Both researchers and training practitioners use the term *training transfer* to describe the process by which training participants extend learned knowledge, skills and abilities (KSAs) into the workplace beyond the training environment and sustain learned knowledge and skills over time (Burke & Hutchins, 2007; Hawley & Barnard, 2005; Nikandrou et al., 2009; Velada et al., 2009). Trainees transfer training when they (a) generalize knowledge and skill learned in training to the job context, and (b) maintain the learned knowledge and skill over time (Baldwin & Ford, 1988; Burke & Hutchins, 2007; other citations). Training transfer links training, as an HR intervention, to actual performance improvement and reduces the gap between post-training potential and characteristic performance on the job (Smith-Jentsch et al., 2001).

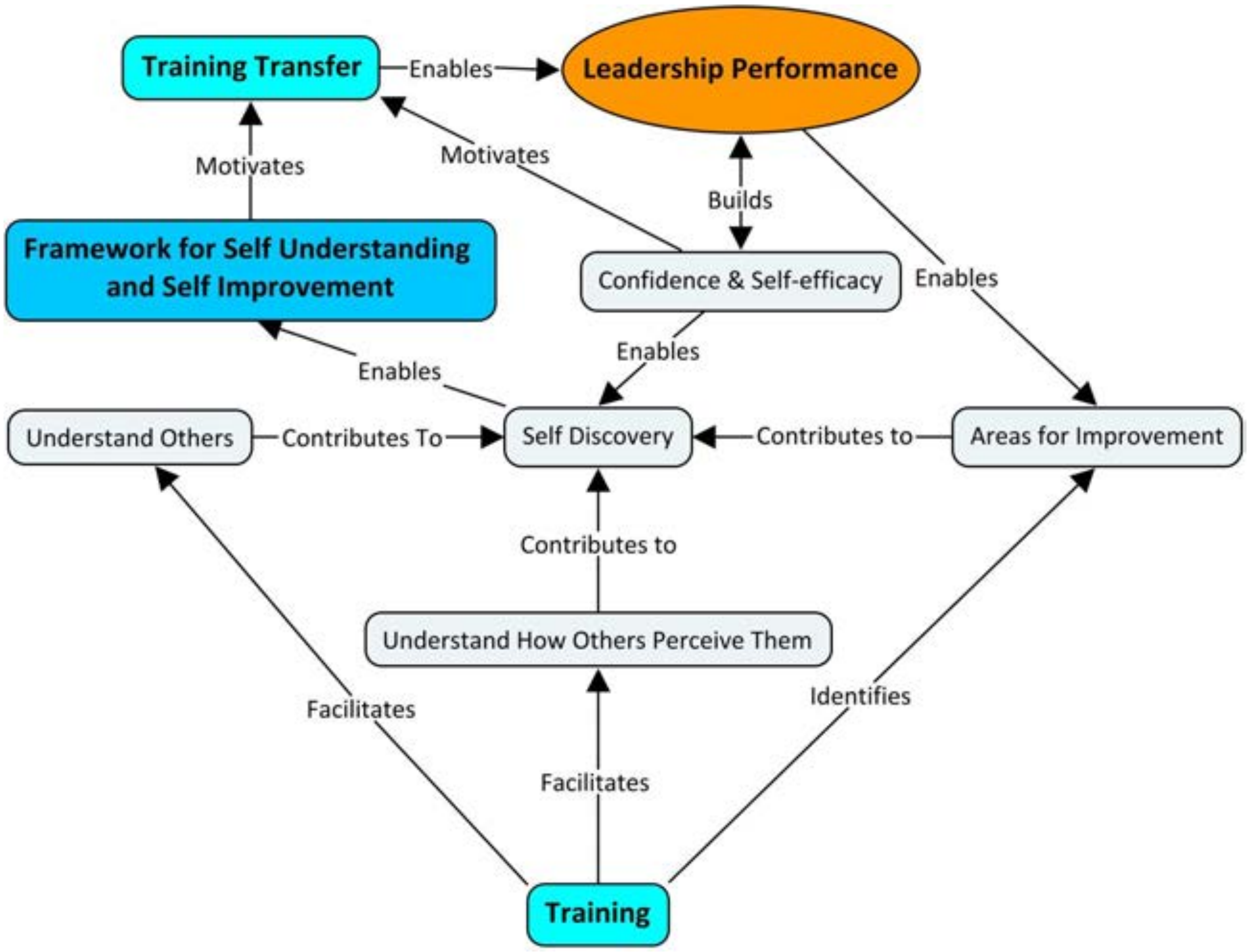
Motivation to Transfer

Synthesizing the definitions available in the extant literature, the author defines *motivation to transfer* as a factor relating to the transfer of training, reflecting a trainee's direction, intensity, and persistence of effort toward using, in a work setting, skills and knowledge learned in training (Velada et al., 2009).

A number of recent studies, including those of Bhatti and Kaur (2010), Burke and Hutchins (2007), Chiaburu and Lindsay (2008), Gegenfurtner, Veermans, Festner and Gruber (2009), and Nikandrou et al. (2009) found that trainee motivation mediated the relationship between learning and training transfer. From this perspective, both original learning and trainee motivation prove necessary to training transfer (Gegenfurtner et al., 2009). Gegenfurtner et al. (2009) illustrated this point well when they observed that without learning, training participants have nothing to transfer from training back to the workplace, but without motivation, participants would transfer nothing from training to the workplace, even if they had learned.

Motivational Factor: Framework for Self Understanding and Self improvement

Nearly half the participants in the author's study (47%) sought to better understand themselves and used self-discovery they achieved in training to guide self-improvement. As illustrated in Figure 1, participants described training experiences that facilitated both their self-understanding and their understanding of how others perceived them. These participants also found that their training helped them identify areas in which they might improve their leadership capacity. By better understanding themselves, understanding how others perceived them, and identifying areas in which they might improve their leadership training participants experienced self-discovery that enabled the participant to establish a framework for self-understanding and self-improvement that, in-turn, motivated training transfer. Training transfer, by definition, enabled leadership performance in the workplace beyond the training environment. In this way, the training provided the participant, as a person who wanted to lead, the capacity to lead and facilitated their leadership performance.

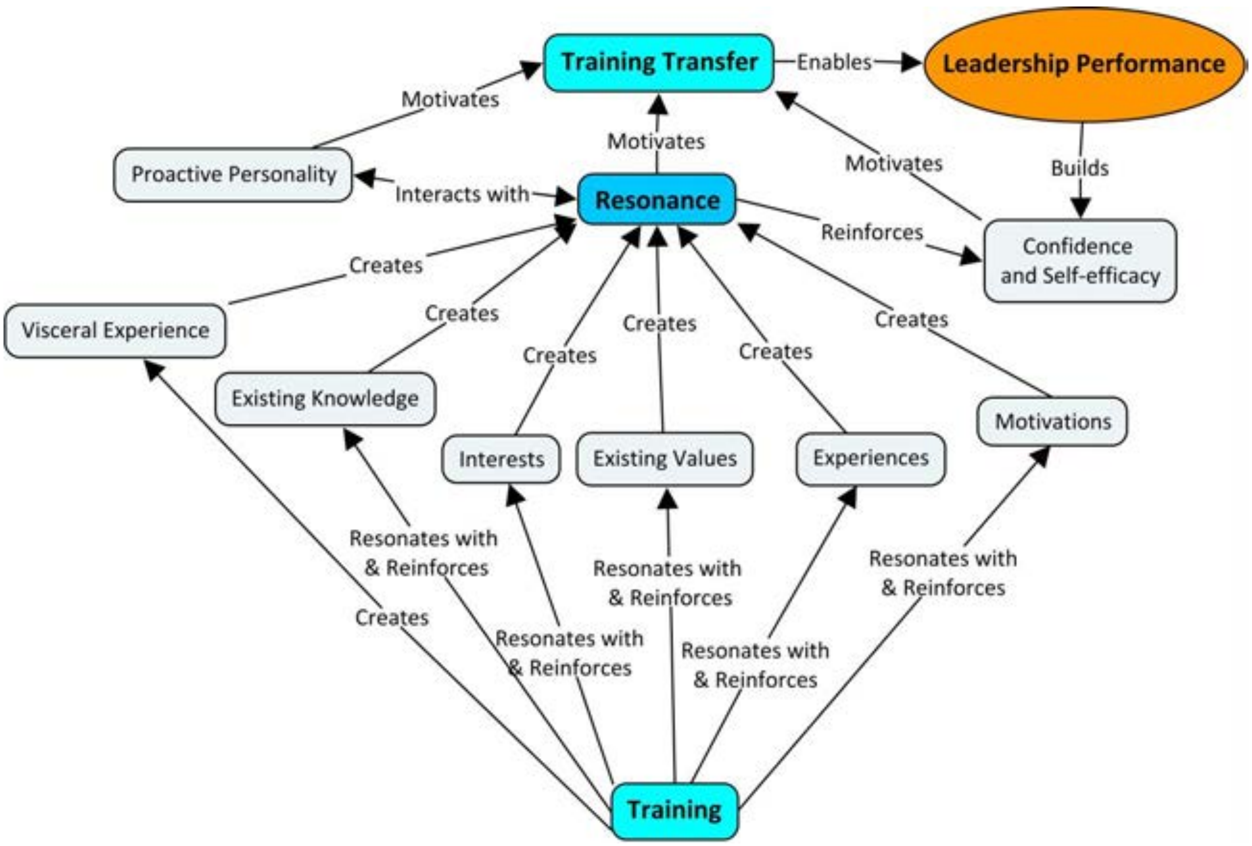


As described by participants who identified a framework for self-understanding and self-improvement as a factor motivating their training transfer, successful leadership performance initiated three reinforcing loops within the training transfer subsystem in which leadership development training contributed to self-discovery, that enabled a framework for self-understanding and self-improvement, which motivated training transfer, which ultimately enabled leadership performance. First, these study participants described successful leadership performance as contributing to a sense of confidence and self-efficacy that directly motivated further training transfer. In essence, participants transferred learned KSAs into the workplace, succeeded with some or all of their attempted leadership, and gained confidence in their leadership capacity which further motivated them transfer learned KSAs. In a second reinforcing loop, a sense of confidence and self-efficacy also enabled additional self-discovery that reinforced the training participants' framework for self-understanding and self-improvement, which motivated training transfer. To explain this relationship, one might argue that self-discovery requires a degree of self-confidence enabling a willingness to reflect on one's personality and performance. By succeeding in their leadership attempts and enhancing their sense of confidence and self-efficacy, study participants found themselves willing to engage in additional self-discovery; thereby reinforcing their framework for self-understanding and self-improvement which, in-turn, motivated further training transfer, which enabled leadership performance.

Study participants who identified a framework for self-understanding and self-improvement as a factor motivating their training transfer did not universally succeed in their attempts to transfer learned KSAs into the workplace. Less than successful attempts at leadership performance also helped these participants to identify additional areas in which they might improve their leadership capacity, which contributed to further self-discovery, which reinforced the participant's framework for self-understanding and self-improvement, which motivated additional training transfer, and further enabled leadership performance. The author noted that, as described by study participants, while successful leadership performance built a sense of confidence and self-efficacy, the opposite was true as well; with a sense of confidence and self-efficacy directly contributing to leadership performance, as described in Figure 1.

Motivational Factor: Resonance

Most of the study's participants (82%) described their motivation to transfer learned KSAs to the workplace as flowing from recognition that the training philosophy and content resonated with and reinforced their existing values and experiences as well as their interests, knowledge and motivations (see Figure 2.)



This result relates to longstanding research indicating that trainee characteristics, also known as learner characteristics, represent a factor affecting transfer, primarily through motivation (Burke & Hutchins, 2007). Trainee or learner characteristics include personality characteristics and Smith-Jentsch et al. (2001) as well as Burke and Hutchins (2007) showed a relationship between personality characteristics and transfer. For example, Smith-Jentsch et al. (2001) found that "predisposition toward training content," a form of personality characteristic, affected training transfer through the trainee's perception of their post-training transfer environment (p. 282). Participants in the author's inquiry perceived that they were inclined to transfer what they had learned in training because their learned KSAs reinforced their existing beliefs, typically expressed in terms of values or experience. This result illustrates a relationship between the participants' predispositions toward the training content and their training transfer experience, as they lived it. Participants also described their lived training transfer experience as resonant because their training opened a door to the ongoing study of leadership as well as pathways to opportunity. Finally, participants also found meaning in a visceral training experience that made a lasting, positive impression that made their learning stickier and facilitated the participants' ability to put to use what they had learned.

Two emerging theories relate to how participants in the current inquiry perceived the role of resonance in their lived training transfer experience. First, a recent study by Prieto and Phipps (2011) suggested that *self-monitoring* and *organizational identification* moderate the effects of personality on learning transfer. Prieto and Phipps (2011) described "proactive personality" as a compound variable that "predicted a number of career development outcomes" in prior research (p. 510). According to Prieto and Phipps (2011), "Individuals with a prototypical proactive personality type identify opportunities and act on them, show initiative, take action, and persevere until meaningful change occurs" (p. 511). The author purposefully selected study participants to confine the study to past participants in a specific training intervention who had time and opportunity to have put what they learned in training to use in the workplace beyond the training environment. Considering the study's design, particularly the process for identifying and selecting participants, the author contends that study participants demonstrated, to varying degrees, proactive personality as described by Prieto and Phipps (2011).

By understanding proactive personality, one can better understand two personality dispositions, (a) self-monitoring and (b) organizational identification described by Prieto and Phipps (2011), that helped the author of the current study to understand how participants' may have formed their perceptions of the relationships between (a) their existing values, beliefs, experiences and desires, (b) the training content, and (c) their motivations to learn and to transfer what they had learned. Of particular meaning to the author's inquiry, Prieto and Phipps (2011) described the utility of the self-monitoring construct to transfer of learning, pointing out that an employee's self-monitoring behavior may play a role in their transfer from a training intervention to the workplace.

According to Prieto and Phipps (2011), individuals with strong organizational identification connect strongly with the work of their organization, tying their sense of survival to the organization's survival, and directing their efforts on behalf of colleagues and the organization as part of a process of making their group distinct from other groups and favoring members of their own group. Social identity theory suggested that such employees with strong organizational identification tend to make their best effort and perform at higher levels, cooperate more, remain with the organization and raise expectations for themselves because they experience a sense of belonging (Prieto & Phipps, 2011). Of importance to the author's inquiry, Prieto and Phipps (2011) pointed to prior research, including that of Burke and Hutchins (2007), establishing that people with higher levels of job involvement experienced more motivation to transfer learned skills to the workplace because they consider their job performance important to their self-worth. Of particular meaning to the current study, Prieto and Phipps (2011) described the utility of the organizational identification construct to transfer of learning, suggesting that the degree to which an employee identifies with the work of their organization may play a role in their transfer of learning from training into the workplace, with organizational identification moderating the relationship between proactive personality and training transfer, with higher levels of organizational identification contributing to higher levels of training transfer.

A second emerging theory related to how participants in the current inquiry perceived the role of resonance with their existing values, beliefs and desires in their lived training transfer experience. Yamkovenko and Holton (2010) proposed "intent to transfer" as an alternative approach to studying transfer, with its roots in theories of planned behavior as well as goal-setting theory (p.381). According to Yamkovenko and Holton (2010), "individuals are likely develop an intent to behave in a certain way after they complete their training, and that intent to transfer can serve as an effective measure of training transfer because intent serves as "an immediate antecedent of action or behavior" (p. 386).

These areas of theory suggest that participants in the current study may have developed intent to transfer as they recognized congruence between the content of the training and their existing values, experiences, beliefs and desires. Other researchers including Gegenfurtner et al. (2009) suggested that transfer motivation is dynamic and that numerous factors affect transfer continuously (p. 419).

Participants in the author's study also described their lived training transfer experience as resonant, in part, because their training opened a door to the ongoing study of leadership as well as pathways to opportunity. This result pertaining to motivation arising from a perception that their training had opened pathways to opportunity aligned with longstanding prior research, including expectancy theory which suggested that trainees will prove more motivated to transfer what they learn in training if they perceive that their effort will lead to rewards that they value (Yanmill & McLean, 2001, p. 200). Participants in the author's study also described their lived training transfer experience as resonant because their training opened a door to the ongoing study of leadership; what several participants described as "becoming a student of leadership," a phrase popularized by a deceased and iconic member of their community. Finally, participants in the current inquiry also experienced resonance in a visceral training experience that made a lasting, positive impression; making their learning stickier and facilitating the participants' ability to put what they had learned to use.

As illustrated in Figure 2, participants in the author's study described training experiences that resonated with and reinforced their existing values and experiences as well as their interests, knowledge and motivations. They also found meaning in a visceral training experience that made a lasting, positive impression that made their learning last and facilitated the participants' ability to put to use what they had learned. Recognizing these connections, participants experienced resonance or an instinctive appeal and lasting affect that contributed to their transfer. Resonance motivated training transfer both directly and by interacting with the proactive personalities of the participants. Training transfer, by definition, enabled leadership performance in the workplace beyond the training environment. In addition, instinctive appeal and lasting affect reinforced participants' confidence and self-efficacy, directly motivating training transfer; aligning with longstanding research suggesting that positive reaction to the training contributes to self-efficacy and that self-efficacy facilitates transfer.

As described by participants who identified resonance as a factor motivating their training transfer, successful leadership performance initiated a reinforcing loop within the training transfer subsystem in which leadership development training contributed to a sense of resonance, which motivated training transfer, which ultimately enabled leadership performance. As with self-understanding and self-improvement, study participants described successful leadership performance as contributing to a sense of confidence and self-efficacy that directly motivated further training transfer. As described previously, participants transferred learned KSAs into the workplace, succeeded with some or all of their attempted leadership, and gained confidence in their leadership capacity which motivated them to further transfer learned KSAs. As previously noted, the author observed that, as described by study participants, while successful leadership performance built a sense of confidence and self-efficacy, the opposite was true as well; with a sense of confidence and self-efficacy directly contributing to leadership performance, as described in Figure 2.

Confidence and Self-efficacy

As illustrated in both Figures 1 and 2, the participants' sense of confidence and self-efficacy contributed to both the training transfer factors previously described (self-understanding and self-improvement as well as resonance.) Confidence and self-efficacy*,* a theme identified by the researcher, corresponded to the self-efficacy construct the researcher used to incorporate training transfer factors previously identified including what Avolio and Hannah (2009) called "developmental readiness" and "developmental efficacy" (p.331), what Bhatti and Kaur (2010) called "performance self-efficacy" (p. 656), and the "trainee self-efficacy" construct described by Chiaburu and Lindsay (2008) as well as by Lent et al. (2009). Unsurprisingly, following their training, most participants (82%) in the author's study found themselves motivated to put to use what they had learned in training because they felt sufficiently confident to do so. Consequently, confidence and self-efficacy represents one of eight factors that motivated the study's participants to transfer the KSAs they had learned in their leadership development training.

Conclusion

Leadership development training represents a form of HR intervention, the central purpose of which is to improve organizational performance. However, leadership development training represents a worthwhile intervention only when training participants transfer what they learn into persistent workplace practices. Both researchers and training practitioners use the term *training transfer* to describe the process by which training participants extend learned KSAs into the workplace beyond the training environment and sustain those learned KSAs over time. The researcher's investigation examined the lived training transfer experience of 17 participants in the National Wildfire Coordinating Group's *L-380* leadership development training intervention. The author identified eight factors that motivated the study's participants to transfer the KSAs they had learned in their leadership development training. In this paper, the author explored the importance of two of those motivating factors, (a) *self-understanding and self-improvement* and (b) *resonance*. Understanding these two motivations, along with their relationship to *confidence and self-efficacy*, will prepare both training practitioners and academics to improve the aptitude of organizations for providing training participants with the capacity to transfer their leadership training into the workplace as a significant driver of training effectiveness.

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Connecting science and decision-making in wildland fire management

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Abstract (200 words):

Climate change has significantly impacted wildland fire in the United States and these impacts are expected to intensity throughout the coming century. Scientific information, decision-making, and management actions that focus on ways to increase both ecological and social resilience are therefore becoming increasingly important. Nonetheless, effectively connecting science, decision-making, and management action remains a challenge for numerous reasons. This study seeks to address this challenge by examining the development and application of scientific information and also by identifying opportunities for connecting scientific information with decision-making and on-the-ground management. This paper describes the results of interviews that were conducted with scientists, managers, and other stakeholders following a workshop about ecosystem resilience in the Southwest U.S. Results indicate that scientific information is being used in formal and informal ways in land management, that there are direct and indirect methods for developing scientific information for management, and that there are advantages and disadvantages to different scientific information communication formats. Two distinct types of scientific information needs are identified, including the need for new research and the need for more effective communication of existing scientific information. Lastly, recommendations for effectively connecting scientific information with decision-making are provided.

Additional Keywords: resilience, Southwest United States

Introduction

Global climate change has already had numerous impacts on fire regimes in the Western U.S. (Westerling *et al.* 2006). In the Southwest U.S., climate change is expected to continue to impact fire by altering fuel moisture, fuel loading, and ignitions (Kent 2015). These fire regime changes create numerous challenges for land managers, scientists, and other stakeholders who are observing novel effects and ecosystem trajectories after fires (Nijhuis 2012). It is critical to begin to identify ways to effectively address these novel scenarios and foster resilience and adaptive capacity, both ecological and social. In order to inform decision-making that can foster resilience, managers need access to relevant, credible, and legitimate scientific information (Cash *et al.* 2003). However, effectively using scientific information for decision-making can be difficult due to numerous institutional factors within both scientific and management cultures (McNie 2007; Sarewitz and Pielke 2007), as well as scientific and management uncertainties about resilience (Ellenwood *et al.* 2012). The intent of this paper is to describe the results of a study that sought to address these challenges by examining the development and application of scientific information and also by identifying opportunities for connecting scientific information with decision-making and on-the-ground management in the Southwest U.S. Recommendations for improving the connections between science and decision-making are also provided.

Background

Decision-making is a complex process that involves a wide range of considerations and forms of knowledge (Doremus 2006). For wildland fire management, scientific information is one of many decision-making inputs (Corringham *et al.* 2008; Steelman and McCaffrey 2011). However, it is important to understand how scientific information specifically informs decision-making and management action, as natural resource managers are mandated to use "generally accepted" or "best available" science under legislative mandates like the National Environmental Policy Act (NEPA) of 1969 and the Endangered Species Act (ESA) of 1973. Despite these mandates, a range of institutional, cultural, and legal factors complicate how scientific information is used in natural resource management (Schultz 2008; Wright 2010). Climate change has introduced numerous scientific and management uncertainties that complicate decision-making further. Managers are increasingly confronted with questions about how to manage ecosystems after disturbances like wildland fire and how to foster ecosystem resilience under rapidly changing conditions. They need access to timely and relevant scientific information to inform decision-making, but there are many factors that complicate the relationship between science and management, as well (Cash *et al.* 2003, McNie 2007; Sarewitz and Pielke 2007).

In order to connect science with decision-making in a way that effectively supports management actions that foster ecosystem resilience, it is necessary to have strong science-management collaborations, which are any interactions that include "members of the research community and members of the non-academic professional community who [have] a stake in environmental research" (Ferguson *et al.* 2014). Developing strong science-management collaborations requires that scientific research be co-produced with involvement from scientists, managers, and other stakeholders (Ferguson *et al.* 2014; Jacobs *et al.* 2005; Lemos and

Morehouse 2005). This co-production of scientific information further necessitates strong human institutions, which Dietz *et al.* describe simply as "ways of organizing activities" (2003). Science-management collaborations are a form human institution that can support or hinder decision-making and adaptive management (Folke 2006). Resilient ecosystems are those that are able to absorb changes and persist (Holling 1973), while resilient human institutions are those that are similarly persistent and flexible under changing conditions (Folke 2006). Therefore, science-management engagements must be flexible enough to allow for the introduction of new information to support decision-making and management action on the ground. This kind of adaptive capacity in human institutions is especially important with respect to climate change, as natural resource management must be able to effectively incorporate new scientific information into decision-making. This study looks specifically at how scientific information is developed and applied within this context.

Methods

The questions driving this research sought to address: 1) How is scientific information about resilience currently used in management? 2) In what ways is management considered in the development of scientific information about resilience? 3) What scientific information is needed to improve our understanding of resilience? 4) How can scientists and managers work together to effectively connect scientific information with decision-making? and 5) What are the most effective ways to communicate scientific information?

This research took place in the Southwest U.S. from February 2014 to May 2014. Data for this study was obtained from semi-structured interviews with participants who had recently attended "Fostering resilience in Southwestern ecosystems: A problem solving workshop", which was hosted by the Southwest Fire Science Consortium in February of 2014 in Tucson, Arizona. The workshop focused specifically on the role of resilience in wildland fire science and management. The event drew a diverse audience of more than 180 managers, scientists, and other stakeholders throughout the region to discuss the topic of resilience, which is characterized by a great deal of uncertainty. It presented a unique opportunity to gain insights into the challenges that climate change and resilience present for both science and management.

A total of 21 respondents self-selected to participate in this study, including 9 managers, 8 scientists, and 4 other stakeholders employed by non-profit or private organizations. All of the interview respondents had had recently attended the resilience workshop, so they were especially attuned to the topic of resilience. Interviews were conducted in March 2014. For the purpose of this study, managers are defined as those who make land management decisions at the federal, state, or local level, scientists are defined as those who conduct research for an academic institution or research organization, and other stakeholders are defined as those who work for non-profit or private organizations. Interviews were recorded and transcribed for use with NVivo 10 for Mac coding software. Interview coding was used to identify salient themes and patterns among the interviews (Cope 2008, Ryan and Bernard 2003). Three rounds of coding were conducted to identify basic concepts about science and decision-making, broad themes or constructs within the data, and finally specific themes using an inductive, grounded theory approach (Strauss and Corbin 1990).

Key Results

Interview coding identified four major themes with respect to connecting scientific information with decision-making: application of scientific information, development of scientific information, communication of scientific information, and scientific information needs. The results section discusses each of these themes, and is followed by recommendations for effectively connecting science with decision-making.

Application of Scientific Information

Respondents were asked to describe how they currently use scientific information about resilience in their work. The majority of respondents who stated that they use scientific information were managers or other stakeholders who described formal and informal approaches. Formal application of scientific information is that which occurs in project planning, such as work associated with the National Environmental Policy Act (NEPA), or project implementation, for example writing a silvicultural prescription. When formally applying scientific information, respondents directly reference or cite scientific information according to statutory requirements that mandate use of "generally accepted" or "best available" science. Many of these respondents noted that in these formal situations they are responsible for finding, interpreting, and applying scientific information, which can be time consuming and challenging.

Meanwhile, informal application is that which occurs more organically, does not involve formal documentation, is used to supplement individual knowledge and experience, and is typically applied during fieldwork or engagement with the public. Informal application occurs within the bounds of current agency guidelines and statutory requirements where flexibility allows. It is not necessarily any less rigorous than formal application, but it does not involve documentation or reference to specific scientific studies.

There are a number of limitations associated with the application of scientific information, both formal and informal. The most frequently cited limitation was communication, which can be hindered by lack of time, uncertainty about who to contact, cursory engagement, and lack of interest. Respondents also noted that access to scientific information, translating scientific results into management contexts, connecting the scales of scientific studies with the scales management concerns, conflicts between scientific recommendations and agency guidelines and restrictions, and emphases on other decision-making factors like social, political, or economic concerns present additional challenges in the application of scientific information.

Development of Scientific Information

Respondents were also asked to describe how they develop scientific information about resilience. The majority of respondents who stated that they develop scientific information were scientists who described direct and indirect approaches. Direct development of scientific information for management occurs when scientists work directly with managers or other stakeholders to design research that is meant to address management needs. This involves long-term engagement and necessitates sustained communication and feedback among scientists and managers over long time periods. The only scientist who described that this type of engagement was affiliated with a non-academic research organization that permits that level of engagement, whereas the other scientists who were affiliated with academic organizations noted that their expectations and responsibilities often limit that level of engagement.

Indirect development of scientific information, on the other hand, was most common for the majority of the scientists. This refers to instances where research results that were not specifically designed for management applications do have decision-making relevance. However, it is often difficult to effectively translate scientific information into a decision-making context unless the research was explicitly designed to do so (Sarewitz and Pielke 2007). Nonetheless, all of the scientists noted that their research was meant to advance some goal beyond basic scientific knowledge.

There are also limitations associated with the development of scientific information. One of the biggest limitations was lack of time for sustained engagements, which can last many years and conflict with organizational responsibilities and expectations. Additional limitations include research timing that conflicts with management responsibilities, poor communication, undeveloped or underdeveloped personal relationships, unclear expectations, and limited resources like funding, equipment, and personnel.

Communication of Scientific Information

Respondents were asked how they prefer to deliver and receive scientific information. Respondents described both verbal and written formats. Verbal formats are those that are delivered aloud, while written formats are delivered in hardcopy. The verbal formats discussed included in-person meetings, site visits or field trips, workshops, conference or interagency meeting presentations, and webinars. The majority of respondents stated that they prefer to receive and deliver scientific information in-person or in the field. In-person interactions provide opportunity for two-way dialogue, on-the-ground examples, and broader knowledge sharing. Respondents were divided about the efficacy of other verbal formats, which tend to be more formal, can vary significantly in quality, and offer more limited opportunities for dialogue and interaction.

The written formats discussed included concise summary formats like fact sheets or digests, white or working papers, formal reports, and scientific articles. The majority of managers noted that they prefer to receive written scientific information in concise, summary formats, which do not require a lot of time to read and digest. However, the majority of managers also described searching for and reading scientific articles, especially when formally applying scientific information. At the same time, most of these managers explained that they had developed personal strategies for skimming scientific articles in order to quickly access the major points. Some of them also expressed concern that their colleagues were turned off by scientific articles or not using them altogether. The majority of scientists stated that they primarily communicated their results with scientific papers or formal reports but that they were aware of their potential limitations. However, because most of the scientists interviewed in this study worked for academic organizations, they noted that they are required to produce scientific papers, so that was their primary format of communication. Only a few respondents discussed white or working papers, but those that did noted that they are useful for getting a broad overview of a topic.

The most preferred method of scientific information communication for all respondents was in-person and in the field. However, there are various advantages and disadvantages for all formats. In sum, there is no single best verbal or written format for communicating scientific information, and it is critical to deliver results in a range of formats in order to appeal to different audiences. It is also helpful to make an effort to distribute results broadly to any potential users of the information, as well as be available for in-person meetings when feasible.

Scientific Information Needs

Respondents were prompted throughout the interviews to identify strategies to more effectively connect science with decision-making and on-the-ground management. Based on the results, two distinct types of scientific information needs were identified, including the need for new research and the need for more effective communication of existing research. It is critical to first determine whether a new study is needed or whether communication of existing scientific information is sufficient. With the case of resilience, scientific information may be rapidly evolving, which oftentimes warrants new research. However, there are many instances where communication of existing information can effectively address a decision-making need.

New research is necessary when entirely novel scientific information is necessary to address a management question. This could include anything from application of established methods in a new context to the development of an innovative approach to address an evolving question. The development of new research necessitates sustained engagements among scientists and managers. Respondents described the following general considerations for conducting new research: partners, questions and concerns, expectations and limitations, resources, study design, study implementation, and interpretation and application. First, it is critical to convene any relevant partners who are united by a common problem or interest in-person and in the field. Relationships among research organizations, land management agencies, non-governmental organizations, and funding agencies should be fostered to allow partners to focus on their particular skillsets within the partnership. The relevant partners should define what specific questions and concerns will be addressed, as well as clearly state their expectations and limitations in order to ensure that the research meets the needs of everyone involved and to develop trust. Next, funding and other resources need to be procured, and if possible, specific requests for proposals (RFP's) should be developed to draw additional partners to the process. The research design should be occurring from the outset of the engagement, but the final design should be reviewed and approved by all partners. Communication and feedback should be ongoing throughout the study implementation to ensure that the research is proceeding according to the agreed expectations and limitations. Finally, once new scientific information is generated, whether it is preliminary findings or larger conclusions, the partners should discuss how to interpret and apply it to the management concerns. Once the information has been interpreted, it can feed into a larger adaptive management process that involves implementation, monitoring, evaluation, adjustment, and future assessment and design as warranted.

Respondents also identified a number of specific research needs to improve our understanding of resilience for management. A number of managers wanted more specific information about how to manage for climate change, as well as more specific climate data or reference conditions that might better reflect potential future conditions. There was also a great deal of interest in broad, landscape-scale experimentation to test the effects of management actions. Respondents also wanted more specific information about how to foster resilience after fire and other disturbances, as well as more social science about the connections between social and ecological systems, decision-making and communication, and public reactions to management actions.

Meanwhile, the need for communication of existing scientific information occurs when the necessary research or data exists to inform a management question but has not reached the appropriate managers or has not been effectively interpreted or applied. Communication of existing scientific information may refer to everything from preliminary data to larger conclusions. Respondents described the following general considerations for communicating existing scientific information: partners, questions and concerns, access, refinement, delivery, and interpretation and application. As with new research, it is first critical to convene any relevant partners who have a common interest or problem. This necessitates the development of communication networks that effectively connect the relevant partners. Next, partners should discuss how the existing scientific information might be able to address the relevant questions and concerns. Once the specific information has been identified, it needs to be accessed, and depending on what formats are available, it may need to be refined into other formats in order to be effectively utilized. Finally, the information should be delivered in a variety of formats so that it may be interpreted and applied to the management questions and concerns.

There may be cases where there is uncertainty about whether scientific information exists to inform a given management question or need. In these cases, knowledge networks, which are composed of the relevant individuals and organizations that are making an effort to maintain sustained communication and information dissemination will need to be accessed and fostered (Feldman and Ingram 2009). Effective communication among scientists and managers is fundamental to ensure that scientific information meets decision-making needs (Jacobs et al. 2005). Knowledge networks can be formal and informal, so it is important that both managers and scientists seek them out in a variety of places, as they vary from place to place. It is also helpful to share success stories in order to identify best practices and share examples widely.

Conclusion and Recommendations

Five major takeaways can be gleaned from this study. First, in order to effectively connect resilience science and decision-making, in-person meetings and discussion among scientists, managers, and other stakeholders should be facilitated before the research process begins. Second, it is critical to identify common goals and design projects to meet those goals while allowing all partners to focus on their strengths and skills. Third, sustained, ongoing interactions before, during, and after research should be encouraged. Fourth, scientific information should be communicated in a range of formats with an emphasis on in-person communication. Fifth, scientists, managers, and other stakeholders should all make an effort to tap into existing knowledge networks and share success stories widely. These recommendations can help to develop resilient science-management collaborations by providing a degree of flexibility within current institutional limitations. It is critical to focus on developing partnerships and knowledge networks over time in order to support existing and developing science-management collaborations. Future research should test these recommendations and identify specific examples of the effective development and application of scientific information about resilience for decision-making and management action.

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The role of departments of transportation in response to wildland fire events

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Abstract:
The state of Texas suffered a devastatingly serious wildland fire season in 2011. In order to better prepare for future fires and to more effectively use available resources, the state determined that additional training for emergency assets was necessary. As one of the supporting agencies responsible for wildland fire management, the Texas Department of Transportation determined that the maintenance division needed to be properly instructed as to how to most safely and effectively be deployed for wildland fire response. The Texas Tech University Center for Multidisciplinary Research in Transportation was contracted to develop and provide this training. This paper presents a synthesis of the lessons learned from developing the training program for Texas Department of Transportation employees. Emphasis is placed on the specific role that the Texas Department of Transportation plays in wildland fire response. Lessons for other departments of transportation are provided based on an examination of what other states do and the findings from the training program.

Additional keywords: Safety, Transportation, Management

Introduction
In 2011, the state of Texas suffered an extremely costly wildland fire season, with a significant number of wildland fires occurring across the state. The extreme conditions took a costly toll on the state of Texas, both financially and emotionally, causing the state government to investigate more effective means of emergency management, particularly in response to wildland fires. One major thrust of this effort was to redefine how various state assets are used in emergency management. During the 2011 season, the Texas Department of Transportation (TxDOT) was one of the main entities that responded to wildland fires. However, TxDOT response was often disorganized and varied significantly from district to district.

In order to address this issue, TxDOT managers contracted the Texas Tech University Center for Multidisciplinary Research in Transportation (TechMRT) to identify best practices for wildland fire management and to train TxDOT personnel on safe procedure. The research team designed six training modules to be taught in one-day workshops to accomplish the following tasks:

- Explain TxDOT's role in wildland fire response
- Utilize data collection resources to communicate and catalog information regarding wildland fire events
- List and safely use the proper resources and equipment for wildland fire response
- Explain the basic fundamentals of fire behavior and fire safety
- Cooperate with other agencies at a wildland fire event

A total of nine training workshops were hosted, and responses from attendants were collected to assess performance.

The purpose of this paper is to illuminate the potential roles of departments of transportation (DOTs) in wildland fire response through the lens of how TxDOT operates. First, a brief literature review regarding how select other departments of transportation are used in wildland fire response is presented. Second, summaries of each training module are presented, including key points and practices. Third, the results of the training workshops are discussed to illustrate how well the core concepts were relayed and how other departments of transportation may benefit from the training.

This research provides a potential training framework for other departments of transportation that respond to wildland fires to adopt and modify as fits in a state's unique socio-political culture. Moreover, the effectiveness of this training is demonstrated. When managed properly, departments of transportation can be a powerful asset for state governments. This paper is based largely on the research documented in several reports and in the workshop materials (Nash, et al., 2012; Nash, et al. 2012; Nash, et al. 2014).

Literature review

The primary purpose of this paper is to illustrate how departments of transportation may be used as state assets for wildland fire response. Although TxDOT is the primary agency under consideration and is the main focus of this paper, select other departments of transportation were also investigated to see if similar roles existed. Colorado, California, Wisconsin, and Florida were all discovered to have state policies in place for how the DOTs could be used during wildland fire situations.

Similarly to TxDOT, the Colorado Department of Transportation (CDOT) has incident annexes that specify that the DOT is a support agency to the state’s lead agency for wildland fire responses. The state Annex document lists the following duties for CDOT when assisting in wildland fire response: to coordinate permanent and mobile electronic road signs as needed for prevention evacuation, road closure, response, and mitigation activities, and to provide equipment as needed and available (Colorado Division of Homeland Security and Emergency Management 2013). Texas wildland fire policy is also governed by annexes, and TxDOT performs the same functions as CDOT, although other responsibilities are also given to TxDOT.

The California Department of Transportation (Caltrans) also takes a role in wildland fire response, but its responsibilities are limited in scope in comparison to TxDOT. The research team found that Caltrans is responsible for providing government staff with early morning notices of fire danger ratings (CTC & Associates LLC 2014) and for publishing road closure information (California Department of Transportation 2009). TxDOT also provides road closure information to the media and performs traffic control duties during wildland fire events. Caltrans does differ from TxDOT though in that it maintains geographic information systems (GIS) maps during wildland fire events to help other agencies coordinate response efforts (CTC & Associates LLC 2014). Although the research team did suggest that TxDOT use available maps during fire events, it is not known at this time if such resources exist.

The Wisconsin Department of Transportation (WisDOT) has an even more limited set of responsibilities, with researchers only being able to identify that WisDOT performs traffic control (Wisconsin Department of Transportation 2012). In contrast, the Florida Department of Transportation (FDOT) is given more thorough responsibilities by the state for wildland fire response. FDOT utilizes Traffic Incident Management (TIM) Strategic Plans to control traffic flow and assist other agencies during fires. These TIM teams are flexible, interdisciplinary, and may operate across multiple jurisdictions (Florida Department of Transportation 2011). Although TxDOT may be part of a multi-disciplinary response team, wildfire events are typically handled on a district by district basis.

It is likely that other DOTs have similar policies and follow their own state emergency operation protocols, but the research team was unable to identify other applicable literature. The majority of government agencies in the United States only consider traffic control and evacuation procedures relevant for transportation agencies during wildland fire response. Numerous agencies, from the Federal level (Wolshon 2009) down to cities and Metropolitan Planning Organizations (MPOs) (Paz de Araujo, et al. 2014) consider transportation a great asset during wildland fire situations but rarely use DOTs for more. The research team agrees with the State of Texas that the capability for transportation agencies to be a critical asset during wildland fire situations extends far beyond the simple planning and traffic control suggested by most (Konstantinidou, et al. 2015).

Training workshop modules

The research team planned and developed six workshop modules to address the various aspects of how TxDOT should respond to wildland fire events. These six modules encompassed the following topics:

- Introduction and best practices
- Organization and communication
- Resources and equipment
- Safety
- Documentation and data collection
- Training programs

A total of nine training workshops were conducted in Lubbock, Alpine, San Antonio, Houston, Corpus Christi, Dallas, Fort Worth, and Brownwood. Attendants included TxDOT Directors of Operations (DOOs), Directors of Maintenance (DOMs), Area Engineers (AEs), maintenance managers, maintenance supervisors, assistants, and crew chiefs, but other personnel were welcome to attend.

The first module of the workshop covered the first phase of the research project. Prior to developing the modules, the research team interviewed DOMs from different TxDOT districts and asked a range of questions regarding how each district responds to wildland fire events. Responses were gathered in relation to advance preparation, requests for services, communication, safety responsibilities, resource utilization, training effectiveness, and experiences from the wildland fire season in 2011. After synthesizing all of the results, the research team worked with the TxDOT Emergency Management Council (EMC) Representative to determine best practices based on the most common responses. These best practices were introduced in Module 1 but were ultimately interwoven into the remainder of the workshop modules. The best practices include:

- TxDOT should not mobilize in response to a wildland fire event until the DOM/DOO is notified by the District Disaster Committee (DDC) unless there is imminent threat to life and property.
- TxDOT does not work off of the right-of-way (ROW) unless notified by the DDC.
- The DOM will authorize which TxDOT resources to use.
- TxDOT must deploy traffic control devices for smoke control and continually update the Highway Condition Report (HCR) on Drive Texas.
- TxDOT must notify county governments regarding evacuation routes.
- As applicable, TxDOT should prepare with dozers, moto-graders, fuel trailers, water trailers, sign trailers, and traffic control devices.
  Only TxDOT personnel may use TxDOT equipment.
- Volunteer firefighters employed by TxDOT may be approved for personal leave during an event.
- TxDOT employees should avoid direct contact with wildland fires.
- TxDOT employees engaged in wildland fire response are required to take Federal Emergency Management Agency (FEMA) training.

These best practices were introduced as a means to frame the remainder of the training workshop modules.

Module 2 dealt specifically with organization and communication. In this module, workshop attendees were introduced to the command structure of wildland fire response in the state of Texas and informed how communication flows between channels during an event. In this module, students were informed that TxDOT is one of several support agencies listed under Emergency Support Function (ESF) F- Firefighting in the Texas State Emergency Management Plan. The primary agency for firefighting in Texas is the Texas A&M Forest Service (TA&MFS). As such, TA&MFS is the lead agency at a wildland fire event, so TxDOT DOMs relay needs from TA&MFS to TxDOT personnel on site. It should be noted that since the workshops were held, the ESF has been changed from ESF F to ESF 4 (Texas Department of Public Safety 2012).

In addition to identifying the corresponding agencies for wildland fire response in Texas, Module 2 also explained the tiered approach to response employed by the state. State resources are typically only activated when fires exceed the control of local fire departments. If state resources are deemed insufficient, out-of-state agencies may be mobilized. This model fits into the existing protocols for different incident types. TxDOT is typically deployed if a fire becomes a Type IV event, as illustrated in Figure 1 from the workshop instructor manual.

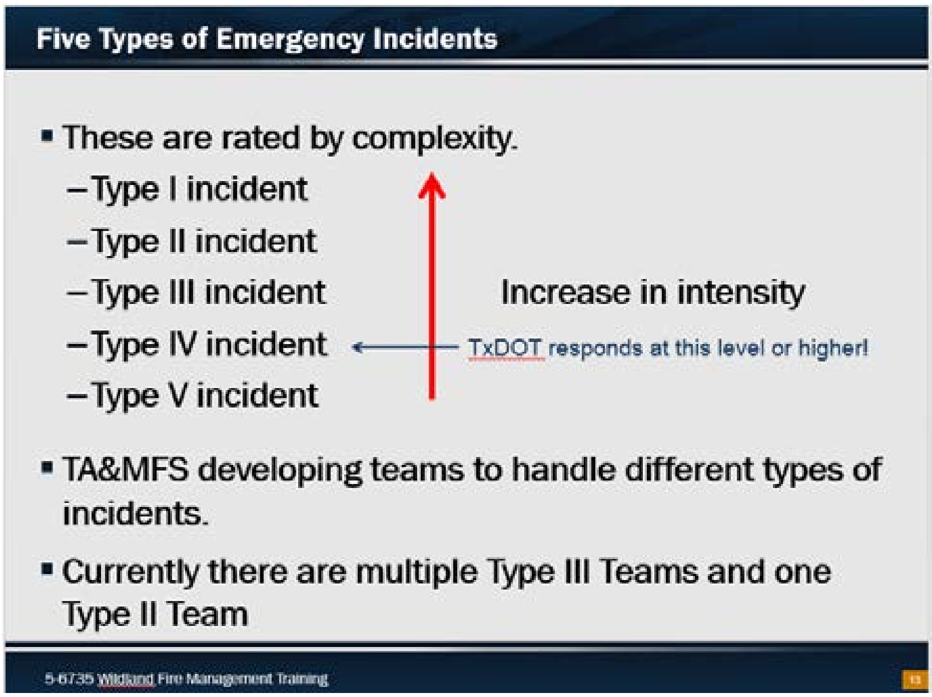

Fig. 1: Incident Types and TxDOT Response

Lastly, in Module 2, students were given a number of helpful resources. These included figures displaying the DDC Chairs and Texas Division of Emergency Management (TDEM) Regional Coordinators, maps showing the locations of various TA&MFS resources, and National Incident Management System (NIMS) communication and training sheets. These resources, particularly the NIMS material, helped attendants to understand their role in wildland fire response.

Module 3 dealt specifically with the resources and equipment that may be deployed at a wildland fire event. A sizeable portion of the content was dedicated to information resources. Attendants were shown how to access maps and information from TxDOT, FEMA, TA&MFS, Texas Interagency Coordination Center (TICC), Meso-West, National Oceanic and Atmospheric Administration (NOAA), and National Weather Service (NWS). Attendants were encouraged to understand these resources so that districts could plan accordingly and stage equipment in case the agency was mobilized.

In addition to the maps and weather information, attendants were given materials from the National Wildfire Coordinating Group (NWCG) Dozer Boss S-232 guide (National Wildfire

Coordinating Group 2006). TxDOT personnel, when assigned to work off the ROW at a wildland fire event, may use their own equipment, such as bulldozers and motor-graders, to assist firefighters in cutting fire lines and escape routes. However, the research team reminded the attendees that they are not firefighters, that they should never engage in a direct attack on the fire, and that they have the right and responsibility to turn down risk as appropriate.

Module 4 was designed to cover the many aspects of safety in regards to wildland fire response. One of the main concerns that developed after the 2011 wildland fire season in Texas was that TxDOT personnel were responding to fires while underequipped. Numerous interviewees expressed a desire for better Personal Protective Equipment (PPE). In response to these concerns revealed through the research project, TxDOT management authorized the purchase of two Wildland Fire Emergency Response Trailers. These trailers came fully equipped with a sufficient number of Nomex coveralls and helmets with face shields, as well as a select number of fire shelters in case of emergencies. Attendees were also encouraged to prepare a bag with gloves, boots, cotton clothing, and safety glasses during fire season. Additionally, the trailers were equipped with cots, first-aid equipment, flood lights, water, and other supplies. One trailer was brought to each workshop to show attendees how to use the equipment. Figure 2 shows a demonstration of the trailer.

In addition to PPE, the importance of communication for safety was emphasized. In the State of Texas, agencies use the Texas Statewide Interoperability Channel Plan to communicate during emergency situations (Texas Statewide Interoperability Committee, The Texas Interoperability Communications Coalition, and the Texas Department of Public Safety 2014). There are dedicated narrowband channels for wildland fire situations, and attendees were encouraged to familiarize themselves with the plan in order to understand how to interact with TA&MFS and other responding agencies. The communication segment also included tips from the “6 Minutes for Safety” series published by the Wildland Fire Lessons Learned Center (Wildland Fire Lessons Learned Center 2015). Other topics from the 6 Minutes for Safety series were featured, including:

- Driving safety
- Hazardous materials encounters
- Vehicle entrapment
- Managing vehicle traffic in smoke
- Health concerns
- Utility hazards
- Weather hazards

These topics were included due to the often unpredictable nature of wildland fire situations. TxDOT personnel are not firefighters and should stay well away from fires, but situational awareness is critical during emergency situations.

Fig. 2. TxDOT Wildland Fire Emergency Response Trailer Demonstration

Module 5 dealt with documentation and data collection. This module was explicitly concerned with how TxDOT employees responding to wildland fires should collect and transmit data. TxDOT personnel use Daily Activity Reports (DARs) to catalog information regarding a day's activities; these logs are also used for wildland fire events, and the data is entered into TxDOT's intranet through wildfire task numbers. This daily reporting allows the agency to track personnel and ensure that equipment is being used responsibly and that personnel are safe. The national archetype for Action After Reviews (AARs) were also introduced to encourage attendees to hold debriefings after a day of activity in order to address possible concerns or needs for improvement. The AAR format used was based on that mentioned in the 6 Minutes for Safety series (Wildland Fire Lessons Learned Center 2015). It should be noted that both response trailers also come equipped with a daily log sheet to keep track of personnel in the field and what equipment is in use. By discussing all of these topics, the workshop facilitators emphasized the importance of clear communication, both within the agency itself and with other agencies. Data collection and storage allows relevant information to be communicated to parties who may need it in the future.

Module 6, the final session of the workshop, was designed to provide attendees with a quick primer on fire behavior and firefighting tactics. The purpose of this module was not to equip attendees to engage in fire suppression. The workshop facilitators repeatedly reminded attendees that they are not firefighters and should never be engaged in direct attacks against the fire; instead, TxDOT may assist firefighters by cutting indirect lines away from the fire's edge. The purpose of informing attendants about how fires behave and what sort of firefighting activities take place was to encourage the TxDOT personnel to know which duties to refuse if requested by firefighting coordinators at an event. An example slide of how the different kinds of attacks were explained is shown in Figure 3.

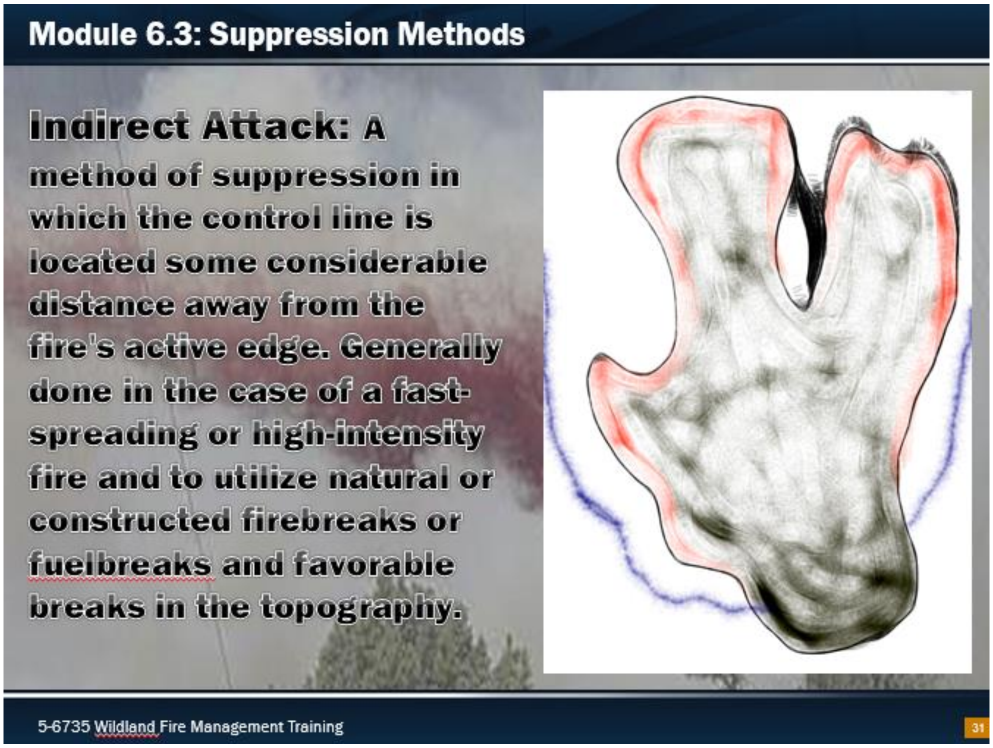

Fig. 3. Indirect Attacks on a Fire

The module was concluded by giving attendees a list of other training courses with applicable links. Attendees were encouraged to pursue further training as interested for the express purpose of gaining more insight into how to keep TxDOT personnel safe while responding to wildland fire incidents. The primary training program recommended was the TICC Wildfire Academies and Fire Schools page (Texas Interagency Coordination Center 2015).

Workshop attendees were given a student manual with a variety of references to provide more information as applicable. These references included a number of 6 Minutes for Safety handouts (Wildland Fire Lessons Learned Center 2015), the S-232 Dozer Boss appendix (National Wildfire Coordinating Group 2006), the full Texas Statewide Interoperability Channel Plan (Texas Statewide Interoperability Committee, The Texas Interoperability Communications Coalition, and the Texas Department of Public Safety 2014), a full copy of the Incident Response Pocket Guide (IRPG) (National Wildfire Coordinating Group Operations and Workforce Development Committee 2010), and a copy of the NIMS Training Program ((Department of Homeland Security 2011). In addition to the expansive student manual, attendees were given two smaller pocket guides. The first was a small Incident Command System (ICS) pocket guide published by QuickSeries (QuickSeries 2012). The second was a TxDOT specific pocket guide containing useful figures from the manuals and itemized key points for quick reference. Both tools are designed to be kept in an employee's belongings when responding to a wildland fire incident in order to quickly provide him or her with relevant information. As mentioned, TxDOT's role in wildland fire response is support, and the agency's key concern is safety.

Results of training workshops

At least 557 TxDOT employees attended the nine workshops. In order to gauge the effectiveness of the workshops, the research team added questions to a standard TxDOT Evaluation sheet. Questions were broken into two sections. The first set contained standard TxDOT boilerplate questions regarding workshop efficacy. The questions included:

1. The course improved my skills, knowledge, and abilities.
2. The course material was useful.
3. The information in this course is current.
4. The activities helped in learning the material.
5. The audio/visual aids improved the course.
6. The trainer(s) were knowledgeable about the topics.
7. The trainer(s) encouraged participation.
8. The trainer(s) provided feedback and answered questions.
9. Overall, I am satisfied with what I learned in this course.

The second set dealt more specifically with the objectives of the workshop. The questions included: By the end of this course, I can…

1. Explain TxDOT's role in wildland fire response.
2. Utilize data collection resources to communicate and catalog information regarding wildland fire events.
3. List and safely use the proper resources and equipment for wildland fire response.
4. Explain the basic fundamentals of fire behavior and fire safety.
5. Cooperate with other agencies at a wildland fire event.

Respondents were asked to rate each question as either:

- Strongly agree
- Agree
- No comment
- Disagree
- Strongly disagree

A total of 527 responses were collected, though two attendees did not answer every question. In order to numerically evaluate the efficacy of the workshops, a numerical score was assigned to each possible answer, with "Strongly Agree" equaling 5 points and "Strongly Disagree" equaling 1 point. Average scores were collected for each workshop, then the total averages were weighted against the number of respondents per session. Table 1 shows the average numeric score for each question from the entire workshop.

Table 1. Results from entire workshop series

1	Lubbock	Alpine	San Antonio	Houston 1	Houston 2	Corpus Christi	Dallas	Fort Worth	Brownwood	Average
1.1	4.21	4.48	4.31	4.30	4.43	4.32	4.32	4.42	4.39	4.33
1.2	4.17	4.57	4.35	4.24	4.43	4.30	4.26	4.42	4.39	4.32
1.3	4.19	4.46	4.24	4.40	4.50	4.30	4.28	4.45	4.43	4.33
1.4	4.07	4.46	4.08	4.20	4.29	4.28	4.13	4.33	4.39	4.22
1.5	4.22	4.34	4.10	4.24	4.29	4.40	4.32	4.44	4.46	4.30
1.6	4.39	4.55	4.45	4.44	4.50	4.57	4.46	4.56	4.60	4.49
1.7	4.28	4.42	4.27	4.40	4.36	4.42	4.38	4.44	4.44	4.37
1.8	4.34	4.48	4.37	4.36	4.43	4.54	4.42	4.52	4.53	4.43
1.9	4.18	4.57	4.33	4.33	4.36	4.38	4.28	4.42	4.36	4.34

2	Lubbock	Alpine	San Antonio	Houston 1	Houston 2	Corpus Christi	Dallas	Fort Worth	Brownwood	Average
2.1	4.22	4.58	4.20	4.36	4.43	4.57	4.38	4.47	4.47	4.39
2.2	4.12	4.40	4.08	4.16	4.29	4.28	4.26	4.29	4.36	4.23
2.3	4.18	4.51	4.20	4.26	4.43	4.38	4.37	4.36	4.39	4.32
2.4	4.16	4.45	4.24	4.29	4.43	4.36	4.33	4.38	4.39	4.31
2.5	4.19	4.55	4.24	4.28	4.43	4.32	4.36	4.44	4.44	4.34

As can be seen in Table 1, the scores indicate that attendants were, on average, supportive of the workshop, with all responses ranging somewhere between “Agree” and “Strongly Agree”. The two highest rated topics from Question Set 2 were “Explain TxDOT’s role in wildland fire response” and “Cooperate with other agencies at a wildland fire event.” From these results, it can be gathered that the workshop accomplished its objective of explaining the DOT’s role and how it fits into the overarching wildland fire response structure. Figure 4 shows the number of actual responses to each of the five questions in set 2. In this figure, “No Comment”, “Disagree”, and “Strongly Disagree” are all grouped together.

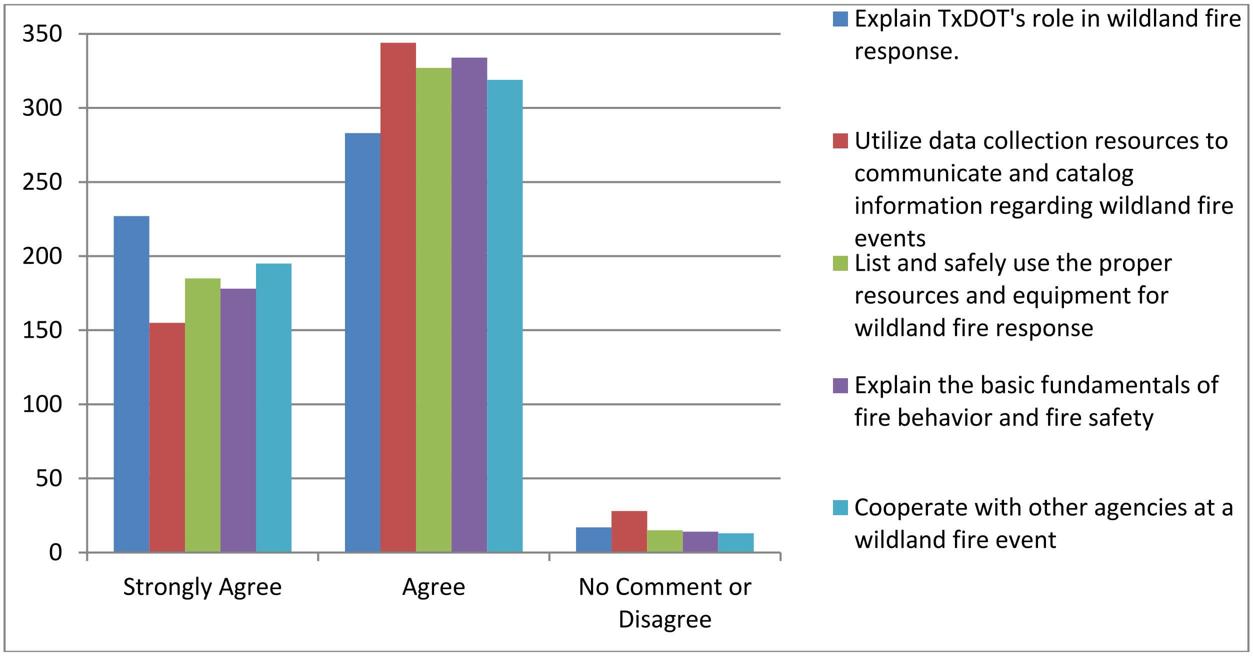

Fig. 4. Number of Responses in Each Category in Each Question

Of note from this figure is that more respondents agreed than any other option. This indicates the effectiveness of the training and shows that the skills were transmitted. A number of positive comments were left on the evaluation sheets, including:

- "Great to finally see this course offered to us. Since we are the ones on the ground during these fires."
- "Clear eye opener."
- "Well thought out curriculum. Very specific info and not a bunch of unneeded 'filler'."
- "Class was very informative and information provided will be useful for future incidents."
- "Needed this basic rundown about this situation."
- "Very excellent class. Covered all aspects needed."
- "Why have we not had this sooner?"

Some critical comments were left as well, and the research team documented these comments and attempted to address them as feasible between each workshop, altering both the visual materials and the handouts. Overall, the responses and evaluations indicated that the workshop series filled a void of needed training for TxDOT employees and helped equip them to properly respond to wildland fire events.

Discussion and conclusions

Ultimately, the purpose of this paper is to identify how DOTs can be used for wildland fire response. Through developing the workshop series and by researching how other states use their DOTs, the research team narrowed down the role of a DOT during wildland fire response to a few narrow protocols. These may not be entirely applicable to every state, but when used properly, DOTs may prove to be a valuable asset.

DOTs are support agencies. Most states have ESFs that dictate which agencies are responsible for wildland fire response. Although DOTs may be invaluable assets during emergency situations, DOT employees should not perform firefighter activities. They should only perform indirect operations to support lead agencies.

*DOTs should only deploy when mobilized by the appropriate emergency agency unless there is imminent threat to life and property***.** DOT personnel are not firefighters and should never perform firefighting activities. However, when life and property is threatened, DOTs may have the capacity to provide evacuation or to perform indirect actions to assist those in need. Understanding how mobilization commands are communicated may allow for swifter response.

DOTs can perform a number of activities to assist in wildland fire response and management. Common activities include distributing fuel and water, cutting lines, and controlling traffic. However, other activities, such as transporting equipment, distributing weather reports, maintaining GIS databases, and notifying citizens of evacuation routes are also applicable. DOTs are typically large organizations with sizeable fleets and equipment, so they may be used in a number of different capacities.

The research team encourages all DOT personnel who may be engaged in wildland fire response to follow these five rules:

- Know the chain of command.
- Know when to deploy.
- Know who will be deployed.
- Know what activities the DOT may perform.
- Know what the DOT's priority is.

Following these rules should ensure safe and efficient response. DOTs are important state assets that can be used to greatly support lead agencies during emergencies. All states should have some emergency protocol in place for how to use DOTs as applicable.

Acknowledgments
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Potential for multimedia dissemination of the Santa Ana Wildfire Threat Index: understanding information seeking and wildfire preparedness in Southern California WUI residents

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Abstract:

Southern California is a particularly challenging environment in which to manage and adapt to wildland-urban interface fires. We examine relationships between wildfire knowledge and experience, readiness actions, and media choice to determine: *How can we best integrate preparedness information and risk information from the recently developed Santa Ana Wildfire Threat Index (SAWTI) into public information dissemination?*. Integration of SAWTI into current Southern California wildfire risk communication is important as Meteorological Forest Fire Risk Indices are most effective when they are geographically specific (ex. Manta et al. 2006; Mestre and Manta 2014), and SAWTI has been shown to generate accurate 6-day forecasts for Large Fire Potential, providing information that can both allow response agencies to position resources, and can enable the public to better understand and respond to wildfire risk (Wall et al. 2014).

This idea of geographically specific risk is important as risk perception and information seeking have been shown to be related (ex. Lindell et al. 2005). Local information seeking and public information dissemination have been linked to both locally-specific public risk perception (ex. Brenkert-Smith et al. 2013) and wildfire preparedness actions (ex. McCaffrey 2004). Research into wildfire risk communication has shown that effective management requires communication to take place both before as well as during events (McCool et al. 2006), and that public trust in media before events can influence information seeking and application during events (Steelman et al. 2013). Messages targeted to specific cultural and social groups and use of two-way as well as one-way communication are recommended to ensure public trust in messages (ex. Chess 2001), as are up-to-date media sources (ex. McCaffrey et al. 2013).

To best understand how to communicate risk to the public, it is important to understand sources from which the public seeks information both on a daily basis and when a wildfire is in the area. This includes understanding whether people use the same sources for daily and wildfire-specific information; which sources they consider trustworthy and up-to-date; respondent knowledge of wildfire; type of preparedness actions, and demographic and geographic differences in information seeking. Based on previous studies we would expect: *H1)* People will be most likely to seek information during fires from sources used when no fire is

occurring; *H2)* Sources considered most trustworthy will not be the same as those considered most up-to-date; *H3)* There is a positive correlation between wildfire knowledge and the total information sources used to seek wildfire information, and *H4)* There is a relationship between type of preparedness actions undertaken and total information sources used to seek wildfire information. We would also expect to find gender differences in information seeking behavior as well as differences in information sources used by geographic area.

Data for this study are from 459 telephone surveys (completion rate 41%) conducted in 2012 with select residents of San Diego (213) and Los Angeles (245) counties, in California. Data analysis was conducted using IBM SPSS Statistics 19. Descriptive statistics, T-tests, ANOVAs, Pearson's correlations and Fisher's exact tests were used to describe and test relationships.

We find partial support for H1, with television as the most frequently used source for both daily news and wildfire information, with most people intend to seek information from the same sources in future fires. We find support for H2, indicating sources considered trust-worthy are not always those considered the most up-to-date. Local television stations were generally considered trustworthy and up-to-date, but there is lack of agreement among other sources including emergency personnel and radio. We find a weak but positive correlation between wildfire knowledge and total information sources used, and that there are significant differences between types of preparedness actions undertaken and total information sources used during fires, supporting H3 and H4. No significant differences were found in information seeking by gender, but importantly, we did find differences by geographic area in information sources used during fires.

Findings from this study add to literature demonstrating that trust, risk perception, and information processing are related. In light of findings we recommend that locally specific risk information like SAWTI should be distributed through trusted, up-to-date, frequently used sources like local television, but caution against reliance solely on uni-directional information sources. Prior to fire season, the public should be educated on geographically-specific risk to encourage mitigation using engagement-based communication between officials and the public, and short, actionable items for homeowners. The public should be familiarized with SAWTI through public information meetings, public service announcements, and, if possible, door-to-door canvassing in areas of highest risk. During fire season, it is important that officials ensure consistent messages between uni-directional and interactive information sources. During times of LFG potential, preparedness and evacuation messages should be concentrated with daily weather information sites and television and internet news sources, and should contain short, succinct, actionable messages for the public.

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Additional Keywords: wildfire threat, preparedness, information seeking

Fuel treatment research and technology transfer – how to better support practitioners' needs

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Significant changes occurring in the wildland fire environment of the United States are generating uncharacteristic shifts in the complexity, behavior, extent, and effects of wildfires. Increases in wildfire numbers, temporal and spatial scales, and ecological, social, and economic impacts are happening across all land uses and jurisdictions.

Treatment of wildland fuels to mitigate the risk of severe wildland fire impacts to human communities and valuable natural and cultural resources, and maintain and improve the health and resiliency of forest and rangeland ecosystems is emerging as a keystone land management process. With fuel treatment activities receiving greater attention and scrutiny, it is imperative to find ways to improve planning and implementation effectiveness. Science is increasingly important in advancing knowledge levels and facilitating opportunities to heighten management capabilities. Science can help identify and address critical research questions, encourage investigations to address those questions, and present and deliver new knowledge that informs decisions of natural resource policy makers and land managers.

As part of continuing efforts to support research and management, the Joint Fire Science Program (JFSP) has solicited, peer-reviewed, and funded proposals to address fuel treatment effects and effectiveness and commissioned development of Science Plans that aid in planning and implementing its research vision for the immediate future. The 2014 Fuel Treatment Science Plan (FTSP) has been constructed to address the full scope of the fuel treatment program. It includes assessments of important program elements and those central considerations and issues that influence and drive the program. It has strategic and operational implications across local, regional, national, and interagency planning scales; across the range of short-, intermediate, and long-term temporal scales; across unit, landscape, regional, and national level spatial scales, and is applicable to both public and private situations.

The FTSP was developed in multiple phases that included: information acquisition, information analysis, synthesis of FTSP framework, and plan preparation. Information gathering processes that were utilized included a web-based questionnaire, which was implemented as two distinct options: one for federal employees and organizations and one for non-federal employees and organizations. The response to both options was outstanding with a total of over 1300 responses received. Personal interviews, published literature reviews, attendance at professional conferences and meetings, and review of other relevant JFSP source information provided additional sources of information for the plan.

Information analysis during development of the FTSP was based on examination of the overall fuel treatment program. This approach supported responsiveness to topics across the entire fuel treatment program spectrum rather than only on current high interest topics.

The synthesis of the FTSP framework led to categorization of the program into four principal program elements: inventory, planning, implementation, and monitoring and evaluation. Seven program drivers that influence these four program elements were then identified. These seven drivers were ecology, climate interactions, humans/values at risk, collaboration and communication, policy and law, efficiency/effectiveness, and prioritization. The combination of program elements and program drivers yielded 28 research focus areas. However, the large number of focus areas necessitated further analysis to develop a smaller, more practical set of research areas. For the purposes of this report, four research themes were developed that represent the foundation for the FTSP. The four themes are:

- Fuel treatment effectiveness
- Ecological science
- Fuel treatment and society
- Program implementation

Each theme has a clearly defined objective(s) to be achieved within a five-year program of research. The FTSP follows the principle that research is directly interconnected with investments, investigations, and in ultimately delivering improved service and outcomes. This FTSP places high importance on the identification of areas of uncertainty having high relevance to management performance and a high likelihood of enhancing high functioning outcomes. Developing the FTSP using program elements and drivers as the groundwork for themes allowed full consideration of factors affecting science, knowledge, management performance, and services. This facilitated the identification and recommendation of research investments.

A recommended five-year program of research (recommended research topics by year for the five-year period of 2015 – 2019) based on foundational needs, logical sequential flows, linkages with other sub-topics, and specific spatial needs (i.e., geographic, and national needs) was prepared and presented. Research recommendations are described within each research theme and point toward specific objectives rather than science needs in general terms. They are presented as annual undertakings to guide progress toward achievement of the plan and JFSP objectives. In addition, JFSP has determined the current contributions of active projects and other efforts to the identified needs and developed an Implementation Strategy. The Implementation Strategy identifies multiple options to respond to the FTSP recommendations that include: task statements, syntheses, workshops, partnerships, scoping assessments, gap analyses, and outreach activities for the period 2015 – 2020.

The seriousness of changing conditions, increasing needs for action, and limitations facing fuel treatment planning and implementation all signified that the most comprehensive approach providing the widest possible perspective would be the most effective way to address this task. The broad approach taken during this project assured that the scope, magnitude, and impacts of the fuel treatment program on land management and society were adequately addressed. It was based on full consideration of all program elements, internal and external program drivers and other influences, and allowed selection of the most important areas in need of research. The establishment of the Knowledge Exchange Network of consortia by JFSP is strengthening the entire program. Inclusion of these consortia to support research direction and geographic area needs can greatly benefit this effort and ensure that local and regional, as well as national conditions are being considered.

The FTSP and Implementation Plans are built to be dynamic and able to respond to changing situations, requirements, and needs by shifting priorities and/or moving new sub-topics into the five-year plan as needed. Annual monitoring of progress, evaluation of accomplishments, and appraisal of current and emerging needs from a variety of sources, including the JFSP Knowledge Exchange Network consortia will be carried out to keep the plan current, consistent with national and regional conditions, and on track with objectives. Outcomes from many of the implementation activities will provide current information that can be used to formulate additional implementation actions and modify research areas as warranted. As a result, the JFSP will be able to conduct annual research that is responsive to the most up-to-date situations.

Additional Keywords: [fuel treatment, science, fire management, wildfire, fire risk, technology transfer]

The Incident Risk Console (RisC) – A risk assessment synopsis for wildland fires

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Wildland fire complexity is increasing dramatically and presenting difficult problems and concerns for wildland fire management agencies. To improve decision-making and management capability, managers need more and better information about changing fire dynamics.

Numerous processes exist and others are under development to provide improved methods to facilitate more efficient wildland fire information management. Most existing processes and systems accomplish information management very well, but few actually account for all pertinent informational components of today's environment. Many systems are basically "niche-systems" that have been developed to meet one or more specific needs and not larger strategic needs. In addition, few existing processes or systems address the full range of spatial, temporal, and planning scales. As a result, the US Forest Service National Director of Fire and Aviation asked if a new system to access and display such information from a variety of sources could be designed.

Rather than utilize the full array of currently existing individual programs and processes to acquire information, a dashboard structure was used to develop a new process to access and display information from a variety of sources. Dashboards can acquire and display information more advantageously than other methods, including spreadsheets, and offer specific positive characteristics that allow to:

- Perform entirely around specific fire management needs and have direct relevance to critical activities - based on a clear strategy and vision
- Be interactive, easy to use, easy to set up, and quick to update as needs and data change
- Support decision validation
- Determine/illuminate problem situations early and provide information for resolution
- Present data in both summary and detailed levels
- Support information dissemination, use, and presentation
- Deliver specific information to help understand the current situation and problems

What has been developed is the Incident Risk Console (RisC), a data analytics dashboard and business intelligence tool for wildland fire decision makers. This application provides national fire program managers with relevant fire information for emerging and complex ongoing wildfires. RisC information goes beyond available fire statistics and includes specific calculated information and indices that provide:

- A visual risk assessment synopsis for wildland fires,
- An early alert/risk assessment for potential problem areas, and
- An overview summary of national and regional incidents.

RisC is structured to present information in one easily accessible location for review. It has been built as part of the Fire Enterprise Geospatial Portal (EGP) and is closely linked to other systems. The EGP incorporates data from a number of systems, including: the Wildland Fire Decision Support System (WFDSS), daily incident status summary reports (ICS-209), Resource Ordering and Status System (ROSS), MODIS fire detection system, InciWeb, Automated Flight Following, NWS fire weather, and GEOMAC (USGS).

Incidents populated into RisC are those having high potential or requiring active management responses. Any fire meeting the following criteria will be populated into RisC:

- A Relative Risk of 'High' as shown in WFDSS (Wildland Fire Decision Support System), or
- A Type 1 or 2 Incident Management Team indicated by the Organization Assessment in WFDSS, or
- Have been manually flagged by a WFDSS National Editor.

RisC presents eight specific risk attributes that summarize a range of conditions and activities on a fire-by-fire basis. The attributes and their definitions are:

RisC Element	Definition
Values Inventory	Types and quantities of values located within a one-mile radius of the incident's origin or Planning Area.
Jurisdictions	Agencies having jurisdictional responsibility within a one-mile radius of the incident's origin or Planning Area when available.
Significant Fire Potential	A simplified adjective rating showing potential for significant fire activity.
Relative Risk	A single, subjective risk rating calculated by assigning a value to three components: Hazard, Value, and Probability.
Suppression Capability	The Actual Daily Production Capacity (chains/day of fireline constructed) compared to the Expected Production Capacity (chains/day of fireline that could be constructed).
Aviation Exposure	The expected aviation accident rate for a fire based on the types and quantity of aircraft assigned to the incident.
Modeled Values at Risk	The likelihood that values within a modeled FSPro (Fire Spread Probability Simulator) analyisis will be impacted by the fire (not populated until FSPro run is completed).
Modeled Suppression Effectiveness	Progress toward containment or effect on protection of threatened structures (not populated until FSPro run is completed).

In the RisC application, each of the eight risk assessment elements has a relative value displayed by a series of "radio" buttons. These buttons are shown in colors of green yellow, red, gray, or will be blank. The general color indications are:

- Green - the information described has a relative low level of concern or impact.
- Yellow - there may be a relative marginal concern or elevated possible impacts.
- Red - relative potential heightened concern and risk, or that additional review or attention may be warranted.
- Gray - some data are available, but not enough to calculate a risk rating.
- Lack of any dot indicates data are not available for that element

The initial Incident Risk Console represents the transformation of an idea into an actual system. The 2014 fire season allowed for a limited test and an evaluation of its applicability. It was found to have specific value in providing new information useful in: clarifying the overall fire situation, understanding individual fire dynamics, and improving understanding of the effects of management decisions. While the risk element data may not provide a full picture of all risks and concerns for an incident and are not meant for tactical decision-making, these data do provide a basis to determine if further information gathering and dialogue with a region or unit may be warranted. Future work will involve improving accuracy, improving data transfer, and enhancing user interfaces.

Additional Keywords: [risk assessment, information technology, decision-making, wildland fire management]

Establishing wildfire evacuation zones—a coupled human-environment system approach

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Extended Abstract:

Wildfires are a common hazard in the western U.S. due to fuel accumulation and seasonal drought that cause significant losses of life and property every year. With the rapid population growth in the wildland urban interface (WUI), public safety in fire-prone WUI areas has attracted significant research interest (Moritz et al. 2014).

When a fire approaches the community and becomes a threat to the residents, relevant protective action orders will be issued by the incident commander (IC) so as to ensure public safety. Protective actions in wildfire evacuations include evacuation and shelter-in-place (SIP), and the latter can be further classified into shelter-in-refuge (SIR) and shelter-in-home (SIH) (Cova et al. 2009). ICs often divide the risk area into several zones so as to facilitate staged evacuation, or one where different groups leave at different times. The ICs need to take into account both fire progression and threatened population before they can delineate evacuation zones.

Wildfire evacuation triggers are prominent geographic features (eg., ridges, roads, and rivers) utilized in wildfire evacuation and suppression practices, and when the fire crosses these features, an evacuation will be recommended for the communities or firefighters in the path of the fire (Cook 2003). Recent studies on triggers have used Geographic Information Systems (GIS) and wildfire spread modeling to calculate evacuation trigger buffers (ETBs) around a location (P) with a given time (T) as the input (Cova et al. 2005). This computerized modeling of triggers is referred to as trigger modeling. Trigger modeling has been formulated into a three-step model called—the Wildland Urban Interface Evacuation (WUIVAC) model (Dennison et al. 2007).

From systems modeling perspective, wildfire spread is an environmental system, while the evacuation of a threatened population is a human system. The environmental systems involved in wildfire evacuations can be further divided into the natural and built environment. Fire spread is primarily a natural system, but may be influenced by the built environment or fuel treatments, but the evacuation route system is part of the built environment. The evacuation warning, response, and travel processes belong to the human systems. Specifically, the ICs in wildfire evacuations are primarily concerned about who should be evacuated and when (Cohn et al. 2006). Thus, evacuation timing is a key element in the evacuation process. Trigger modeling takes evacuation timing into account and uses the estimated evacuation times for a threatened community as the input to generate ETBs based on fire spread rates, which may help improve an IC's situational awareness.

This work examines how to couple wildfire simulation and trigger modeling to establish evacuation zones by using a coupled human-environment system approach. The proposed coupling approach takes into account fire simulation and evacuation modeling at the data, model, and knowledge level. The proposed evacuation zoning method consists of three steps: 1) using trigger modeling to calculate trigger buffers for each household; 2) employing fire spread simulations to trigger the evacuation of all at-risk households and derive the recommended evacuation departure times (REDTs); 3) households aggregation into evacuation zones based on the REDTs and their proximity, which will enable the ICs to develop a staged evacuation plan. This method uses GIS to model the process in which a spreading fire triggers the evacuation of a set of households based on their trigger buffers. A case study of Julian, California is used to test the effectiveness of the proposed method, and the results reveal that the proposed method produces staged evacuation zones and may be used for household-level staged evacuation planning.

Additional Keywords: wildfire evacuation zones, triggers, wildfire simulation, coupled human-environment system

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Local Perceptions of Forest Management and Wildfire Risk in Northeast Oregon

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Abstract:

Millions of acres of public forestland in the U.S. require fuel treatments to reduce the risk of catastrophic fire. The ability for agencies to treat forests is constrained by limited capacity and funding, and requires public support, which depends on an informed and engaged public. We conducted telephone surveys during the fire seasons of 2011 and 2014 of residents in the Blue Mountains region of eastern Oregon to understand perceptions of forest health and management. Like many parts of the American West it has experienced more frequent and larger wildfires in recent years. Our results revealed that residents claim to be informed about declining forest health on public lands and appear more informed in 2014 compared with 2011. In addition, twothirds identified active forest management and prescribed burning on public lands as a high priority. However, only 39% identified commercial logging as a high priority, indicating that the public may be less aware of the potential for commercial logging to contribute to fuel treatments. There was low support for increasing public land use fees or local taxes to pay for forest restoration, so more creative policy solutions are likely needed to address the forest restoration funding gap.

Additional Keywords: active forest management, wildfire risk, public opinion, telephone survey

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Adaptation of physical training and task performance to wildland firefighting in Spain. Improving firefighters wellness, capabilities and safety.

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Abstract:

Understanding the need to adapt physical training and task performance to singular characteristics related to environmental conditions and type of work in wildland firefighting makes a great difference in firefighter's wellness, capability and safety. Since 2007, the Spanish Forest Fire Service belonging to the Ministry of Agriculture, Food and Environment, has launched and implemented a specific program focused on these relevant aspects. The analysis of several indicators, such as heart rate, level of dehydration, core temperature, carbon monoxide inhalation, heat flux exposition, and environmental temperatures during real wildland fire operations plus the direct observation of different suppression performances and type and amount of injuries suffered by firefighters have made us develop specific fitness programs for our wildland firefighters. These programs, after almost 8 years of existence, have shown us great results in terms of damage rates reduction, efficiency rates improvement and safety and performance enhancement.

A personal trainer, in each of the 10 helitak crews the Ministry of Agriculture, Food and Environment has, is in charge of developing and implementing a specific training program based on environmental conditions, task performance and individual characteristics. Since 2009 active

prevention measures like core stability and proprioception ankle exercises have been included. Since 2010, the inter-annual evolution clearly shows the reduction of ankle and low back pathologies since the introduction of new training exercises. Sick leaves have also been reduced. Quantification and classification of incidences, both in prevention and suppression seasons is really positive in order to visualize how accidents rates behaves within the helitak crews. At the same time, these records could allow us to observe personnel behavior in the long term; as well as identify injures patterns in order to modify and adapt the training program.

Additional Keywords: helitak crews, fitness programs, active prevention measures, incidents, accidents, injuries.

Acknowledgements

The authors want to express their gratitude to all wildland firefighters who volunteered in these studies and who daily participate with a high compromise in maintaining their physical aptitude in order of warranty their wellness and safety.

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Enhancing Community Response

Utilizing existing information networks during bushfires

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Abstract:
Inquiries undertaken after major bushfires in Victoria Australia invariably mention difficulties with information flow to and throughout communities during bushfires, as well as highlighting that a significant number of people continue to be unprepared for bushfires when they occur.

Considerable improvements in the timing and dissemination of warnings and information during bushfires have occurred since the Victorian Black Saturday Bushfires of 2009. Emergency Service Organizations (ESOs) have given increased priority to the provision of information to communities under threat of bushfire. Great emphasis is placed on planning for bushfires, both at personal and community level by fire agencies.

However, people without bushfire plans and people getting helpful, reliable, timely, and tailored information, when and how they need it during bushfires, continue to be major challenges. Understanding how communities communicate and disseminate information outside of times of disasters will help develop strategies that will assist during times of disaster. Connecting existing emergency structures and processes with existing community networks and processes during bushfires and other emergencies must be considered if we are to increase the effectiveness of community response.

Building on a project undertaken in 2011, this presentation discusses ways that local governments and communities (including ESOs), may work together to better utilize existing information networks within communities during disasters. It will also encourage discussion on how new approaches may enhance community response and resilience when bushfires threaten, as well as what are barriers to change.

Additional Keywords: networks, local knowledge, response, recovery

Introduction

Information is critical for communities that are both responding to and recovering from bushfires. Arguably, providing incident information is the most important function of the control agency at the height of any extreme event. During bushfires and other emergencies, people receiving or conveying the locally specific incident information that is needed, when and where it is needed, through familiar or formal networks remains a challenge.

Recommendations from the Victorian Bushfires Royal Commission (VBRC) 2009 recognized the importance of local knowledge during incidents. Underpinning The Victorian Bushfire Safety

Policy Framework (2013) is the recognition that governments, organizations and agencies must work together and with their communities to build safe and resilient communities.

Recent research in Australia (McLennan J, 2015) indicates that a significant number of people in areas affected by bushfires since 2009 were unprepared and hadn't planned for bushfire. People need and will be seeking local information from trusted sources to help them take action during bushfires. Considering additional actions to those already undertaken by Emergency Service Organizations (ESOs) that will further address how people respond and seek information and advice during bushfires is required.

Rethinking the challenges, looking for new solutions

Focusing on how a substantial number of people do respond and behave during bushfires, as is proposed in this instance, creates additional perspectives for thinking about the challenges. The attention shifts from what people are told to do and is safest (planning and preparing), to what else can be done to create safer response and more streamlined recovery.

Local governments have invaluable knowledge of their communities, their demographics, values, priorities and connections. The services local governments provide and the interactions they have with other services, individuals, community groups and sporting clubs to name a few, would indicate they have knowledge and skills vital for community response during bushfires. Acting as a linchpin, local government would help connect what already exists in the community day to day, with bushfire response agencies. Although local governments have a clearly defined role in recovery from disasters, for that role to be seamless and most effective, local government needs to be present and active with their communities when they are responding to bushfires and other emergencies.

Community Information Networks During Emergencies Project –Western Australia

A multiagency (DEC1, DFES2 and SWLGEMA3) project (Reid T, 2013) undertaken in Western Australia in 2011/12 aimed to improve information flow and access to local knowledge during incidents. It was:

- Determined that community development officers in local government are well placed to work with Incident Management Teams (IMTs) to facilitate information flow through existing networks.
- Demonstrated the value of using "local channels of communication that are trusted and responsive and can transition into the recovery phase for the impacted community."

From this project, recent government inquiries and current policies, it is evident that additional actions will contribute to implementation of stated key government goals for community response and safety.

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Creating improved community outcomes

A number of post fire research studies and inquiries in Australia since 2009 identify that communities have issues with information flow during emergencies and depend on their networks for information (Victoria (2014); Trigg J, et al (2015)). In order to address these issues and create better outcomes for communities both during response and recovery:

- A formal (not assumed) link between response agencies and the local community is required during response.
- Processes that better recognize and adapt to local community information needs during and after bushfires are developed and implemented.
- Information flow between the IMT, recovery agencies and the impacted communities is improved.
- Increased knowledge and skills in both communities (about emergency management) and emergency response agencies (about community development) are needed.
- Relationships across local government areas and within local government are strong and reliable.
- Collaboration and alliances between local governments and ESOs in relation to community response and recovery outcomes are developed and ongoing business.
- There is increased participation of women in bushfire/emergency management to help address gender imbalance in the sector.
- Processes are developed to enable streamlined transition to community-focused recovery at local government level.

Actions for change

1. Local government community development officers are included in existing emergency management planning processes to provide specialist skills and knowledge of community perspectives and needs. Community development officers are often women and could increase participation of women in the sector.
2. Information focused planning is incorporated in emergency management plans. Information planning would enable agencies to learn about and incorporate what is known about how information is sought and accessed by the community. Examples may include local information hubs, community gathering points, tourist destinations, health and welfare networks and schools.
3. ESOs collaborate with community development officers in local government as well as with operational connections e.g. municipal emergency response officers.
4. Community development officers receive basic training in Incident Management Systems and Public Information.
5. Trained community development officers from affected local governments are linked to IMT Public Information Section through existing emergency response procedures to provide local knowledge of critical contacts and how the community is connected.

Barriers to change

From experience, there are many barriers that may inhibit change or acceptance of new ideas. Entrenched culture and practice favoring the status quo, different values and priorities that exist between organizations, focus on operational response and unpredictable funding cycles all contribute to difficulty in developing and implementing community based initiatives. It is important to recognize that commitment to community initiatives must be ongoing and long term. It is widely acknowledged that relatively little of the emergency budget is dedicated to community initiatives. Local governments often lack resources to take on further responsibilities and people may be reticent to overstep organizational boundaries.

Anecdotally, an entrenched belief in communities about the protective role of emergency services, combined with a corresponding lack of awareness of personal responsibility continues to be an issue. However, it could also be suggested that agencies may be inadvertently creating these expectations by using terminology and approaches that encourages people to believe they will be protected. People believe that agencies are in charge, through campaigns and programs that both visually and through content, suggest that they are. Communities trust and depend on their emergency organizations and what this means for response is very complex.

Conclusion

For Emergency Service Organizations, working with local government community specialists, being able to adapt and respond to the information needs of affected communities, as well as utilizing the wealth of knowledge and skills that already exist, will enable better outcomes during bushfires. An approach that both extends opportunities for collaboration and partnerships between agencies, as well as more effectively connects communities with response agencies, will help to further entrench the notion of 'shared responsibility'. Networks identified and used during response will assist in the transition to recovery and for implementation of subsequent recovery programs.

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How effective is wildfire communication to New Zealand communities and how can it be improved?

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Abstract:

Effective communication is the key to raising awareness, reducing the risk of human-caused fires and hence the impact wildfires hold for communities. However, how effective is current wildfire communication to New Zealand communities and how can this be improved?

Scion's Rural Fire Research Group analysed communication strategies within three New Zealand rural and rural-urban interface communities and with national fire managers as part of an Australasian Bushfire CRC project. The research has shown that fire agencies should carefully consider their methods of communication, which range from one-way communication using no face-to-face contact to two-way dialogue with one-on-one personal communication with individuals and communities. The research concluded that a universal approach is not effective in communicating rural fire messages. Instead, communication needs to target the relevant audiences (rural and semi-rural, recreational users/visitors and cultural fire users and non-fire users) with the appropriate message. The focus of the message and communication type should be tailored to fit each audience's needs to optimise the use of limited resources.

Additional Keywords: communication strategies; rural communities; rural fire users; risk awareness; preparedness.

Introduction

Worldwide, most wildfires are caused by human activity (Ellis et al., 2004). Likewise in New Zealand, human activity is responsible for the vast majority of wildfires, which arguably can be largely prevented. Between 1992 and 2007, approximately 3,000 wildfires per annum occurred in New Zealand (Anderson, et al., 2008). This number is predicted to increase with global climate change, an expanding rural-urban interface and changing fuel loads (Jakes & Langer, 2012). As a result of the present relatively low fire occurrence, evidence suggests that the majority of communities have low awareness of the rural fire risk and consequently low levels of preparedness for wildfire events that could impact on them (Jakes & Langer, 2012). Matched against this, the use of rural fire for land management, recreation and cultural purposes (e.g. cooking food by traditional methods) is relatively high. At present, the intensity of public communication and education in New Zealand varies greatly, from the establishment of FireSmart activities (modelled on the US FireWise programme) in some areas, to minimal community engagement or education in other areas.

The Scion Rural Fire Research Group undertook a study to determine the most effective strategies to inform and educate New Zealand communities regarding wildfire risk and preparedness. The study was linked to a more comprehensive Australasian Bushfire Cooperative Research Centre project led by RMIT to study effective communication of wildfire messages across four states of Australia. The RMIT framework and methodology was adopted by the Scion researchers to expand the relevance of the study across Australasia by including consideration of effective communication methods in less fire prone environments with smaller communities that have experienced smaller, less frequent fires.

Methodology

A mixed-method social research approach was utilised to study effective communication of wildfire messaging strategies in New Zealand communities. The core of the research was a set of three carefully selected case studies that fitted well within RMIT's established project criteria. All three areas had suffered from wildfires and represented different types of communities. These were: a rural-urban interface community (Atawhai, Nelson, northern South Island); a community close to a tree-change, tourism town (Closeburn, Otago, central South Island); and a traditional farming / rural community (Mahia Peninsula, Hawke's Bay, East Coast North Island). National representatives of the National Rural Fire Authority, Department of Conservation and land managers from the forest industry and Federated Farmers of New Zealand were also interviewed to bring a national perspective to the research. Ethics approval was obtained from the University of Waikato Ethics Committee prior to the case study research.

Field research at each site included semi-structured interviews and focus groups with members of the community and key respondents. In total, 80 people participated in the project: 42 community members, 22 local key respondents, and eight national key respondents. Each interview/focus group was recorded and fully transcribed, and data analysed using qualitative analysis software (NVivo 10). The coding frame was adapted from the RMIT research to allow full consideration of the New Zealand data with codes analysed thematically, keeping the predominant theme ('what is effective communication?') central to the analysis.

Research Outcomes

The study defines effective wildfire communication as a process that ensures that correct messages are delivered in the most appropriate way for individuals and communities: to understand, and act on, the risks of wildfire; to prevent wildfires from occurring; and to be prepared for wildfire events. The research highlights four distinct types of messages: awareness of fire risk; information about fire use restrictions; ways to prevent fires starting; and how best to be prepared for a wildfire (at household, property and community levels) should one occur. Additionally, four audiences were identified: non-fire users; rural and semi-rural fire users; recreational users/visitors, and cultural fire users. Fire communication was determined to be most effective if relevant messages are targeted at each specific audience, with careful consideration given to the mode of communication in each case.

Currently, a wide range of wildfire communication techniques are employed across New Zealand at national and regional levels. The study found that to be most effective, specific messages should be targeted to each of the four audiences using the most appropriate communication techniques.

At present, the most frequent method of fire communication is one-way traditional broadcast approaches, which include leaflets, signage, local media, websites and social media. Such options have the advantage of reaching a large number of people quickly and relatively inexpensively. The research suggests that an increased emphasis on more targeted communication and incorporating two-way dialogue into fire managers' strategies would increase effectiveness of better focused messages. Opportunities exist for targeted communication via conduits, such as by sending emails and text messages to key people in the community or using FireSmart champions and volunteer fire fighters to disseminate amongst their own networks. Face-to-face communication with both individuals and groups, which allows two-way dialogue, remains the most effective means of communication, although it requires more time and financial resources than one-way communication. Again, carefully targeting certain messages to each audience will improve effectiveness and be a more efficient use of resources.

Most people in the case studies, and in New Zealand as a whole, never use fire or pose any risk of starting a fire. However, non-fire users in fire prone areas require communication to ensure they have a heightened awareness of the risk wildfire poses to their communities and that they are appropriately prepared at household, property and community level should a wildfire occur.

The largest group of fire users is rural and semi-rural property owners who light fires for land management purposes (e.g. vegetation clearance, rubbish removal). Rural and semi-rural fire users who participated in the study generally tended to have good knowledge of fire use (which they referred to as 'common sense') and wildfire risk awareness. To ensure effectiveness, fire managers need to find ways to target this group with all four message themes to ensure this group remain aware of wildfire risks; have up-to-date information about fire restrictions and permit requirements; retain information on fire prevention precautions; and are encouraged to be fully prepared for wildfires.

Participants in the research were extremely concerned about the dangers posed by recreational users of fires in their localities, generally visitors and absentee property owners (both domestic and international). All three case study areas had suffered wildfires as a result of visitors' activities. A noticeable proportion of recreational users, especially visitors, appear to lack knowledge about, or ignore, fire restrictions and have little awareness of fire risks and fire prevention precautions. Hence fire managers must deliver messages to address these three aspects.

The fourth audience identified use fire for cultural purposes, generally for cooking food by traditional methods (e.g. earthen ovens or hangi by Māori). Respondents who used fire culturally showed excellent levels of knowledge around fire restrictions, awareness of fire risk and how to prevent a hangi from becoming an out-of-control fire. Fire managers need to ensure their messages continue to target this audience for wildfire awareness, information, prevention and preparedness.

The research emphasises that effectively communicating with communities is not a simple 'one size fits all' approach. It demonstrates the importance for fire managers to have a carefully considered communications policy, at both national and local levels, which identifies which messages each audience requires and how best to disseminate these messages.

Conclusion

Effective communication is the key to minimising human-caused fires and hence the impact wildfires hold for communities. This research has shown that a universal approach is not effective in communicating fire messages. Rural fire and bushfire agencies throughout Australasia can use the research findings to more accurately target their fire user and non-fire user audiences, tailor their messages and tune their methods of communication to be more effective in communicating with members of rural and rural-urban communities as well as visitors to these areas.

The research findings are freely available in a summary note for stakeholders (Langer & Hart, 2014) and a comprehensive report is available on request (Hart & Langer, 2014). It is hoped that findings from this project will be incorporated into future risk-communication strategies planned by fire and land management agencies and that results of the study will inform changes in policies and practices within agencies. Ultimately this research has the potential to promote better awareness of rural fire risk, prevention of wildfires and improved preparation by households in wildfire prone communities.

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Māori use of fire: understanding traditional use of fire to guide present day wildfire management in New Zealand

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Abstract:

New Zealand's landscape and history have been shaped by fire. Māori, the indigenous people of New Zealand, and Europeans have both contributed through planned and accidental use of fire. Māori had an established fire culture stemming from mythology, with associated belief systems and rules surrounding the sacredness of fire and its uses before they arrived in New Zealand in the thirteenth Century. Fire was regarded the most important of the natural elements of the environment and was used in land clearing and propagation, storage and cooking of crops. Fire was also used to aid in felling selected trees to make canoes, harden or aid the bending of wood for weapons and ease shaping of bark vessels used for carrying water or preserving food. European settlers from the early 1800s accelerated the use of fire to clear native forest for land settlement and pasture.

Scion's Rural Fire Research Group has studied historical knowledge on the use of fire by Māori from published literature and interviewing of elders in Māori society in the eastern Bay of Plenty. The research will assist rural fire authorities to undertake rural fire management and fire mitigation responsibilities together with Māori in New Zealand rural communities.

Additional Keywords: Te ahi, fire, Māori, traditional, rural, land management.

Introduction

Fire (te ahi) has shaped New Zealand's landscape and history. Māori, the indigenous people of New Zealand, and Europeans have both contributed to modifying the landscape through planned and accidental use of fire. Although no specific modern day fires have been attributed to Māori, human activity is responsible for the vast majority of wildfires in New Zealand that can therefore arguably be largely prevented. Preliminary research conducted by Scion's Rural Fire Research Group has focussed on the effects of fire on the New Zealand landscape, and traditional use of fire as a primary resource and tool by rural Māori communities.

The events of the past, both written and oral, reveal pertinent background understanding to guide the design of some practical solutions to age-old issues regarding the use of fire. This lays the foundation to understanding current use of fire in rural communities. It also guides future prevention of wildfires resulting from the accidental use of fire by rural communities for land management, recreation, or traditional hangi (earthen oven) methods of cooking still used today, especially for large gatherings (e.g. funerals or celebrations such as weddings).

Method

Scion's Rural Fire Research Group studied historical knowledge on the use of fire by Māori gathered from existing documented material in books, published journals and websites. Considerable material was obtained from *Te Ao Hou* and the *Journal of the Polynesian Society*, including literature by Best (1924 a & b) who provided one of the most comprehensive accounts of Māori use of fire. This describes cultural use of fire, its purpose, and relationship of fire in Te Ao Māori (the Māori world or domain) during the early 1900s.

Interviews with three kaumātua (elders in Māori society) in the eastern Bay of Plenty, undertaken using a kaupapa (subject or matter) Māori theory approach, have added to this by drawing on personal and family experiences. The research aimed to provide background understanding of the traditional Māori use of fire and some perspectives on current Māori use of fire to assist in rural fire authorities in New Zealand conduct present day rural fire management activities.

Research findings

Much of New Zealand was covered in native forest when the first Māori Polynesians arrived around 1280 AD (Perry, Wilmshurst, & McGlone, 2014). Māori had an established fire culture stemming from mythology, with associated belief systems and rules surrounding the sacredness of fire and its uses before they arrived in New Zealand. Traditional Māori belief is that fires are an intrinsic part of their natural environment and connect through genealogical ties to their ancestors, Ranginui (sky father) and Papatuanuku (earth mother). Māori brought fire to New Zealand when they migrated from Hawaiki. Fire became an important and useful tool and resource (Best a & b). Throughout Māori history, fire has contributed to changing and reshaping the native forest landscape (Ogden, Basher, & McGlone, 1998). The use of fire by Māori has therefore played a significant role in their culture, land and people.

Best (1924b) described how Māori had an utmost respect of fire and considered it as being the most tapu (sacred) of all the four natural elements (the others being water, air and earth) in the natural world. He determined that "Māori had a great respect for fire, and spoke of it as a parent of man as he did of a house".

Fire was regarded the most important of the natural elements of putaiao Māori (natural environment). Prior to the arrival of Europeans in the early 1800s, Māori did not possess adequate wood-cutting tools; therefore fire was their principal tool to clear land to aid travel and provide areas for cultivation and residency. They used fire in the propagation, storage and cooking of a number of crops in hangi and umu (cooking with hot embers) which contributed to their staple diet. Fire was also used to aid in the felling of selected trees to make waka (canoe), to harden or aid the bending of wood for weapons, and ease shaping of bark vessels used for carrying water or preserving food.

European settlers accelerated the use of fire to clear native forest for land settlement and pasture (Ogden, et al., 1998). Due to limited exposure to fire, native forests in New Zealand show few if any pyrogenic adaptations and are highly susceptible to fire. Forest cover has been reduced from approximately 85-90% to 25% of New Zealand's land cover (Perry et al., 2014).

Case studies with three kaumātua provided a further historical perspective and a greater understanding of traditional and present day use of fire from their life experiences growing up in rural Māori communities that can be used to help guide current and future fire management. The kaumātua explained the meaning of places that have been named after historical fire events. They imparted their learned knowledge of traditional fire use and their experiences of tribal use of fire as part of domestic necessities of life, such as cooking, lighting to see in the dark, heating tools for soldering, horse-shoeing and ironing clothes as well as pacifying bees with smoke. Some useful recommendations were provided to develop appropriate fire risk mitigation strategies to ensure that wildfire ignitions do not occur from Māori use of fire in the future.

Conclusion

The research provided an understanding of the historic use of fire by Māori and background on the relationship of fire, as a natural element of the natural environment and Māori people.

The knowledge gained from the research provides a positive step towards gaining a better understanding of Māori perspectives on their use of fire in the past, and which can also be used to assist rural fire authorities undertake their rural fire management and fire risk mitigation responsibilities with Māori in New Zealand. An increased understanding of past and present use of fire by Māori will aid rural fire authorities in their work with rural communities to increase awareness of the risk of wildfires and to design strategies to communicate safe controlled use of fire more effectively, thereby minimizing the chances of future wildfire events.

This research has been published in the *MAI Journal - A New Zealand Journal of Indigenous Scholarship* (Stone and Langer, 2015).

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Bushfire psychological preparedness: The development and validation of the Bushfire Psychological Preparedness Scale (BPPS)

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Background: Bushfires can be threatening and stressful events and people need to make decisive and immediate action to ensure their safety. However, it is widely accepted in psychology that high levels of stress can hamper a person's ability to perform and recover. Numerous studies have found stress to adversely impact people's decision making, memory, and attention (e.g. Starcke, Wolf, Markowitsch & Brand, 2008), all of which are important for implementing physical preparedness actions and plans in the bushfire setting. Additionally, stress has been linked with long-term psychosocial problems such as post-traumatic stress disorder, depression, anxiety, domestic violence and divorce (Rowney, Farvid, & Sibley, 2014). These psychosocial outcomes can consequently increase vulnerability in future bushfires.

In an effort to help people cope with and manage the effects of stress during and after a bushfire, fire agencies encourage residents living in bushfire prone areas to prepare both physically and psychologically. Despite the endorsement for psychological preparedness, it is currently an under-researched area, with most preparedness campaigns and research projects focusing on physical preparedness. The impact of this has been reflected in a recent mental preparedness study, which found ambiguity in the understanding of mental preparedness amongst fire agency staff and volunteers (Eriksen & Prior, 2013). It has further been reflected in post-fire surveys, with residents displaying behaviours suggesting a lack of psychological preparedness (2009 Victorian Bushfires Royal Commission. & Teague, Bernard, 2010).

It is argued that part of the reason this is an under-researched area is that there have been few attempts to conceptualize and operationally define psychological preparedness in the bushfire setting. Therefore, over the past four years we have attempted to fill this gap in the research by conducting a series of studies aimed at conceptualizing and operationalizing bushfire psychological preparedness. This conceptualization and operationalization will help pave the way for a better theoretical understanding of psychological preparedness, which is important for the development of education and intervention programs. This extended abstract aims to provide a snap shot of some of our findings.

Method: Research was comprised of five phases and was guided by the classical theory approach to scale development. In *phase one* we identified the content domain and developed a conceptual model of bushfire psychological preparedness. In *phase two* we developed a large pool of items to reflect the conceptual model by reviewing previous measures, community education information, and bushfire and natural disaster research. In *phase three* we recruited 21 subject matter experts to review the face and content validity of the items. In *phase four* we piloted the scale with a sample of 262 residents living in bushfire prone areas across Australia, with the purpose of further refining the scale. In our final phase, *phase five*, we recruited a sample of 661 residents living in bushfire prone areas to check the reliability and validity of the scale.

Results: *Phase one – Conceptualization:* A review of the literature revealed that psychological preparedness is a multifaceted concept, which enables people to prepare, respond and recover from a natural disaster (Reser & Morrissey, 2009). Our conceptual model therefore included multiple dimensions, which encompassed: bushfire knowledge and bushfire psychological resilience, respectively. It was intended that these two overarching dimensions covered a combination of mental, psychological and emotional preparedness. The bushfire knowledge dimension included safe human behavior, bushfire behavior and bushfire outcomes. The bushfire psychological resilience dimension included: social support, coping self-efficacy, positivity, perceived control and proactive coping.

Phase two & three – Item development and refinement: Using a 5-point Likert type scale, an item pool of 140 items was generated. Forty nine items were developed for the bushfire knowledge scale (BK) and 91 items were developed for the bushfire psychological resilience scale (BPR). However, a review of the face and content validity data (clarity and relevance estimates, and expert comments) saw the item pool reduced from 140 to 134 items.

Phase four – Pilot study: The purpose of the pilot study was to further refine the BK and BPR, and to use exploratory factor analysis (EFA) to investigate the psychological structure of the BPR. In terms of scale refinement, an item analysis of the BK items, which is an appropriate analysis for a knowledge-test type construct (Nunnally & Berstein, 1994), resulted in the scale being reduced to 19 items. Utilizing several EFAs for the BPR, which is an appropriate analysis for psychological constructs (Nunnally & Berstein), the scale was reduced to 25 items.

The EFA was also used to explore the factor structure of the BPR. Following several EFAs a five factor model was extracted for the BPR which accounted for 59.828% of the variance. The factors included: social support (7 items accounting for 24.84 % of the variance), coping self-efficacy (6 items accounting for 10.92 % of the variance), proactive coping (4 items accounting for 9.02 % of the variance), locus of control (4 items accounting for 8.16 % of the variance), and positivity (4 items accounting for 6.89 % of the variance). This provided preliminary evidence for the construct validity of the BPR.

At this stage, we also obtained preliminary evidence for the reliability of both the BK and the five factors of the BPR, with the Cronbach alpha ranging between fair and good: .75 to .85.

Phase five – Reliability and validity: Another item analysis of the BK items resulted in further refinement of the scale, reducing it to an 18 item scale with good reliability, $a = .86$. Furthermore, a series of EFAs and confirmatory factor analyses (CFAs) of the BPR resulted in its reduction to a 17 item scale with good overall validity, $a = .86$.

The CFAs of the BPR also revealed strong model fit for a higher order four factor model of BPR: $\chi^2(115) = 167.758$, $p < .001$; RMSEA = .026 (90% CI: 0.02 TO 0.04); CFI = .982; TLI = .979, SRMR = .037. All factor loading were significant ($p < .001$), and a target coefficient of .98

was obtained, which provided evidence for the use of a total score for the BPR. The four factors included: social support, coping self-efficacy, positivity and proactivity. In contrast to our previous study, it was evident that locus of control was a weak representation of bushfire psychological resilience.

Correlations between the factors of the BPR ranged from weak to moderate (r =.166 to r = .439) indicating discriminant validity. The correlation between BPR and BK was .31, suggesting they are moderately related to one another, according to Cohen's (1988) guidelines.

Discussion: These studies resulted in the production of a 35-item scale, with stable psychometric properties, that captures bushfire psychological preparedness. From an academic standpoint, this study adds to the limited research on psychological preparedness for a bushfire, and provides a tool for measuring the concept with a focus on mental, psychological and emotional preparedness.

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Description of Firebrand Generation in a Pine Stand Fire

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Abstract: A study on firebrand generation was carried out during two high intensity prescribed fires in the New Jersey Pine Barrens in March 2013 and 2014 (El Houssami *et al.* 2015). The fires were characterized using various instrumentations at different locations in order to better understand the fire behavior (Mueller *et al.* 2014) and correlate the firebrand generation to the fire properties. Meteorological conditions were also monitored before and during the burn in order to supplement the firebrand generation study. A network of meteorological towers in the overstory and in the understory was established. Additional instrumentation was also deployed to measure wind speed and direction, air temperature, relative humidity, atmospheric pressure, and soil temperature. Multi-spectral airborne imagery was prepared using Wildfire Airborne Sensor Program (WASP) (McKeown *et al.* 2011), to track the fire progression in both visual and infrared (IR) bands. Pre- and post-fire canopy fuel loadings were estimated using an airborne LiDAR model allowing the generation of a canopy height profile (Skowronski *et al*. 2011), as

well as 3D canopy bulk density. Additionally, a number of cameras were placed throughout the block, intended to record characteristics of the fire. For instance it was spotted that during the burn, firebrands allowed a surface fire to cross easily a narrow fuel break (Fig. 1).

New methodologies were tested to obtain insight on the firebrand activity, and to quantify firebrand showers close to a fire front. Firebrands were collected in aluminum pans from different locations in the forest during the fire and were analyzed for mass and size distribution. Firebrand loadings ranged from 0.2 to 98 gr/m^2 and most of the particles had a surface area smaller than 100 mm^2. Most firebrands were bark slices with substantial amounts of pine and shrub twigs. Bark consumption was also studied by measuring the circumference variation at several heights on each of three different pine trees. In both years, the variation was in the same order of magnitude as the bark thickness determined in the firebrand collection section (1 to 5 $x10^{-3}$ m). Shrub branches were compared before and after the burn with subgroups for 1h fuels then were compared to the collected shrub originated firebrands. This work represents first exploration of various methodologies that will facilitate the collection of compatible data in a wide range of ecosystems and fire environments. Results from the field experiments were used to determine the range of embers to be used in the laboratory, by testing the accumulation of firebrands on wooden material, typically used in decking and roofing construction in the USA. It was found that using the range of size and mass of the embers collected in the field, it was possible to ignite samples laid in different geometrical arrangements, representing a deck or a roof. It was noticed that flaming ignition could occur on the back face of a sample, after a smoldering front has penetrated through the sample and allowing oxygen inflow to transition into a flaming combustion. These finding will indicate vulnerabilities and critical conditions for structural ignitions in the Wildland Urban Interface.

Fig. 1. Snapshot of firebrands flying across a fuel break and igniting the other side

Additional Keywords: Firebrand, Bark, Generation

Acknowledgments:

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Distilling and disseminating new scientific understanding of wildland fire phenomena and unfolding of large wildfires to prevent wildland firefighter entrapment

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Abstract:

Large wildland fires are dynamic phenomena that may produce fire whirls, blow-ups, 100-m long bursts of flame shooting ahead of the fire line, fire winds 10 times stronger than ambient winds, deep pyrocumulus, and firestorms in which the fire-generated winds overwhelm ambient winds – all resulting from interaction between a fire and its atmospheric environment, notably the production of fire winds. Observational and modeling research has unearthed dynamic fire phenomena and confluences of atmospheric, fuel, and topographic conditions that likely contributed to numerous firefighter fatality incidents but which had not yet reached training curricula. This work distilled recent research aimed at understanding wildfire phenomena and wildfire events to improve firefighter safety and prevent burnover accidents. For example, infrared imagery has revealed bursts of flame that shoot ahead of the fire line along the ground; as part of this work, such imagery and phenomena has recently reached S290 training curricula. In addition, the CAWFE™ coupled weather-fire model was applied to fatality incidents including the Esperanza Fire and Yarnell Hill Fire for understanding and to distill knowledge for the wildland firefighting and scientific community. Results were disseminated through scientific publications, social media, a wildland fire safety conference, university classes, and briefings.

Additional keywords: fire weather, coupled atmosphere-fire model, burnover

Introduction

Despite uniform training curricula, rigorous command and control structures, and memorization of succinct principles like the 10 Standard Fire Orders and 18 Watch Out Situations, even seasoned firefighters may be tragically unprepared for complex and explosive fire behavior that can lead to burnovers. Burnover fatalities made up 21% of wildland firefighter fatalities between 1990 and 2006 (NIFC 2007), concentrated in multiple fatality incidents such as the Dude Fire (1990, 6 fatalities), the South Canyon Fire (1994, 14 fatalities), the Thirtymile Fire (2001, 4 fatalities), and the Esperanza Fire (2006, 5 fatalities). Burnovers do not solely result from unusual fire behavior; failure to adhere to one or more of the Standard Fire Orders as well as command instructions is often noted as a contributing factor. However, as the National Fire Service Research Agenda Symposium report (National Fire Academy 2011) states, many of these occurred "due to a lack of understanding of fire behavior or rapidly changing conditions that lead to burnover".

Planning Sections of incident management teams combine weather forecasts with anticipated fire behavior under those burning conditions with perhaps a century of combined wildfire experience, but human intelligence cannot combine all the interacting factors, for example, where diurnal winds or local topographic wind effects (which could vary day to day depending on wind speed, the rate the wind speed changes with height, and atmospheric temperature lapse rate) combine with canyons that concentrate winds to dramatically accelerate fire growth. Moreover, understanding of why fires unfolded the way they did in past events is often incomplete in describing what fire behavior occurred and event descriptions that are presented to educate and caution do not take advantage of recent research tools and results.

A recent project applied the most recent scientific tools and knowledge on fire behavior and the fire environment to past wildland fire events during which fatalities occurred with the goal of distilling results with applications to firefighter safety and disseminating this understanding to prevent recurrences. The methodology was to draw from observational and numerical modeling research that unearthed dynamic fire phenomena and confluences of atmospheric, fuel, and topographic conditions that likely contributed to fatality incidents, use these to understand why fatality fires behaved as they did, distill this into understandable narratives and engaging visuals, and disseminate it through disparate and wide-reaching channels to inform and prepare firefighters for rapidly changing and complex conditions.

Background

It is widely accepted factors in the fire environment (weather, slope, and wildland fuel properties) cause variations in fire behavior. This understanding is encapsulated in a semi-empirical relationship, the Rothermel (1972) formula, which estimates the fire rate of spread and intensity at the leading edge as a function of these properties. This relationship forms the basis of operational models currently available for training and in the field, including BehavePlus (Andrews et al. 2008) for estimating rate of spread at a point and FARSITE (Finney 1998), which projects the expanding perimeter of an fire assumed to be shaped as an ellipse, and Wildland Fire Decision Support System tools for near term fire behavior (Noonan-Wright et al. 2011). While these tools have been useful for making simple projections of fire rate of spread or fire perimeter, (1) many influences are not accounted for (diurnal effects, wind speed changes in time, inversions, cloud downdrafts, etc.), (2) they do not include the interplay between fire and atmosphere that is known to be the basis of fire behavior, and (3) cannot explain or predict fire phenomena, rapid changes in fire behavior or blowups, or extreme fire behavior. In addition to limiting their skill at predicting behavior, this limits their ability to explain and instruct.

In contrast to the tools mentioned previously, coupled weather-wildland fire models such as the CAWFE™ (derived from Coupled Atmosphere Wildland Fire Environment) modeling system have shown some skill in this regard. CAWFE arose with the recognition that coupling between a fire and the atmosphere surrounding it is the basis for many fundamentals of fire behavior. Fire whirls occur because the difference in air temperature inside vs. outside the fire line generates a rotation that is tilted into the vertical by the buoyant air. The bowed shape commonly observed in fire lines ("convective fingers") results as heat released over a fire line will break up into round cells, each of which becomes a plume that draws air into its base, most strongly over the fire immediately adjacent to it, making the fire spread faster there and explaining why wildland fires develop the widely observed bowed fire line shape (Clark et al. 2004) (Fig. 1). Streets of burned fuel are hypothesized to result from horizontal roll vortices (Haines 1982) or shifting winds. Counter-rotating fire whirls that are brought to the fire's head may combine at the tip and roll over forming turbulent balls of flame shooting ahead of the fire line. Coen (2011) condensed the basics of this new understanding from scientific publications to the wildland fire practitioner community.

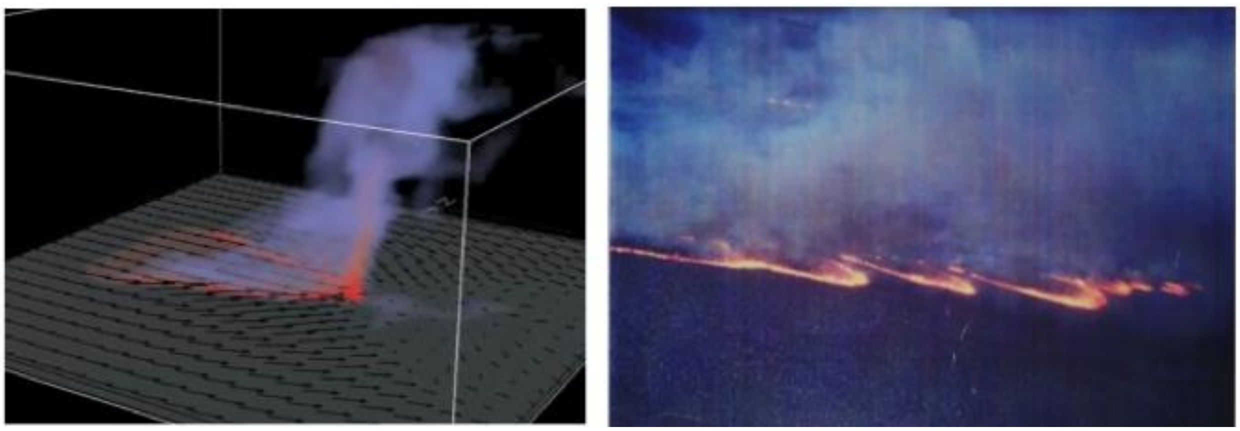

Fig. 1. As a fire line simulated with the CAWFE modeling system spreads from ignition as a line (left), it evolves into a universally observed shape (right, courtesy C. George) with three parts: the "head" - the fire's leading edge where the heat is focused, "flanks" - along the side where winds blow parallel to the fire's edge, and the "backing region" – the slowest moving part of the fire that creeps against the wind. The heat from the fire rises in updrafts over the fire's head. These updrafts draw warm air into their base from all directions, guiding the wind to flow along the flanks and focus the heat at the front. In this way, the fire's interaction with environmental winds shapes the winds and creates a self-perpetuating, universally observed shape. (from Clark et al. 2004, Copyright American Meteorological Society)

Meanwhile, infrared imagery has been used to explore crown fire dynamics from ground (Clark et al. 1999; Coen et al. 2004) and airborne (Radke et al. 2000) platforms, revealing the formation of fire whirls on fire flanks and, as the counter rotating whirls are brought to the heading region (Fig. 4), interactions between them form balls of flame that shoot forward bursts forward as in Fig. 1d. In other experiments, analysis of infrared imagery of crown fires traveling upslope are observed to produce repeated examples of narrow flaming fingers burst upslope along the ground for 10's of meters at 28-48 m s^{-1} before turning upward (Fig. 2). Other instruments onboard confirmed the fingers were low enough to preheat, dry, and ignite canopy. These bursts exceeded ambient winds by a factor of ten and resulted from nonlinear vortex interactions. Thus, Coen et al. (2004) concluded that rapid spread was not a result of strong environmental winds and hypothesized that this powerful, dynamic mechanism could be behind reports of firefighters being overtaken by "fireballs", consistent with the forensic evidence in the South Canyon fire fatality report and several other incidents. Moreover, the measured maximum updrafts of 32-60 m s^{-1}, downdrafts of 18-30 m s^{-1}, and strong inflow into the fire plume's base are among the extremes of winds in atmospheric phenomena and pose other hazards.

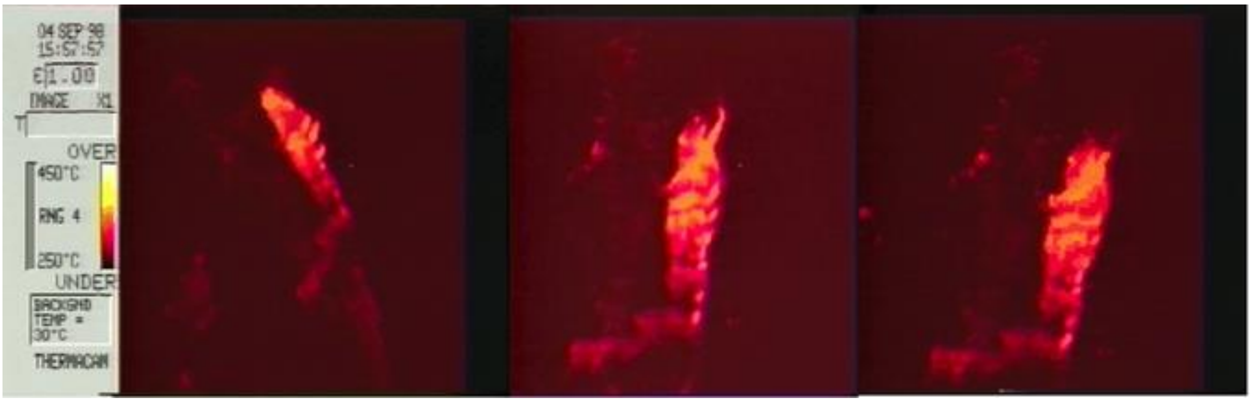

Fig. 2. This sequence of infrared imagery (hotter radiant temperatures are show in yellow, cooler temperatures in dark red in scale at left) from an airborne mounted infrared video imager show a wildfire traveling up a slope towards the upper right, the appearance of a 30-m long finger of flame shooting upslope along the ground, and its disappearance in less than 2 s.

Coupled weather-fire modeling

Current operational tools diagnose the growth of a fire from local fuel properties, slope, and a measurement(s) of wind from a nearby surface weather station(s), which even in high density networks may be miles from the fire and which indicate what the wind is now, not in the future. New modeling paradigms have shown increased realism by integrating numerical weather prediction models that model that way weather varies in time and space even in complex terrain with models that diagnose how a fire will grow and consume vegetation, in response to wind, terrain slope, and fuel properties. These are connected in two directions in that weather directs where the fire grows and how fast, while heat released by the fire modifies its atmospheric environment, i.e. 'creates its own weather'. This contains two advances that directly fill weaknesses with the current approach: coupled weather-fire models consider how weather varying in time and in complicated manners particularly in mountainous regions directs a fire and how interactions between the weather and fire, notably fire-induced winds, in turn affect fire behavior. Over the past decade, one of these coupled weather-fire models, CAWFE has been applied to dozens of large wildland fire events in varying weather conditions and regions.

CAWFE combines a numerical weather prediction model that incorporates the effects of complex terrain on airflow (and thus on fires) with a fire behavior model to simulate the intertwined influences of weather, fuel, and terrain on wildfire growth, plume development, and smoke transport (Clark et al. 2004; Coen 2005a; Coen and Riggan, 2014). These are coupled so that heat and water vapor fluxes from the fire alter the atmosphere, notably producing fire winds, while simultaneously, the evolving atmospheric state affects fire behavior. Simulating the terrain-induced airflow effects, the fire's forces on the air that alter winds, and the role of winds directing the fire spread creates much of the uniqueness of the unfolding of each fire event. Hence, in summary, *models such as CAWFE that couple fire with weather have shown that they can (1) simulate the weather near fires, notably the near-surface wind speeds, including how they vary spatially and with time and are affected by terrain, the fire, and cloud downdrafts, (2) reproduce fire spread characteristics, but more importantly, (3) reproduce critical fire/wind interactions that determine fire shape and simulate important fire phenomena not simulated by* *the operational models.*

The numerical weather prediction component of CAWFE is a three-dimensional non-hydrostatic meteorological model (Clark and Hall 1991) based on the Navier-Stokes equations of motion, a thermodynamic equation, and the continuity equation using the anelastic approximation. These formalize commonly accepted principles that mass, momentum, and energy must be conserved in moving fluids. Vertically stretched terrain-following coordinates allow detailed simulation of airflow at horizontal resolutions of 100s of kilometers while several interactive, nested modeling domains telescope in to focus at 10s of meters in, for example, a particular mountain valley. The fire component of CAWFE is based on semi-empirical relationships and incorporates a simple crown-fire algorithm and the Rothermel (1972) algorithm to estimate surface-fire spread as a function of terrain, fuel properties, and local wind that in this system is altered by the fire. It estimates fuel consumption rates in post-flaming front burning areas as per Albini (1994) and calculates the sensible (thermal) and latent (water vapor) heat releases and, using emission factors, smoke particulate release from different fuel types. The surface fire heats and dries the tree canopies if present, and if the heat flux still exceeds a threshold, a canopy fire is ignited and consumes the tree biomass, releasing more sensible and latent heat into the atmosphere. A simple radiation treatment distributes sensible and latent heat fluxes and particulates from the fire into the lower atmosphere, the depth based on analysis of ground-based infrared fire imagery (Coen et al. 2004) and instrumented measurements (Clements et al. 2007).

Studies using CAWFE have shown that interactions between a fire and the atmosphere are behind even the most basic fire dynamics (Coen 2011), including elliptical fire shapes, formation of single- or multiple-head fires, and parallel alignment of a fire's flanks to the wind. CAWFE has been applied to dozens of large wildland fire events in many different fuel, terrain, and weather conditions, notably the 2012 Little Bear Fire in New Mexico (Coen and Schroeder 2013), the 2006 Esperanza Fire (Coen and Riggan, 2014), the 2012 High Park Fire in Colorado (Coen and Schroeder 2015), the 2014 Yarnell Hill Fire in Arizona (Fig. 3), and the 2014 King fire (unpublished data). In 2004, CAWFE was applied in a faster-than-real-time scenario (Coen 2005b) for Colorado wildfires.

Studies of fatality events

This project produced CAWFE simulations of wildland fire events exemplifying types of complex behavior during which fatalities occurred – events that sometimes strongly resembled preceding events. For example, the 2006 Esperanza Fire, which caused five fatalities, was a Santa Ana-driven wildfire characterized by complex mountain airflows, multiple heading regions, and rapid upslope growth orthogonal to the ambient wind direction. The Banning Pass location was the site of previous safety incidents. The 2013 Yarnell Hill Fire (19 fatalities) in Yarnell, Arizona, was characterized by heavy fuel, topographic airflow effects, and thunderstorm outflows creating a change in wind speed and direction, fanning a less active region of the fire line into rapid growth – the fire environment and weather circumstances of which resembled the nearby 1990 Dude Fire (6 fatalities).

The methodology for simulation of past events is documented in detail in scientific publications.

In summary, the approach is to gather input data including gridded atmospheric analyses for initial conditions and boundary conditions defining the state of the atmosphere, spatial fuel mapping data from LANDFIRE (www.landfire.gov), and terrain elevation data, along with information on fuel moisture and fire ignition or mapping data. The numerical weather prediction component of CAWFE simulates the weather in the fire region, beginning shortly before the event and telescoping with higher resolution domains to the immediate vicinity of the fire with spatial grid resolution of 100s of m. When the ignition is known to have occurred or at the time of the fire mapping data, the fire is ignited in the model, and the weather, fire, and interactions between them are modeled for the remainder of the simulation, which in total may extend as long as approximately 36 h. Subsequently, four-dimensional visualizations are produced with the Visualization and Analysis Platform for Ocean, Atmosphere, and Solar Researchers (VAPOR) interactive three-dimensional visualization environment software (https://www.vapor.ucar.edu).

The CAWFE simulation of the June 30 2013 Yarnell Hill event (shown in Fig. 3) illuminated the complex but reproducible sequence of events in the fire environment and fire behavior that, independent of human actions, has been the basis of discussion. Initialized at 12 AM local time, a sequence of 4 nested domains that telescope from the western U.S. down to west central Arizona recreated the weather that, over the fire area, was characterized by near surface flow from the southeast, while at mid-atmospheric levels, a moist layer of air passed over the fire area from the northeast. The fire, which had been burning for several days, was ignited already in progress using the extent mapped by the Visible and Infrared Imaging Radiometer Suite (VIIRS) using techniques described in Coen and Schroeder (2013). The fire initially spread northward, as supported by the incident map (Fig. 3), before experiencing a gap flow between buttes, changing its direction to eastward. In passing over a sequence of three mountain ranges to the northeast of the fire area, the moist layer of air was lifted and thunderstorms grew. The simulations showed that precipitation falling into the dry subcloud boundary layer evaporated, cooling the air, producing strong outflow that spread southwest at the surface, reaching the northeast edge of the fire at 4:15 PM local time (seen in frame 4 in Fig. 3), and the southwest edge at 4:30 PM local time (frame 5) in Fig. 3) in agreement with reports. The change in wind speed and direction directed the fire into unignited fuels, rapidly increased the fire intensity, and drove the fire to the southwest, through the entrapment site. The animation of the visualized airflow and fire spread information over local geography illuminated a complicated sequence of events, including flow through complex topography and rapidly changing weather, resulting in two shifts in fire spread direction during one burning period, including the dramatic effect of the gust front rapidly intensifying and expanding the southwest part of the fire line.

Scientific outlets, social media, education and training

While scientific products have standard outlets including journal publications and conference presentations and proceedings, a need was highlighted in the 2nd National Fire Service Research Agenda Symposium report (National Fire Academy 2011), which identifies among its top issues "The lack of [a] central clearinghouse for wildland fire research limits the dissemination of research results. Stakeholders feel that there is a lot of research out there that may impact wildland firefighter safety and effectiveness, but don't know how to access it. Fire service and researchers don't know what has been done, or is being done in terms of wildland firefighting research." In addition, despite uniform training curricula, rigorous command and control structures, and memorization of succinct principles like the 10 Standard Fire Orders and 18 Watch Out Situations, even seasoned firefighters may be tragically unprepared for complex and explosive fire behavior that can lead to burnovers. Thus, while this project introduced products into standard research and wildland fire training forums, more direct approaches such as briefings with a wide range of stakeholders, contemporary social media tools such as blogs and YouTube, and outreach to those at earlier points in their careers were used as well (Table 1).

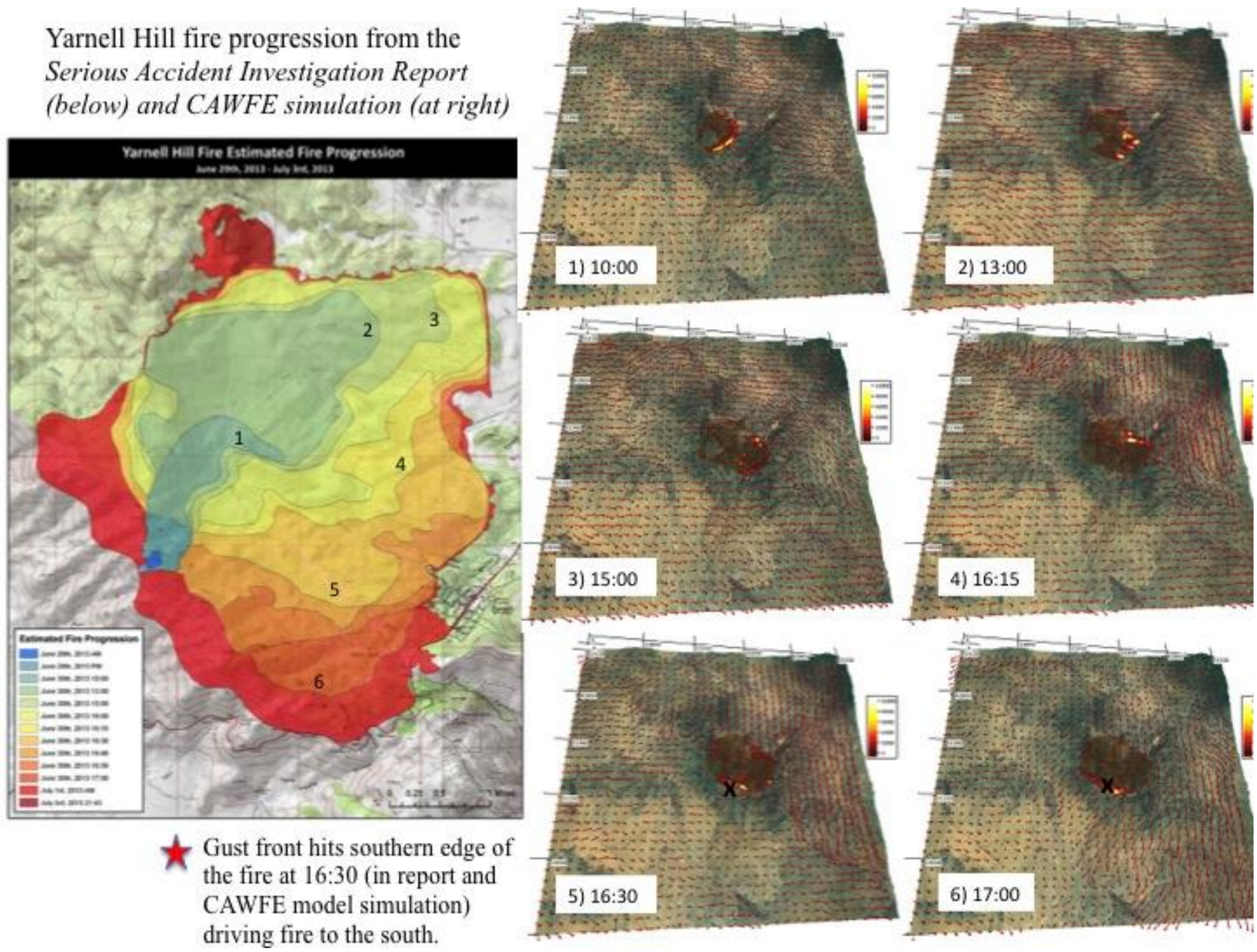

Fig. 3. Snapshots of simulated fire evolution, showing the sensible heat flux ($W\ m^{-2}$) (colored according to color bar at right) and the near surface wind (arrows point downwind, and longer arrows indicates stronger winds) at six times (times is given in local time) when the fire extent was mapped in the Serious Accident Investigation Report (left, courtesy T. Foley).

Table 1. Outreach and dissemination activities and products.

Publications	Scientific Conferences
• Coen, J. L. and W. Schroeder, 2015: The High Park Fire: Coupled weather-wildland fire model simulation of a windstorm-driven wildfire in Colorado's Front Range. J. Geophys. Res. Atmos. 120:131-146 • Coen, J. L. and P. J. Riggan, 2014 Simulation and thermal imaging of the 2006 Esperanza Wildfire in southern California: Application of a coupled weather-wildland fire model. Intl. J. of Wildland Fire. 23, 755-770. • Coen, J. L. and W. Schroeder, 2013: Use of spatially refined remote sensing fire detection data to initialize and evaluate coupled weather-wildfire growth model simulations. Geophys. Res. Letters. 40:1-6.	• Large Wildland Fire Conference, "Coupled Weather-Fire Modeling of Landscape-scale Wildland Fires using Satellite Active Fire Detection Data: Application to Firefighter Safety". Presentation. • 13th Intl. Wildland Fire Safety Summit & 4th human Dimensions of Wildland Fire Conf., "Distilling and disseminating new scientific understanding of wildland fire phenomena and unfolding of large wildfires to prevent wildland firefighter entrapment". Presentation and preprint.
University Classes	**Firefighter Training Material**
• Presentation coupled weather/fire modeling, infrared imagery, fire phenomena for Prof. Dicus' Fire Ecology class • Educational track for many students leads to wildland firefighting career	• Oklahoma State Univ. Fire Service Training • Phenomena showing forward bursts of flame from the fireline – a hazard indicated in a number of fatality events – as revealed by infrared imagery include in S290, a National Wildfire Coordinating Group course widely taken by wildland firefighters
Over 50 Briefings spanning practitioners to agencies responsible for safety on wildland fire incidents, including:	**Blogs/Social Media**
• Governors, state & local elected officials • Fire weather agencies and practitioners • Incident teams • Non-governmental organizations • State Fire agencies • Technology developers • Fire training/curricula committees	• Wildfire Today (wildland fire community blog) • Case animations published on NCAR's YouTube channel • NCAR-Wyoming Supercomputing Center Visitor center video (YouTube)

Discussion

The project began with an underlying assumption that understanding of physical cause and consequences in the research community could increase firefighter knowledge and thus lead to safer actions. Several challenges became apparent. A gap, coinciding with agency jurisdictions, between weather and fire in research, operations, forecasting tools and personal outlooks still exists. Fire behavior and phenomena are not recognized for how common, deterministic (given the environment conditions and forcing), comprehendible (using recent research tools and knowledge), and predictable they are. Instead, it is rare that the complete cause-effect relationship linking the evolving weather and fire behavior in an event is thoroughly understood. It may frequently be complex, but is within current coupled models' capabilities. Thus, the tendency remains to cast the unfolding of events during fatality incidents as rare and unpredictable, and to invoke the phrase, "the perfect storm". Consequently, the opportunity for learning is diminished, as rare may be interpreted as unlikely, i.e. "it won't happen/isn't happening to me". Alternative approaches to interpreting events that have been successfully used in other hazardous environments such as that of test pilots were raised (B. Scott, pers. comm.) such as preparing by visualizing things going wrong and mentally practicing "bailing".

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Students of fire

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Extended abstract

Introduction

The late Paul Gleason, a US Forest Service Hotshot Superintendent, spent his working life promoting fireline safety, in 1991 developing the acronym LCES (Lookouts, Communications, Escape routes, Safety zones). He left a legacy of thinking firefighters whose safety was linked to their application of fire science principles at the fireline. He wanted firefighters "to realise the importance of being students of fire". His vision fostered experiential learning where knowledge was passed from those bearing battle wounds of near-misses to those just beginning their inherently risky wildland fire career.

Australian wildfire educator Rod Stebbing, inspired by Gleason's vision, in turn fired the interest of fellow wildfire instructor Roger Strickland. Both have experienced first-hand the value of sharing experience from the results of debriefing crews who have experienced traumatic events such as burn-overs and other near misses. An example is a crew from the 2009 Nixon Road fire who nearly died in a tanker burn-over. After making sense of what happened to them, they went on to share their story with hundreds of their fellow firefighters, who have benefited by learning from the crew's experience. With the support of ex-president Chuck Bushey and Executive Director Mikel Robinson who gained the patronage of the IAWF, Stebbing and Strickland co-founded Students of Fire, a community of practice that acts as a platform for sharing experience, inquiry and knowledge transfer.

The concept enthused Kelsy Gibos, a Canadian wildfire management specialist, especially the aspect of knowledge transfer. Gibos finds that it is personal connections that are powerful, and has gained the support of her agency management to spread the concept of Students of Fire via Students of Fire poster walls in multiple agency offices. She uses the poster walls to transfer knowledge by publicizing fire research findings and posing questions, asking readers to communicate their own experience. The authors, keenly aware of the existing active communities of practice in wildland fire, and of the value each of them has gained from their own personal networks, hold up Students of Fire as a way of further encouraging personal connections between researchers, scientists, fire-fighters and people with an interest in fire.

SoF is about activity and continual improvement; it is about local action to learn about a global issue. It builds connections across the wildfire community, but most importantly, its focus is a dialogue between firefighters, researchers, local government authorities, educators, and all those with responsibilities in wildfire.

The power of dialogue

Dialogue is important because it implies personal connection, and personal connection can be influential in changing thinking. The Canadian Student of Fire Kelsy Gibos, working as a field technician for a fire operations research team, recognised this when a Fire Behaviour Analyst took the time to explain to her personally the fire behaviour visible in front of them. She describes her thought processes as changing at that instant from simply reacting to the fire behaviour to thinking about the fire behaviour.

The power of stories

SoF recognizes the value in informal sharing of personal experiences; it is born from those in-camp-after-dinner reflections between strangers on what was supposed to happen, what really did happen and attempts to explain discrepancies. SoF seeks to utilize the power of stories of personal experience passed from one person to another to build understanding of fire and hence, how to better manage and live with fire.

Richness in diversity - the learning inherent in a multi-discipline approach

SoF arises from a desire to challenge the science of fire behaviour prediction, from the need for a safe place to ask questions, to step outside of the boundary of the ‘norm’ and to challenge the use of terms like ‘unprecendented’, ‘unexpected’, ‘extreme’ and ‘unforseen’. SoF is for thinkers; it is about inquiry and a search for understanding and, beyond that, a need to blur jurisdictional borders to include disciplines beyond fire science. Fire safety is contingent not only on a sound working knowledge of fire behaviour and the operational tools and technology, but also of the human dimensions of working in teams, working across organisations and working with fire-prone communities.

A universal language.

SoF highlights that the language of fire amongst those who observe it is universal. Comradery is widespread amongst personnel whether it is national or international boundaries that are breached by a spreading fire. Emergency management environments change over time and space, but the mathematics of fire spread and the feeling of heat on skin will remain the same.

This presentation outlines the mission of the Student of Fire project and provides details on how to participate at the workplace level. It is delivered by a practicing Student of Fire who will provide tips to help ignite mindfulness about the relationship between science and safety and encourage calibration based on personal experience.

The vision

A global network of fire practitioners committed to improving understanding of:

- Wildland fire and all related natural & social phenomenon

- How humans can best live with wildfire to benefit all life on earth

Mission

To learn about wildfire from personal experience & self reflection & from the experience of others to share those learnings responsibly for the benefit of all

Values

- Openness to ideas
- Inclusiveness
- Respectful dialogue & collaboration
- Gaining skills & knowledge through reflection
- Seeing wildfire incidents as learning opportunities & not as personal failures
- Respect for the environment
- Ongoing promotion of fireline safety

How it works

- Join IAWF
- Get information from the SoF tab on the IAWF website
- Make contact with other SoF
- Form a SoF group with interested peers
- If you don't have one already, start a fire journal
- Think of a fire project to pursue
- Arrange an event with a speaker with advanced knowledge of an aspect of fire
- Report to IAWF on your activities

Suggestions for projects

- Hold a speaker event with fire related topics
- Develop a case study – seek feedback
- Pose a question about something that puzzles you – put it out to the world!
- Write a fire journal with your musings, discoveries, collaborations. Share the journal with other Students of Fire
- An opportunity for scientists to get feedback from the field
- Collect 'rules of thumb' – prove them useful or not.
- Get agency/employer permission to start a Student of Fire Information Board. Post interesting articles, photos, notes, bulletins, journal pages. Pose questions about the information- e.g. does it match real world experience?

Additional keywords: community of practice, dialogue, experiential learning, knowledge transfer, collaboration

Increasing Community Resiliency by Promoting the Use of Prescribed Fire in the Southeastern United States: The Fire in Southern Ecosystems Program

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Abstract:

The lack of effective, coordinated, targeted fire education programs are an obstacle to prescribed burning. The public often has a poor understanding of prescribed fire and the natural role of fire. Understanding these two concepts is important for the public, especially in WUI areas with high wildfire risk. The Fire in Southern Ecosystems (FISE) curriculum was started to provide educators with the background, knowledge, and skills they need to teach about fire. The goal of the free FISE workshops is to engender a citizenry that supports prescribed fires. The program can be used as a model for fire education programs in other regions.

Evaluation is important to improving the FISE program over time. More than 1,200 educators provided input for needs assessment for the program. Participants show statistically significant changes in knowledge and attitudes about fire after attending a workshop. In the past 15 years, this program has reached 95% of the school districts in Florida and more than 3,000 educators, with a potential impact of more than 1 million people. Workshops are coordinated and taught by Normandeau Associates, Inc., for the Florida Forest Service. The FISE curriculum and teaching resources are available to download for free from www.fireinsouthernecosystems.com.

Additional Keywords: FISE, Community Resiliency, Florida, Southeastern, Southern,

Ecosystem, Education, Educator, Teacher, Workshop, School

Wildfire Smoke Health Costs: A Methods Case Study for a Southwestern US "Mega-Fire"

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Exposure to wildfire smoke can increase morbidity in urban areas. Economists are increasingly calling for such health impacts to be included in wildfire damage assessments. However, collecting original health outcome data is costly and time-consuming. Benefits transfer is a more accessible alternative that is often employed. Yet several methodological issues remain unexplored regarding transfers of economic values and air quality concentration-response functions. Ignoring these issues may lead to misinformed wildfire policy based on inexact estimates of smoke-induced health costs. This research provides a case study illustration of a new air quality benefit transfer tool, the US EPA benefits mapping and analysis program – community edition (BenMAP-CE), which is used to estimate smoke damages of a Southwestern US "mega-fire" event and investigate methodological issues surrounding the analyst's choice between transferring results from "wildfire-specific" and "urban air" (unrelated to wildfire) studies. Results indicate that the economic costs of wildfire smoke are substantial. Additionally, transfer of wildfire-specific study results produces substantially higher morbidity estimates and costs compared to use of results from urban air studies. These findings demonstrate: (i) that BenMAP-CE can be applied to wildfire events; and (ii) the importance of transferred study appropriateness when conducting a smoke damage assessment using benefits transfer.

Keywords: wildfire, benefits transfer, health effects, BenMAP-CE, willingness to pay

A conceptual framework for coupling the biophysical and social dimensions of wildfire to improve fireshed planning and risk mitigation

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Abstract:

The need for improved methods for managing wildfire risk is becoming apparent as uncharacteristically large wildfires in the western US and elsewhere exceed government capacities for their control and suppression. We propose a coupled biophysical-social framework to managing wildfire risk that relies on wildfire simulation to identify spatial patterns of wildfire risk and transmission within "firesheds" surrounding communities, and social science to understand wildfire risk perceptions and the degree of collaboration and mitigation behavior among landowners, land management agencies and local officials. Such an approach potentially would provide an improved method for defining the spatial extent of wildfire risk to communities compared to current planning processes, and creates an explicit role for social science to improve understanding of community-wide risk perceptions and predict landowners' capacities and willingness to mitigate risk by treating hazardous fuels and conducting Firewise activities. Moreover, this biophysical-social approach would enable identifying potential comparative advantages in the location of risk mitigation effort, whether on public or private lands, according to both the degree to which specific locations contribute to the transmission of wildfire risk and how likely they are to contribute to the mitigation of risk.

Additional Keywords: wildfire risk transmission, firesheds, wildland-urban interface.

Introduction

The need for more improved methods for managing wildfire risk is becoming apparent as uncharacteristically large wildfires in the western US and elsewhere exceed government capacities for their control and suppression. Natural hazards research suggests that to be effective, the process of evaluating and mitigating hazards must acknowledge the influence of both biophysical and social factors on risk (e.g., Corotis and Hammel 2010), since both can influence the probability of and potential losses associated with adverse events. In a wildfire context, risk is influenced both by biophysical factors that determine the likelihood and intensity of wildfire in particular locations, and social factors that determine how landscape managers, local officials, and individual landowners perceive and address risk (Ager et al. 2015). These characteristics call for broader approach to evaluating and addressing wildfire risk—one that combines assessment of biophysical factors associated with the likelihood of wildfires and of varying intensities, with assessment of social factors associated with risk perceptions and mitigation capacity in exposed communities.

The challenge of addressing wildfire risk is well suited to an emerging coupled human and natural systems approach to natural resource management (e.g., Spies et al. 2014). Coupled human and natural systems conceptual framing explicitly acknowledges that people and nature interact reciprocally across diverse organizational levels, forming complex webs of interaction that are embedded within each other (Lui et al. 2007:639). These interactions can include (1) organizational couplings involving reciprocal effects and feedbacks, indirect effects, thresholds and resilience, human-natural system vulnerability; (2) spatial couplings, across spatial scales and boundaries; and (3) temporal couplings, characterized by significant human impact, increasing reciprocal effects of nature on humans, time lags, and legacy effects (Liu et al. 2007). These features well characterize the challenges of managing wildfire risk—specifically that it involves spatial and temporal landscape processes interacting with socioeconomic processes at diverse scales and across ownerships and administrative boundaries.

We propose a coupled biophysical-social framework to managing wildfire risk that relies on wildfire simulation to identify spatial patterns of wildfire risk and transmission within "firesheds" surrounding communities, and social science to understand wildfire risk perceptions and the degree of collaboration and mitigation behavior among landowners, land management agencies and local officials. We discuss how such a framework can be implemented to manage wildfire risk in communities located in fire-prone landscapes, by combining recent advances in wildfire simulation modeling with social science, including social network analysis, examining the likelihood of risk mitigation effort. Such a coupled systems approaches potentially can contribute to a more effective implementation of the new Federal Cohesive Strategy, and provides a more robust framework for prioritizing federal fuel management investments.

Conceptual Framework for Managing Wildfire Risk

Conceptually, fire-prone landscapes are comprised of biophysical conditions, including forest stand structure, fuel, topography, and other factors, that interact with a wildfire regime and together make up a biophysical fire network (Figure 1). Typically, there are numerous landscape actors, including landowners and public land managers, who manage portions of the fire-prone landscape, as they both influence and are influenced by the biophysical fire network. Public land managers, for example, may observe biophysical conditions and the recent wildfire regime and conduct fuel management to reduce the likelihood of high-intensity wildfires. Private landowners too may observe fuel conditions and chose to thin or harvest to reduce their exposure to risk.

In addition to their interaction with biophysical wildfire network, landscape actors interact within one another within a social network via public meetings, person-to-person contacts, engagement with various agencies and organizations involved in wildfire management, or other civic functions (Figure 1). For example, select wildfire agencies and organizations may work to influence landowners and land managers toward particular wildfire mitigation or landscape management goals. Individual landowners may engage one another as friends, family, or neighbors, and agencies and organizations may collaborate together toward accomplishing shared wildfire risk management goals. All of these interactions take place across varying spatial scales and administrative boundaries, as numerous actors work to address wildfire across jurisdictions of varying size and scope. These include interactions with the biophysical, but also interactions that take place solely within the social network, but ultimately influence management of the biophysical.

We believe that to adequately address wildfire risk on fire-prone landscape, managers and public officials need to consider the combined effects of both the biophysical and social factors involved in both creating and mitigating wildfire risk. We feel that doing so would help to address questions such as: (1) To what degree can fuel reduction actions by particular landowners or managers reduce wildfire risk for the entire fireshed, and how do you incentivize those actions? (2) Does improving dialog between wildfire protection organizations and private landowners and homeowners yield greater private effort to augment mitigation by public land managers? and (3) Would greater coordination be possible among private landowners and public land managers in fuel reduction and other mitigation measures, and if so, how would you accomplish that? These types of questions are not necessarily new, but we feel that our approach to answering them has been somewhat piecemeal, because it has not been sufficiently cognizant of varying spatial scales at which the biophysical and social aspects of wildfire and its management play out in fire-prone landscapes.

Current Challenges in Evaluating and Mitigating Wildfire Risk

Current US wildfire policy focuses technical and financial assistance for risk mitigation on areas subject to high wildfire potential, largely through the Community Wildfire Protection Planning process. Current Community Wildfire Protection Planning boundaries tend to feature a wide-ranging assortment of administrative and political boundaries often unrelated to the scale of wildfire risk transmission to communities and often unrelated as well to social factors relevant to the mitigation of wildfire risk. We argue that current efforts to evaluate risk from biophysical and social perspectives tend to be disconnected in planning processes because of mismatch between both the temporal and spatial scales at which biophysical and social processes operate. For example, large wildfires can range over extensive areas, influenced by forest conditions that are often quite distant from affected communities, while both forest management decisions and community-level mitigation planning often may occur at more local spatial scales. Scale mismatches can inhibit identifying both those locations most likely to contribute to the creation and transmission of high levels of wildfire risk, and those locations where property owners and land managers are more or less likely to mitigate risk.

Specifically, we feel that these scale mismatches can lead to four problems: (1) landowners, land managers, and communities potentially are not aware of the most likely sources of wildfire risk, thereby affecting their risk perceptions and responses; (2) social networks may form without key ties among landowners and managers that share risk; (3) communities can become maladapted by emphasizing wildfire response (e.g., suppression) at the expense of creating fire resilient landscapes and fire-adapted communities; and (4) planning boundaries can leave relevant landowners and public land managers out of the planning process. We think that by framing wildfire management as a problem involving coupled human and natural systems, we can begin to explore whether there are more effective ways to organize our collective social response to the biophysical aspects of wildfire.

A Biophysical-Social Approach to Identifying Risk Mitigation Opportunities

To address these problems, we propose that any strategy for addressing wildfire must include biophysical assessment of wildfire risk transmission in combination with assessment of the social capacity for risk mitigation effort on the part of private landowners, public land managers, and local officials (Figure 2). Both are necessary for both defining the appropriate biophysical and social scale at which to conduct wildfire protection planning and defining the most effective strategies for addressing wildfire risk. Such a fireshed approach would define on the biophysical side, where the major sources of wildfire risk are and the routes by which risk is transmitted across the landscape to vulnerable communities. It would also characterize where and how likely particular actors on the landscape are to take mitigation actions. In this way, such assessments would identify comparative advantages regarding where to target particular types of mitigation effort, whether its fuel reduction, incentives provided to particular actors, or other measures.

Addressing first the biophysical side of the process—wildfire simulation capabilities have advanced to where it is now possible to generate maps of large fire risk transmission among landowners and affecting individual communities (Ager et al. 2014). Tracking repeated simulations of wildfire ignitions and perimeters allows analysts to define both the most likely sources of wildfire and the most likely affected areas. Simulated wildfire ignitions and perimeters can then be combined with landowner and wildland-urban interface boundaries to determine the potential landscape and community impact of specific ignition locations. The result is a mapped “fireshed” which delineates the relevant wildfire mitigation planning area for a given locality (Ager et al. 2015). In many cases, we suspect that relevant firesheds affecting communities will be different than current Community Wildfire Protection Planning areas. Use of a fireshed approach to wildfire management thus helps to ensure that planning areas include those portions of the landscape most relevant to risk transmission and those landscape actors who are potentially most relevant to any risk mitigation strategy.

Taking biophysical assessment process a step further, applications of social network analysis (e.g., Fischer et al. 2013) of wildfire risk transmission maps are beginning to enable analysts to characterize the risk transmission network among landowners, administrative actors, and even specific landforms and ecological conditions (Ager et al. 2014). Such analysis can reveal the degree to which various landowners, management agencies, and communities are linked to each other through the transmission of wildfire risk of varying levels. Such methods are useful for identifying, from a biophysical perspective, those landscape actors whose engagement in wildfire risk mitigation planning is most vital.

Shifting to the social side of the assessment process, recent research is showing that it may be possible to anticipate wildfire risk mitigation effort by private landowners and homeowners, based on both social and biophysical factors. Fischer et al. (2014), for example, suggest that nonindustrial private landowners are influenced in both their wildfire risk perceptions and their mitigation behavior by a combination of biophysical and social factors. Biophysical factors include landowners' exposure to past wildfires, and the actual likelihood of future wildfires of varying intensities as determined by wildfire simulation models. Social factors include landowners' interactions with various agencies and organizations engaged in addressing the wildfire issue. Analysis of these factors can provide ways to predict which landowners are most likely to contribute to landscape-level risk mitigation efforts and which landowners may need additional incentives to do so. Such assessments also can indicate how likely particular landowners are to be influenced by contact with specific agencies and organizations involved in wildfire risk mitigation, potentially informing outreach efforts to encourage greater mitigation effort (Fischer et al. 2014).

Lastly, increasing use of social network analysis can be useful for identifying connections among private landowners and public land managers, and agencies and organizations involved in wildfire risk mitigation (Fischer et al. 2013). Initially, such analysis can be helpful for simply identifying which agencies, organizations, and landscape actors are collaborating with others. It also can be used to identify how information and influence move among agencies, organizations, and landscape actors. If combined with biophysical network analysis, such analysis potentially can reveal mitigation opportunities not evident from individual analyses of the separate systems. For example, comparing wildfire risk and social networks could reveal differences among communities in terms of sources of risk and also mitigation potential as indicated by composition of the ties among landscape actors within the social fire network. Conceivably, such analysis could reveal evidence of a biophysical transmission of risk from one actor group to another, but no apparent comparable connections within social networks by which those actors are collaborating to address their shared risk. A need thus would be identified for strengthen social ties between such actors to improve collaborative efforts to mitigate risk.

Conclusions and Policy Implications

We feel that a coupled biophysical-social approach to managing wildfire potentially could provide an improved method for defining the spatial extent of wildfire risk to communities compared to current planning processes, by creating an explicit role for social science to improve understanding of community-wide risk perceptions and collaborative efforts to mitigate risk, as well as predict landowners' capacities and willingness to mitigate risk by treating hazardous fuels and conducting Firewise activities, among other actions. This biophysical-social approach would enable identifying potential comparative advantages in the location of risk mitigation effort, whether on public or private lands, according to both the degree to which specific locations contribute to the transmission of wildfire risk and how likely specific landowners and public land managers are to contribute to risk mitigation efforts.

Specifically, we propose that wildfire biophysical analysis, including wildfire simulations, be used to characterize wildfire risk transmission, in combination with social science to characterize landscape actors and their potential to mitigate risk. We suggest that mitigation opportunities exist where high wildfire risk transmission coincides with high potential for mitigation effort. Additionally, locations characterized by high wildfire risk transmission and low mitigation potential identify locations and specific landscape actors who may need policy intervention, whether it is education and technical assistance, or financial assistance, to encourage greater awareness and mitigation effort.

We acknowledge the potential challenges in implementing new biophysical and social analyses within community scale planning processes. However, landscape-level wildfire simulation and risk modeling already are increasingly being applied in the US. Risk transmission and network analysis methods also are well-developed. However, greater investment in social science likely is needed to develop practical methods for conducting social assessments, including social network analysis and analysis of landscape actors and their potential to mitigate risk. Together, such investments could help to foster the application of both biophysical and social science to the management of wildfire risk in fire-prone landscapes.

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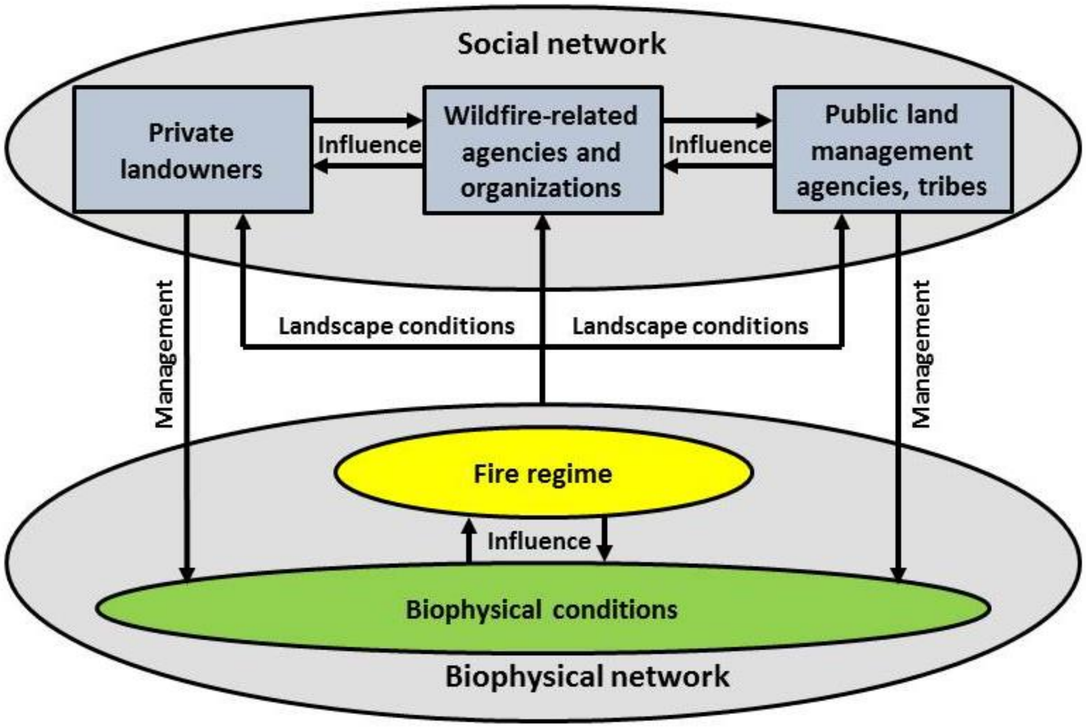

Figure 1. Biophysical-social conceptual framework describing firesheds

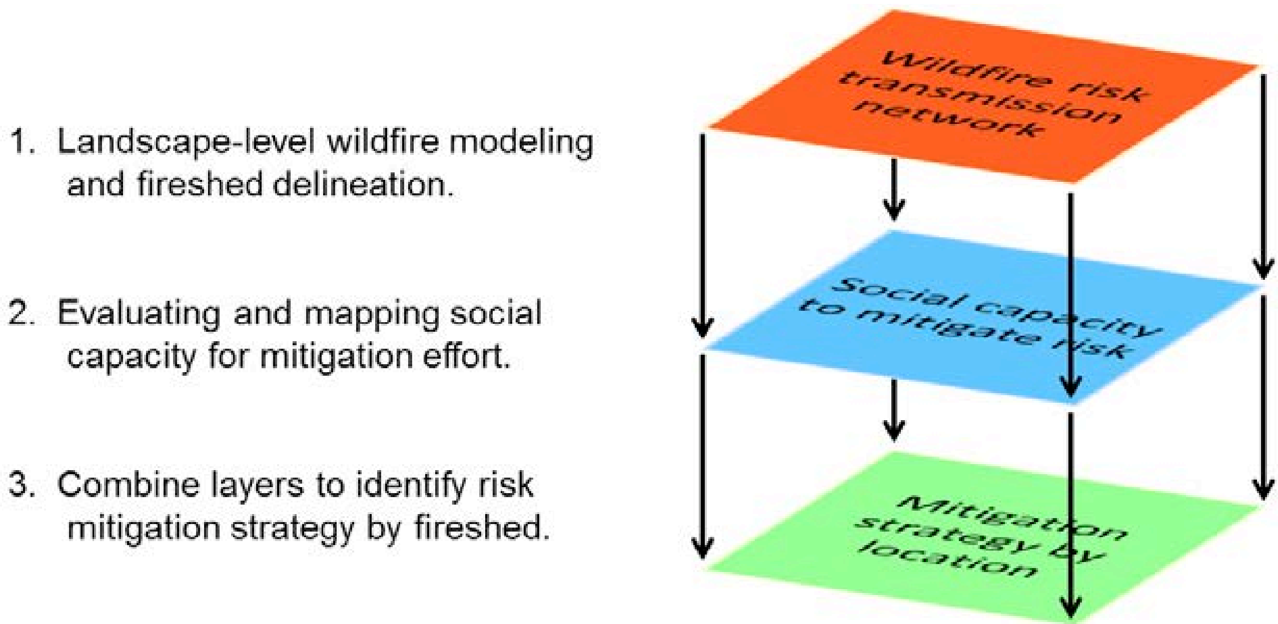

Figure 2. Biophysical-social fireshed assessment process

Wildfire risk management in Europe: the challenge of seeing the "forest" and not just the "trees"

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Abstract:

In Europe, the fire suppression policy (*command and control chain approach*) even though it has been able, for the time being, to stop the increase in annually burned area, it has not addressed the diversity and complexity of fire causes and to prevent the appearance of extreme fire events that result in major disasters.

Signs of the necessary change are already going on but they still focus on "*trees*" (the discrete factors) and not on the "*forest*" (the entire socio-ecological system), i.e. not following a holistic perspective of problem solving. Human activities in earth's systems make wildfires inherently and dialectically tied to social systems, thus the challenge of sustainable solutions to most fire-related problems is impossible without understanding the links and interdependencies between humans and ecosystems. As an answer to this challenge we propose the concept of *Fire Smart Territory* (FST). Territory and not landscape is its target. The purpose of this paper is to formalize and present a detailed conceptualization of FST which reframes the relationship between society and territory, with the aim to reduce fire incidence by making of a wise and knowledgeable fire use a broad, allowed and accepted practice, and not just by putting fire out of law.

Additional Keywords: Coupled Human-Natural System, European Union, Fire Smart Territory, prevention, mitigation, risk management, suppression model

Wildfires: an unsolved problem in Europe

In Europe [this paper only refers to the 28 countries constituting the European Union (EU28)], in the post II WW era, very significant socioeconomic changes have taken place in the rural world. A rural population exodus towards the large cities and the building of an urban society with new lifestyles have gradually established new relationships of the people with the forest and wild lands, so contributing, among others, to create hazardous fire environments, where the former minute mosaic of agricultural lands, grazed lands and forest patches has been often replaced by highly connected, continuous, less intensively used, and flammable wildland (Mateus and Fernandes 2014).

In EU28 about 50,000 to 65,000 wildfires occur every year, burning, on average, around 0.5Mha of land (EC 2011; Moreno *et al.* 2013). Approximately 85% of the total burnt area occurs in the EU28 Southern Member States (EU-Med, i.e. France, Greece, Italy, Portugal, and Spain) (San-Miguel-Ayanz and Camia 2010; Vilar *et al.* 2014). The number of fires and burned surface follows a North-South and East-West gradient (Tedim *et al.* 2014a). A discontinuous urban sprawl within EU-Med forests and wild lands, along the coastlines or close to metropolitan areas (Xanthopoulos *et al.* 2012), and the abandonment of agriculture lands which are close to forests and wildland led to the formation of large wildland–urban interface (WUI) (Moreno 2014) and rural urban interface (RUI) areas (Xanthopoulos 2013), where people and high-value properties are placed in proximity to highly flammable areas. Lack of awareness of the high fire risk which is common in WUI areas, leads to careless use of fire (Mateus and Fernandes 2014) creating diffuse sources of ignitions; such fire-prone wild lands are expected to become even more flammable in the years ahead (Moriondo *et al.* 2006; Camia *et al.* 2008; Lavalle *et al.* 2009; Goldammer and Stocks 2011; IPCC 2012).

In EU28, natural causes of wildland fires, mainly lightning, represent less than 4%. The anthropogenic causes of wildfires, on the contrary, are numerous and complex, differing among countries and at regional scale. With the exception of Spain, Italy and Poland, where deliberate fires are the most representative cause, in all the other countries, wildfires start by accident, negligent actions, or risky behaviors. The most common cause is ‘‘agricultural practices’’, followed by ‘‘negligence’’ and ‘‘arson’’ although there are differences among EU28 countries (Vilar Del Hoyo *et al.* 2009; Tedim *et al.* 2014a,b). Since the late Stone Age (2,500 BP) fire was used to clear the land and improve the quality of grazing, to flush out wildlife and to improve wildlife habitats (the domestication of fire). The use of fire as a tool for land management is thus embedded in the Traditional Ecologic Knowledge (TEK) (Ribet 2002; Huffman 2013) of European rural communities, but it has been handled and almost criminalized by an urban centric perspective and an anti-fire bias.

The current policy of fire suppression based on more firefighters, more airplanes, stricter rules, and stronger tactics (Blasi *et al.* 2004; Moreira *et al.* 2011; Fernandes 2010 and 2013; Mateus and Fernandes 2014; Huffman 2014; Corona *et al.* 2015) can appear successful since it is likely to reduce damages in the short-term (Collins *et al.* 2013). However, without addressing the roots of the increasing wildfire potential, the problem remains unresolved. After decades of such fire suppression policies based on the Fight, Control, Exclude principle (command and control chain model; Holling and Meffe 1996) and on very restrictive legal frameworks of fire use, aimed at containing the increasing fire occurrence, it is recognized that the problem of wildfires is far from being solved. The five Southern EU Member States invest more than 2.5 billion € per year in prevention and suppression, 60 % of which is allocated to equipment, personal and operations (Vélez Muñoz 2008), but the reinforcement of suppression capacity (i.e. firefighting tactics, resources, and equipment, and changes in the fire management organizations) did not prevent an increasing number of fires.

Fire management unbalanced approach in EU28, focused on putting out fires or merely increasing the technical capacity to put out fires, is less effective than it could be (FAO 2011) and its main shortcomings are: *(i)* the lack of a strategic approach of problem solving, with the consequences of short-term fixing of problems, or merely of suppression of their symptoms, rather than understanding and addressing the underlying factors that cause the problems; *(ii)* the top-down suppression approach, that is realized without concertation with local communities; *(iii)* the lack of any provision for the long run, the inexistence of reference to the cost, and the unawareness of environmental constraints (Xanthopoulos 2007); *(iv)* nurturing the public opinion with the catastrophist approach (Clément 2005) that all fires are bad, that they are an evil to be fought, controlled, excluded; this vilifies the opportunity to re-consider the wisdom-based customary uses of fire in agricultural, livestock, forestry and other livelihood activities (Laris and Wardell 2006; FAO 2011) and bans or makes difficult the use of fire (under the form of *prescribed fire, suppression fires*) as a management tool (Leone *et al.* 1999; Ascoli and Bovio 2013; Corona *et al.* 2015). This rooted anti-fire sentiment is based on the criminalization of fire use and on the postulate of a fragile and threatened Mediterranean forest (Clément 2005): "*…forestry had demonized fire and the Mediterranean alliance between fire and herds, particularly goats*" (Pyne 2000: p.112); and *(v)* the incapacity to master the dynamic characteristics of fire environment emphasized by local (e.g. changes in forestry and agricultural production systems, WUI expansion) and global changes (e.g. climate change) (Tedim *et al.* 2014b).

The fire extinction paradox or *firefighting trap* (Collins *et al.* 2013) is the result of the view that fires are a suppression challenge rather than a symptom underlying management problems (FAO 2011) or social problems. Focusing on fire suppression for fixing problems diverts attention from preventing them, and thus leads to inferior outcomes (Collins *et al.* 2013). The fire exclusion model is a social construct (Pyne 2007) influenced by media, resulting in expenditures on high-tech firefighting solutions, which emotionally and psychologically resonate with public opinion (Collins *et al.* 2013). Politics also exert influence, since investments in preventative initiatives (e.g. fuel management) lack immediate, visible short-term benefits. This makes them less attractive to both the public and policymakers with short terms of office, since the result of coping with the problem can never be attributed to their initiatives (Collins *et al.* 2013). Preventive actions are less visible than suppression equipment (mainly aerial resources), so they receive less political attention and, subsequently, are assigned fewer resources (FAO 2008). Fire exclusion policies can succeed on the short-term, but they may not be sustainable in the long run, as the combination of fuel accumulation and severe weather can overwhelm the suppression capacity, fostering larger and more severe fires (Collins *et al.* 2013; Mateus and Fernandes 2014).

Many problems originate from this policy: for instance, fire-fighting services are often not directly integrated with prevention; consequently, in many cases, the problem is left unsolved and feedbacks on itself. The pressure on firefighters fostered in periods of maximum fire frequency to extinguish fires and quickly move on to new ones (the dual-duty problem; Pacheco *et al.* 2012) may result in insufficient mop-up, and consequently in repeated rekindles.

The challenge

The pervasive reach of human activities and interests in earth's systems, makes wildfires inherently and dialectically tied to social systems (Coughlan 2015, pers. comm.). As a consequence, the socially constructed fire risk can be solved only by social means (Pyne 2007). Society needs to learn to co-exist with wildfire in a sustainable way, which is only possible through an integrated socio-ecological approach (Birot 2009; Moritz *et al.* 2014; Paton *et al.* 2014a,b).

Signs of the necessary change in European wildfire policies are already going on, but they still focus on *trees* (the intervention on single, discrete factors of the wildfire phenomenon, independently adopting an ecological or a social approach) and not on the *forest* [the coupled human-natural system (CHNS or CHANS) where people interact with natural components (Liu *et al.* 2007) and wildfires are produced and occur]. This demands a better knowledge of the complex interdependencies between fire, landscape, climate, communities and societies (Berkes and Folke 1998; Liu *et al.* 2007; Spies *et al.* 2014) which are critical to develop integrated and efficient strategies and measures to contain the possibility that fire will become a detrimental disturbance or hazard. This perspective is crucial in Europe, where the small size of scale, the high population density, the presence of historical, diffuse heritage landscapes, the high density of conservation areas and habitats of community interest and the relatively reduced extent of forests must co-exist with new trends in timber production, agricultural changes and intensity of agricultural reclamation (Pyne 2000), settling, lifestyle, and recreation demand, that play complementary roles in the development and thus the management of wildfire risk. In this very fine pattern fire is only perceived as a factor of negative impact, hardly being considered in its beneficial ecological role (Bowman *et al.* 2011).

Our aim was to identify a possible and feasible model of wildfire risk management, geographically coherent with the wildfire/society problems, in order to cope with the compounding wildfire problem. We developed a theoretical model called *Fire Smart Territory* (FST) which is at the same time an operational framework. It supports a comprehensive conceptualization of innovative, nature and social based solutions at a territory level. Its main pillar is involving local communities as a crucial factor to prevent and control destructive wildfires (FAO 2004). FST is an effort to integrate the different physical, biological, social, and cultural paradigms (Pyne 2007) in an updated knowledge of wildfire trends and patterns, and moreover it is a possible response to the more balanced approach between prevention and suppression (Collins *et al.* 2013). The purpose of this paper is to formalize and present a detailed conceptualization of FST and its operational framework.

The change of perspective: "See the forest behind the trees"

The metaphor in the title well depicts the fact that protection programs against wildfires still today attempt to manage the frequency and severity of fires by exclusively focusing on fire suppression activities and by promoting a model of rapid and strong reaction on every fire start (a tree) rather than a holistic approach in which all components of the complex problem are considered (the forest; Taylor 1997; Moran and Ostrom 2005). It is therefore an asymmetric approach symptomatically acting, i.e. only on the effects of the problem and not etiologically, i.e. on the root of its causes. Fig.1 explores the complex relationships established in the scope of CNHS which stay behind fire occurrence, and which justify the attention to the reality before fire appearance, on which it is possible to successfully act.

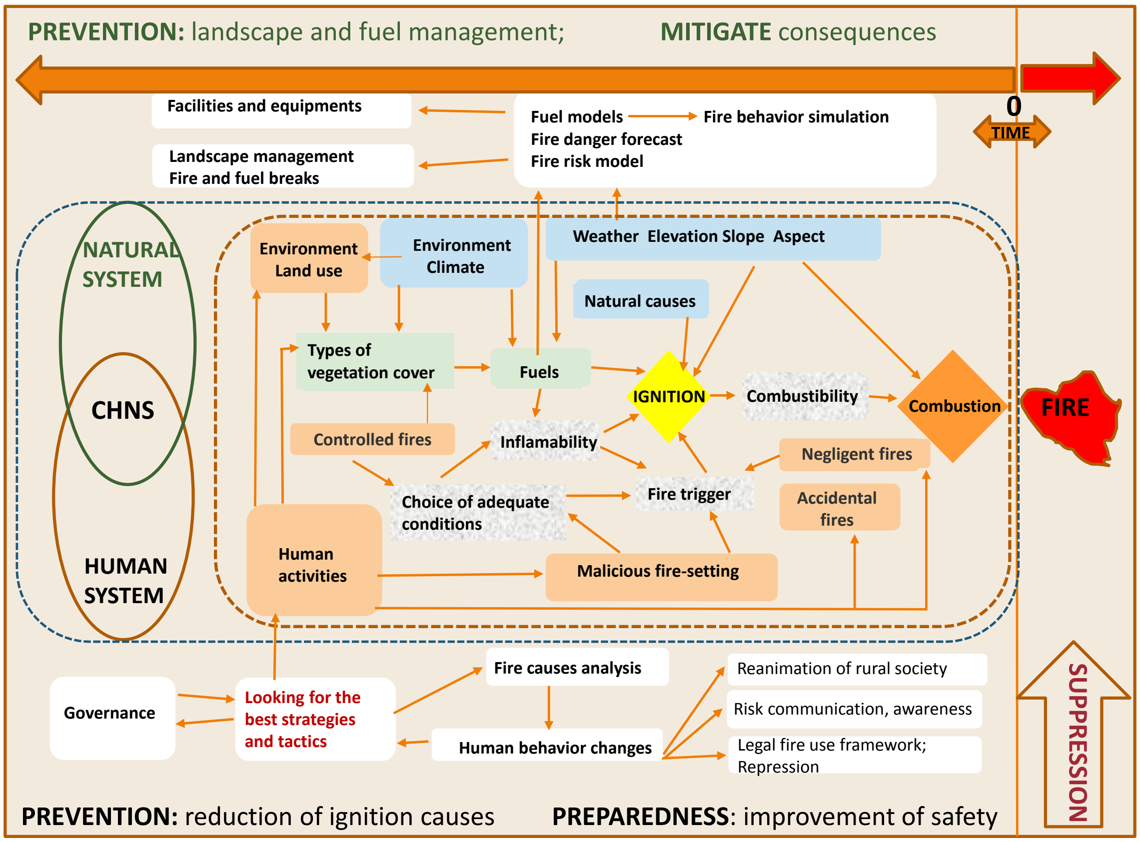

Fig. 1. The metaphoric "forest". The image picks the components of CHNS (Adapted and modified from Leone *et al.* 2000)

Our arguments for a change of perspective are: *(i)* Fire is a dual and ambiguous process. Depending on the context, it can be a source of destruction, *"a conservation threat, a natural and even necessary ecological process, and an irreplaceable, life-sustaining tool for rural communities*" (The Nature Conservancy 2015: p.1). The challenge is to sustain the beneficial aspects of fire and reduce their negative impacts through understanding the roles of fire in natural and anthropic systems, focusing on sustainable development; *(ii)* Fire has an ecological role. It is crucial for the functioning of many ecosystems and for nature conservation (Myers 2006). It promotes regeneration, sustaining biodiversity and ecosystem services: it fosters nutrient input into soil, recycling of organic material, control of insect pests, control of tree pathogens, maintaining species diversity. The challenge is to base all management activities on sound knowledge or inferred knowledge on the role of fire in each particular ecosystem; *(iii)* Fire is a social issue. Human activity plays a significant role in determining the fire regime worldwide because fire is not merely a biophysical process, but a social process as well (Coughlan and Petty 2012), culturally framed and transmitted, and it continues to undergo rapid changes (Pyne 2000). "*Humans cannot completely control the fires they set, nor always limit the spread of fires caused by natural ignitions*" (Bowman *et al.* 2011: p.2225) but they can reduce fires intensity and severity. The challenge is to accommodate "*political tensions amongst groups with competing models of fire management*" (Bowman *et al.* 2011: p.2225) and, mainly, to identify the relationships communities have with fire before any management project; and *(iv)* Wildfire is a complex issue. It cannot be solved adopting an "*ecological or social research alone*" (Liu *et al.* 2007: p.1513) or by policy panaceas (Ostrom 2007) or by implementing them without considering the environmental and social context. The challenge is to design programs and projects of fire management adopting an integrative and holistic approach, based on the concept of CHNS (Liu *et al.* 2007; Spies *et al.* 2014).

The development of FST concept is based on the CHNS and the disaster risk reduction approaches. In CHNS the two systems have been co-evolving together. Fire was surely one of the tools used by the people for covering their livelihood needs and in this context helped to shape the environment. The crucial point is that fire often was, and still is, a natural response to problem solving when technology is very low or non-existent to eliminate vegetation residuals, to abate phytopathologies, to reduce pathologies of animals, to clear forested areas. So it is a natural resource for the local communities. In the current scenario of fire management in Europe, commonly there is no distinction between the beneficial use of fire, and an unwanted fire. Thus, fire, seen through an external inadvertent perspective, is viewed only as a problem or a menace. The communities' beliefs, needs and experiences must be studied and used in order to change the current fire scenario, rather than resorting to the implementation of technological and sophisticated apparatus which have no link with the social system in which fire permits to solve needs and difficulties of livelihoods (Myers 2007). Fire in the Mediterranean is "*an unavoidable cultural and ecological phenomenon, but an avoidable catastrophe*" (FAO 2008: p.3) and the current fire-suppression policy should be turned into a 360°view fire management approach (Moreira *et al.* 2011; Mateus and Fernandes 2014; Corona *et al.* 2015; Huffman 2014), by integrating science and fire management (Gaylor 1974; Alexander 2000; Myers 2006, 2007) with socio-economic needs (Silva *et al.* 2010; FAO 2011). The reduction of the environmental and socio-economical impacts of wildfires (Birot 2009) requires wildfire risk policies acting on the ignition causes, hazard and vulnerability (i.e. exposure, susceptibility or fragility, coping capacity) (Tedim *et al.* 2014c).

Our proposal: *The Fire Smart Territory*

Several frameworks have been developed to reduce fire impacts, following three main approaches: *(i)* Emphasize the wise use of fire as a tool. An approach to addressing the problems and issues posed by both damaging and beneficial fires within the context of the natural environments and socio-economic systems in which they occur is the *Integrated Fire Management* (The Nature Conservancy, 2015). Its purpose is "*to reduce the threats posed by fire to both people's livelihoods and to biodiversity while at the same time recognizing and maintaining fire's important role in many ecosystems and economies*" (Myers, 2006: p.24); *(ii)*

Acting on fire dynamics. An interesting approach is the *fire smart management of forest* (Hirsch *et al.* 2001; Fernandes 2013) defined as the opportunity to use forest activities to modify the forest fuels for fire reduction. It consists of strategically located, landscape-level fuel treatments or compartmentation creating a reduced fire spread potential in significant locations, so limiting fireline intensity. It is conceptually similar to ships' bulkheads (Loehle 2004) or to installing fire doors in a building to reduce fire spreading between compartments (Hirsch *et al.* 2001); and *(iii)* and Acting on reducing vulnerability and assets damages. Several frameworks have been developing in order to reduce vulnerability and assets damages inspired by the *FireSmart* concept of living with and managing for wildfire. A *Fire wise community* includes minimizing the risk of home ignition by carefully landscaping around residential structures, such as thinning trees and brush and choosing fire-resistant plants, selecting ignition-resistant building materials and positioning structures away from slopes. A *Fire adapted community* accepts fire as part of the natural landscape, understanding its fire risk, and taking action to minimize harm to residents, homes, businesses, parks, utilities, and other community assets. *Community Based Fire Management* (CBFiM) is a participatory approach of land and forest management in which a local community has substantial involvement in deciding the objectives and practices in preventing, controlling and utilizing fires (Ganz *et al.* 2003; Mukhopadhyay 2007; FAO 2013). It is inspired by the concept that since people cause most of the fires, it is logical to involve the population in relevant policy development and fire management practices (FAO 2011).

The described frameworks, acting at landscape level, do not cover completely or minimize the concept of CHNS. Although inspired and under the umbrella of the *FireSmart* concept, they cover "patchy" portions of territory since their space of reference is limited to single assets or a community and the immediately surrounding wilderness, or a forest. They represent valuable self- (but also selfish, we observe) protection initiatives, which are oriented to protect one's assets and to promote people and goods safety and surrounding landscape, without regarding the rest of the territory, but they are not directed to diminish unwanted fires.

Such concepts cannot be transported and implemented in Europe, also due to the strong difference in social behaviors, cohesion, individualism or lack of collective feelings of belonging, which characterize the majority of our European countries. Other constraints stay on the differences in vulnerability perception by the communities. The main constraint is the long and established culture of fire use which characterizes European countries.

In order to go over those constraints we propose the FST model, which focuses not on landscape but on the territory. These two concepts are not synonyms. Landscape is an area as perceived by people, resulting from the interaction of natural and/or human factors (Council of Europe 2000). Landscape is not a tangible reality but its picture (Raffestin 2015). On the contrary, territory is a socially appropriated space closely "*interconnected with society on different spatial, temporal and social scales*" (Raffestin 1980: p.133), conceived as a relational, socially produced reality, or the dynamic reflection of communities in the geographical space (Sack 1986; Elden 2010; Raffestin 2015).

We define FST as *a fire prone territory in which the integration of economic and social activities aimed at risk reduction and conservation on natural values and ecosystem services is accomplished by aware and well trained empowered communities able to decide the objectives and practices for preventing, controlling or utilizing fires*.

Communities will determine for themselves what they need to do, depending on the level of risk they are in (e.g. due to fuels, topography, road network), their sources of livelihood (e.g. agriculture, animal herding, tourism, agro-tourism) that may guide them to select different options. The achievement of objectives so remains in the hands of the communities, implying a shift from a top-down to a more collaborative, process-oriented form of decision-making (Greiving *et al.* 2012) and the creation of more resilient communities (Sapountzaki *et al.* 2011). FST is not only a management process but also an outcome expressed by performance indicators of reduced occurrence of unwanted wildfires and of the negative ecological, social and economic impacts of fire.

FST supports on the CHNS complex interaction developed at different scales, and has five main structural components: landscape management, livelihoods and lifestyles, collaborative work and awareness, traditional and scientific knowledge, and empowerment and governance (Fig. 2). It promotes wildfire reduction through the "*wildfire chain*" concept, based on a systemic approach of the interactions and synergies between all the phases of the fire process (pre-fire; ignition; fire spread; fire suppression; fire severity; post-fire recovery) which guide the strategies and tactics in an integrated view of prevention, mitigation, preparedness, suppression and recovery.

The implementation of FST is not easy, mainly from the social side. One of the negative outcomes of the top-down suppression model is that it creates a sort of dependency, where small space is left to citizen's autonomous initiatives of management and protection of their space of life. Suppression technology may also create a false sense of safety, thus influencing the pre-fire mitigation or fire saving measures undertaken by communities and individuals (Cohn *et al.* 2008). On the other side, solutions imposed by distant entities tend to engender resistance or

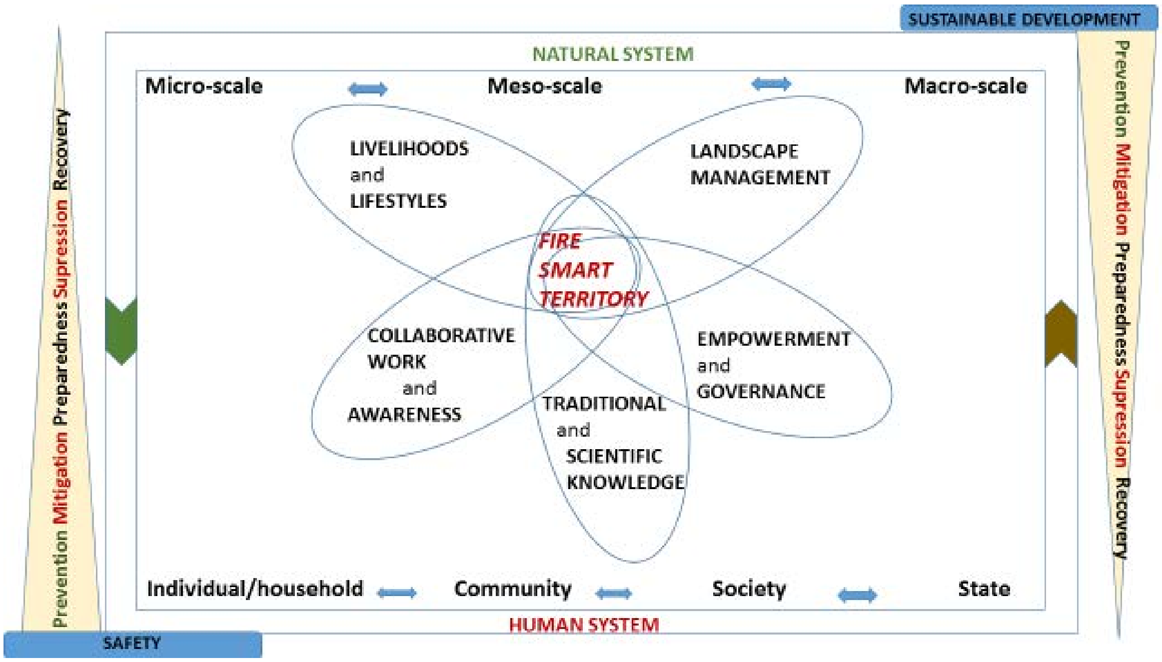

Fig. 2. FST concept, components and scales

(even worse) passivity by local stakeholders (Paveglio *et al.* 2009). Even in fire-prone areas there is a tenuous link between understanding risk and taking personal action to mitigate it (Moritz *et al.* 2014). The conviction is rather diffuse that, as for natural hazards, wildfires must be tackled by the State, and that emergency services (Civil Protection, Foresters) will protect from wildfire (Mercer and Zipperer 2012). The growing number of citizens who settle in highly wildfire-prone areas and often develop high-value properties, does not necessarily translate into more actions towards fire safety, even when they are aware that they live in a hazardous area (Moritz *et al.* 2014). More commonly, however, the residents are unaware of the risks they are facing, and they may have hazardous behavior or not have the suitable behavior to cope with disasters (Raffalli *et al.* 2003; Bouisset 2011; Bouisset and Degrémont 2013). They expect protection and response in case of a fire event, and are unlikely to blame themselves for failing to undertake adequate preventive measures, which are often considered unnecessary or invasive on their private landscape. Living in hazardous places with relative imprudence is often accompanied with a dangerous risk dampening (Cohn *et al.* 2008), in the sense of assigning scarce probability to the repetition of hazardous events or even by denying that it is likely to happen in one's lifetime, or by discounting its potential impacts (Gill *et al.* 2013). A blaming behavior is also frequent, i.e. a tendency to find a human agent to blame or hold responsible after the experience of a severely disruptive event. Self-protection measures request investing monetary resources so they always tend to be applied spottily and patchily, with the inevitable result of scarcely influencing the propagation of fire in space.

All this makes clear the wide action of awareness raising which must accompany the creation of FST, through the development of knowledge, competencies and skills necessary to enable changes in people attitudes, beliefs and behaviors towards forest fire prevention in order to promote resilient societies and environments. This can be obtained by empowering people and communities rather than imposing solutions upon them as well as constructing trust (Paton 2008).

Such action is made difficult by the fact that human communities strongly differ from each other and, in European countries, are far from the myth of cohesive communities with residents who know each other, work together, or communicate (Paveglio *et al.* 2009). Probably, the most limiting feature is the loss of solidarity which in the past was a main resource of communities in the rural context.

Our proposal considers all the territory including forests, wildland, agricultural lands and all the humans collectively living there, thus it relies on communities and on their connate capacity of management and modifications of landscape connectivity at a wider scale. This takes advantage of the residual capabilities, if any, of rural peoples to manipulate fire in a knowledgeable way but demands reducing the anti-fire bias which characterizes our conflictive relationship with fire, and thus hampers relying on it as a beneficial and economic tool. If these capabilities have already been eroded it is fundamental to build them.

FST tries to reframe the relationship between society and territory, and to reduce wildfire incidence by recuperating the fire use wisdom and making of a wise and knowledgeable fire use a broad, allowed and accepted practice, and not by putting fire out of law. The ultimate goal is minimizing risk, given the difficulty to eliminate the phenomenon (Gill *et al.* 2013). If this is true, minimization must be applied to the whole territory, not on selected or privileged portions of it.

People still possessing a residual TEK must be considered for teaching and disseminating it, also integrating them in firefighting crews: in case of extreme fires, the involvement of people knowledgeable in the use of fire will facilitate application of *suppression fire* (Rego *et al.* 2010; Silva *et al.* 2010) which is the only way for improving the probabilities of mastering the event. Since fuel reduction may increase the chances of suppressing large fires or at least reduce their intensity in adverse weather conditions (Williams 2013; Regos *et al.* 2014), FST can play an important role to reduce, by a multiplicity of tools and coordinated interventions, at territory level, the fuel hazard at a point where the firefighting mechanism will more easily intervene and will be more effective in wildfire control (Regos *et al.* 2014).

We imagine simple nature and social based solutions, in which the ancient fire wisdom recovers a role and the dignity of resource, and a tool to improve livelihood and support lifestyles. Its use is imagined in the frame of a general planning which covers high fire risk territories and aimed to abate fire activity through fuels reduction, mainly 1H and 10H fuels, which are the easy fire propagators. This consists in a planned and coordinated action of fuel management by a prepared and aware social body. Fuel management must be a blanket action, not a spotty or locally adopted one. Its emphasis should be on the use of the vegetation and the fuels. When this extensive fuel management proves difficult (e.g. due to high cost, reduced population and lack of working hands), planning should identify fire risk hot-spots and guide towards the development of gaps in the horizontal continuity, such as fuel-breaks. Animal grazing and understory prescribed burning are ways for maintaining effective fuel breaks (Xanthopoulos *et al.* 2006). This approach of fuel removal reconstructs the patch-mosaic of locally reduced fuels, so lowering the potential for large, destructive, uncontrolled events and creating edges that increase ecosystem biodiversity and foster its resilience and sustainability (White and Pickett 1985; Laris 2002). The professional use of fire must be entrusted to rural populations, avoiding to them to be passive spectators of costly and often choreographic top-down suppression interventions. This is an example of the possible social based solutions, aimed at recuperating their know-how and to give a new dignity to suppression fires, as it was common in the past, when fire control was not existent and fire containment was carried out by countrymen with simple tools. This could be a shift from the permanent condition of criminalized practice in which the urban-centric perspective confined fire use. It means to understand the use of fire but first of all to consider the traditional knowledge as a resource.

In operational terms we propose to intervene on all the territory: *(i)* in the forest through silvicultural tending and the sustainable use of harvested biomass for energy; *(ii)* applying prescribed burning to locally reduce hazardous fuels or for other forest management purposes, in synergy with grazing; *(iii)* linking already occurred unplanned fires, where fire cannot further be fueled, with patches in the landscape pattern where agricultural uses of fire is traditionally planned and adopted, such as straw and residues burning, pasture regeneration with fire, shrubs elimination (Mateus and Fernandes 2014), and areas where plowing temporarily will eliminate fuels; *(iv)* use of grazing as integrative tool to reduce fire hazard; and *(v)* avoiding blanket forestry cover for industrial purposes.

This means to uniformly abate fire hazard, by a series of obstacles to fire spread represented by repeated local fuel reduction initiatives interwoven in the mosaic of land-use classes. Our model encompasses not only forested patches and wildland areas, but also agricultural lands, which often represent the broader matrix inside which forest is present, and where cured vegetation in summer can easily fuel running fires. Such lands are considered less at risk and even the current term "*forest fires*" partly supports this opinion, suggesting a sort of fire selectivity or preference toward forested areas. This is not new (Cohen *et al.* 2007) and could partly explain the reluctance to adopt mitigation measures in non-forested areas, such as WUI, with the result that the majority of space remains untreated and can fuel rapid wildfire spread and intensity.

The management we propose couples a fire use policy with extensive fuel modification, aimed to produce a fuel mosaic "*putatively capable of preventing large wildfires*" (Keeley and Zedler 2009: p.70). Fuel treatments are a barrier to fire spread and provide access and anchor points for firefighting activities, also contributing to reduced flame lengths and providing defensible space around urban development (Keeley and Ziedler 2009). This pattern fits the patch-mosaic theory, reducing potential for a large, destructive, uncontrolled event and creating edges that tend to increase ecosystem biodiversity and foster its resilience (White and Pickett 1985; Laris 2002). Applying the percolation theory a treatment with a leverage (how many additional hectares a single hectare with fuel treatment can influence) as little as 30% of the landscape if done randomly (it could be much lower, about 18%), limits fire spread and would result in a fire tolerant landscape (Loehle 2004; Scasta 2013); patch-burn grazing could be therefore adopted as an integrated fuel reduction and fire spread prevention strategy (Kerby *et al.* 2007); once a patch burned, it is a temporary barrier to fire spread for a time span, due to insufficient fuels (Keeley and Zedler 2009). This does not mean excluding wildfires presence, which is not achievable (Gill *et al.* 2013), but to reasonably abate their intensity and to avoid the possibility they get giant sizes (Loehle 2004) and high severity.

The operational implementation of FST passes through the identification of proper spatial and temporal variability and distribution of the single patches, of their size, of their leverage. The identification of surfaces to be treated can be made through the hazard assessment (Chuvieco and Congalton 1989; Vicente-Serrano *et al.* 2000).

Conclusion

The FST concept does not deny neither substitutes the suppression based approach, but it aims to integrate it with strategically planned prevention, mitigation and preparedness activities valorizing its synergies, i.e. considering suppression as a component of the wildfire chain. Its expected role is not avoiding wildfire presence, but minimizing at best its consequences.

Protection against wildfires thus shifts from the self-protection of single assets, or communities, or forest massifs to the totality of living space, with an obvious scale economy but above all, with equal opportunity of protection for all the involved community there present.

This means to overcome the short-sighted and inefficient perspective of the elimination of the consequences of the problem by the necessary holistic perspective of acting on all the components of the CHNS in which wildfires occur, in the effort of acting on the very roots of the problem itself, so reducing the number of unwanted fires. FST is aimed to create, by incorporating acts of fire management into the everyday activities and lives of communities, a diffuse situation of patterns of disconnected fuel treatment patches (Finney 2001) which makes difficult for fire to easily spread, and suppression intervention more easy and efficacious. The blanket effort to reduce fuel load on the landscape represents the only opportunity to minimize the occurrence of large and extreme fires. In the same time, a different approach in manipulating fire as a management tool rediscovers and enhances its role of ecologic factor, vilified by its criminalization. Not only this means a gain in terms of recuperating a common and diffuse wisdom, but a way to enhance the role of rural communities. Rediscovering their role could also reduce fire ignitions caused by bad land management and by risky behaviors, often induced by current fire criminalization. Many of the activities on which FST is based are traditional and recurrent in agriculture; FST only puts them in synergy with specific and strategically located activities of fuel reduction. In addition this is socially more acceptable because it refers to the whole territory and can use internal resources of communities.

The main problem in the implementation of FST concept is in terms of governance, since it means to overcome a diffuse and strong anti-fire-bias and to gradually pass from a passive expectation of institutional intervention in case of fire event to a situation where local communities are actors of bottom up initiatives in terms of prevention and fast suppression. It is the way to see the *forest* and not only the *trees.*

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Managing firefighter safety applying the ISO 31000:2009 Risk Management – Principles and Guidelines

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Abstract:
Presented is the application of the International Organization for Standardization, ISO 31000:2009 Risk Management – Principles and Guidelines for informing wildland fire, risk management decision making. This international standard provides a consistent framework for systematically defining the effects of uncertainty on organizational objectives. One of those objectives at the forefront of decision making is the health and safety of firefighters.

While managing risk in the wildland fire management business is seldom, if ever, managed to zero risk, assessing risk in this manner can improve upon the chances of achieving positive outcomes. It also provides a process for enhancing situational awareness and facilitating continuous improvement while providing explicit evidence of due diligence and standard of care. Embedded in the framework is a Monitoring and Reviewing cycle that tracks the changing risk environment and provides for a continuous improvement of an agency's risk management processes, systems and ultimately its risk management culture.

In 1996, Mike Johns, Assistant U.S. Attorney for the District of Arizona reported in Wildfire Magazine on the litigation following the 1990 Dude fire fatalities. "Fire managers would shudder at the legal arguments made in the Dude Fire litigation which demonstrates the great amount of discretion which the Standard Fire Orders and Watchouts permit. There is no objective standard against which to measure the risk against the propriety of the action."

Three things in particular resonate from this statement. The great decision making discretion that firefighters have. The measurement of risk against an objective standard (risk assessment). And the appropriateness of an action (control) in relationship to the measured risk.

In addition to the Standard Fire Orders and Watchouts there is a plethora of common denominators, guidelines, standard operating procedures (SOPs), rules, checklists and acronyms. All developed with the best of intentions for keeping firefighters safe. No one can know how many lives these may have saved but history shows they haven't been entirely successful and it is unlikely that more guides and acronyms are going to improve things.

Acknowledging that these guides and rules need to inform and culminate in appropriate risk management decisions and actions, perhaps a risk management approach may better serve our needs. Providing risk managers with a framework, processes, systems, latitude and culture for making informed risk management decisions for achieving a hierarchy of objectives may prove more fruitful.

Good risk management contributes to the achievement of an agency's objectives through the systematic and repetitive application of risk management processes and systems. These processes and systems assist risk managers to identify, analyze and evaluate the risk components and the contributing risk drivers. By systematically assessing the effects of uncertainty on their organization's objectives, risk managers can identify priorities, implement controls and make informed decisions on a course of action to maximize the chance of gain while minimizing the chance of loss. To be effective it is important to consider and understand all available intelligence relevant to a business activity and to be aware that there may be limitations or uncertainties in that intelligence.

Risk management is an active process and should be integral to management and decision-making at all levels, integrated into practices and the very culture of the organization and its business activities. Ongoing monitoring and review is equally important for tracking real-time changes in the risk profile and taking corrective action, plus committing to continuously refining their risk management processes and systems.

The International Organization for Standardization, ISO 31000:2009 Risk Management – Principles and Guidelines (ISO 31000) was developed to fit this purpose.

Additional Keywords: [risk profile, risk assessment, controls, accident, disaster, severity, likelihood, exposure, values, vulnerability]

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Leadership, Accountability, Culture and Knowledge (LACK)

Victor Stagnaro[A]

[A] Director of Fire Service Programs, National Fallen Firefighters Foundation

Abstract:
Is your agency on the path to a Line of duty death (LODD)? This presentation by the National Fallen Firefighter Foundations examines the root causes of LODD's and the role of Leadership, Accountability, Culture and Knowledge as it influences and end result. Many fire service organization across the United States "LACK the Right Stuff" to prevent them from being on a path to a line of duty death, with Leadership, Accountability, Culture and Knowledge being the elements that need to be addressed and managed in those environments. Through education and training, those organizations can improve their survivability by understanding the root causes of firefighter fatalities and tackling these four elements with special emphasis on understanding how culture may contribute to the problem.
The LACK program is designed to reach the leadership within the fire service and provide the opportunity to learn how Leadership, Accountability, Culture and Knowledge can guide them toward recognizing how they can improve their own and their organizations skills. While improving leadership skills, accountability skills, deal with engrained cultural issues as well as the need for continuously increasing and improving the knowledge of how to operate on a fire incident.

A program dedicated to reducing the line of duty deaths in America through:

1) Leadership and making the tough and sometime unpopular decisions
2) Holding one accountable for the decisions made, understanding that there may be unfavorable consequences
3) Understanding the value of good culture and making cultural changes, when necessary to keep firefighters safe.
4) Having the knowledge needed to assist with the decision making process

Working to assure that Everyone Goes Home is not just a slogan but something that.

Proceedings of the 13th International Wildland Fire Safety Summit &
4th Human Dimensions of Wildland Fire Conference
April 20-24, 2015, Boise, Idaho, USA
Published by the International Association of Wildland Fire, Missoula, Montana, USA

Managing Fire, Understanding Ourselves:

Human Dimensions in Safety and Wildland Fire

13TH INTERNATIONAL WILDLAND FIRE SAFETY SUMMIT
& 4TH HUMAN DIMENSIONS OF WILDLAND FIRE

BOISE, IDAHO, USA • APRIL 20-24-2015 • #IAWFCon15

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WELCOME

Wildland fire management has risen to the forefront of land management and now receives greater social and political attention than ever before. As we progress through the 21st century, these areas of attention are continually presenting challenges never experienced before.

We may consider ourselves well positioned to move into the future. Our knowledge of many areas of fire management pertaining to the physical fire environment, ecological interactions, science and technology, and management strategies and tactics has never been greater. But, an improved understanding of human behavior - at individual, group and organizational levels – is vital to making fire management safer, more active, progressive, and adaptable. This is a far-reaching topical area that includes, but is not limited to, firefighter and public safety, best practices in safety training and operations, safety related research, new approaches to safety, fire response, safety issues in wildland urban interfaces, training, equipment and technology, risk assessment, risk informed decision-making, high reliability organizations, sense-making, shared responsibility, preparedness, organizational discipline, organizational performance, organizational breakdown, decision making, communications, resilience, risk, decision support, community and homeowner fire protection and hazard mitigation, fire education, and social, economic, and political effects of fires. Each year's fire seasons around the world reinforce that we have much to respond to and to learn in these areas.

The International Association of Wildland Fire (IAWF) is extremely proud to present the 13th Fire Safety Summit and the 4th Human Dimensions in Wildland Fire Conferences this year together for the first time. The IAWF recognizes the importance for both these areas to wildland fire management and the challenge for interested individuals to attend two separate venues. As a result, we feel that a combined single conference will afford the maximum benefits of a substantially elevated conference program during a single event.

This conference is designed to be innovative, revolutionary, and not focused only on a single component, but rather on the many aspects of human behavior and safety in wildland fire management. The conference will bring together at one time the significant body of knowledge about these program concerns. It will provide a forum for discussion, a stage where workshops, oral presentations, poster paper presentations, special sessions, workshops, and plenary presentations by leading experts in the field can facilitate the sharing of what is known, what needs to be learned, what lies ahead, how to advance knowledge, and how to use this knowledge to effectively respond to increasing concerns. During this conference you will be able to explore ways to expand collaborations, gain new knowledge, discuss the latest relevant research findings, learn about and from management treatments, engage in policy discussions, and conduct global fire management interaction.

On behalf of the International Association of Wildland Fire, all conference sponsors and partners, I welcome all participants and hope that this conference will meet, and even exceed your expectations of increasing awareness, knowledge, and capability in this important field in addition to networking with peers to establish future avenues of discovery. We hope that you will enjoy attending and gain significant information from what promises to be the most informative, enlightening, and powerful conference to date on safety and human dimensions in wildland fire management.

If you were not previously a member of the IAWF, you are receiving a one-year membership in the association included in your registration. By participating as an active IAWF member you can help to improve communication between firefighting organizations, enhance firefighter and public safety, increase our understanding of wildland fire science, and improve our ability to manage fire. Your membership in the IAWF provides you with a connection to other wildland fire professionals from across the world. Our membership, which is truly international, includes professionals from the fields of fire ecology, suppression, planning, contracting, fire use, research, and prescribed fire. Our members are scientists, firefighters, mangers, contractors, and policy makers. As an association, we are unique in that we represent all areas of wildland fire management.

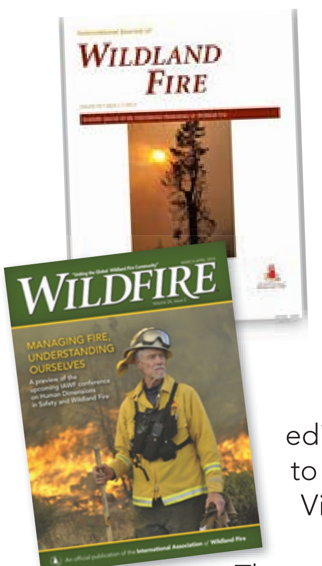
On behalf of the Board of Directors of the IAWF, thank you for your support of our association.

ABOUT IAWF

The International Association of Wildland Fire (IAWF) is a non-profit, professional association representing members of the global wildland fire community. The purpose of the association is to facilitate communication and provide leadership for the wildland fire community.

The IAWF is uniquely positioned as an independent organization whose membership includes experts in all aspects of wildland fire management. IAWF's independence and breadth of global membership expertise allows it to offer a neutral forum for the consideration of important and at times controversial, wildland fire issues. Our unique membership base and organizational structure allow the IAWF to creatively apply a full range of wildland fire knowledge to accomplishing its stated mission.

Vision: To be an acknowledged resource, from the local to global scale, of scientific and technical knowledge, education, networking and professional development that is depended on by members and partners in the international wildland fire community.



INTERNATIONAL JOURNAL OF WILDLAND FIRE

Our official fire science journal, published on our behalf by CSIRO, is dedicated to the advancement of basic and applied research covering wildland fire. IAWF members have access to this leading scientific journal online, as a members benefit. For those members who want to receive the hard copy version of the journal, they may receive it at the IAWF discounted rate of US $220, which includes your IAWF membership and a 1-year subscription to WILDFIRE.

WILDFIRE MAGAZINE

All IAWF members receive WILDFIRE magazine, official publication of the IAWF. Our authors submit fire articles from all corners of the world and our topical editors cover a broad array of important issues in wildland fire. We encourage you to submit articles and photographs for inclusion in the magazine. Visit www.wildfiremagazine.org for more information such as Writer's Guidelines.

There are so many reasons to become a member of the International Association of Wildland Fire but most importantly, the opportunity to be a member of a professional association that is committed to facilitating communication and providing leadership for the wildland fire community. Join today at www.iawfonline.org.

International Association of Wildland Fire
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International Association of Wildland Fire

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GENERAL INFORMATION

BANKING
Boise Centre has one ATM within the facility located in the lobby. (There is a $2.50 fee per transaction.)

CONFERENCE PROCEEDINGS
All those who present a poster and oral presentation are encouraged to submit an extended abstract or full paper for the Conference Proceedings. The proceedings will be published by the International Association of Wildland Fire and will be made available online. The deadline for submissions will be June 1, 2015. Visit the conference webpage for the guidelines and template.

DINING
Coffee/Tea will be provided each morning of the conference; coffee/tea and refreshments will also be provided during morning and afternoon networking breaks. Lunch will be provided on Wednesday. All breaks will be located in the Exhibit Hall, Eagle. The luncheon on Wednesday will take place in the middle section of the ballroom - Hawk.

EXHIBITORS
The exhibitors will be set up all day Tuesday and Wednesday through the Social Reception on Wednesday Evening. The Exhibit Hall is located in a section of the ballroom – Eagle. We encourage you to visit our sponsors and exhibitors during the Social Receptions on Tuesday and Wednesday, each morning and during lunch and breaks.

INTERNET/CHARGING STATIONS
Boise Centre offers a complimentary 5MB Wi-Fi network designed for event attendees. This service is available throughout the facility. There are 4 charging stations located in The Meadow.

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To download the mobile app:

- iPhone and iPad users--search "EventBoard" on the Apple App Store.
- Android users--search " EventBoard " on the Google Play Store.
- Our Conference will be listed under All Conferences
- Click on our conference to enter the mobile app site.

Thanks! We hope you enjoy the mobile app!

PARKING
Parking for the Boise Centre is available at primary parking facilities through an agreement with the Downtown Public Parking System.

PARKING RATES
First Hour Free
Hourly $ 2.50
All Day $12.00

POSTERS

Poster will be displayed on panels in The Meadow. The formal poster presentations will be on Wednesday from 1:30-2:30 pm. Please see the detailed program for the list of posters. All posters will be left up the entire three days, and will be staffed by the authors during the formal presentation on Wednesday.

Poster presenters may place posters anytime beginning Monday Evening from 5:00-8:00 pm, please ensure your poster is placed no later than 12:00 pm on Wednesday, April 22nd. We will provide you with the means to attach your poster (pushpin, Velcro, clips).

PRESENTERS

Please note that all presenters will be required to use the computers we are supplying; this will ensure smooth transitions between presentations.

We have provided an on-line submission system to upload your presentations. All oral presenters are required to turn in their presentations the day prior to their session. This is very important so we can load your presentations and make any adjustments that may be needed before your presentation. Please do your very best to help us out with this! Please do not upload your presentation until it is finalized, otherwise you will need to withdraw and resubmit.

You can either use the online system or you can upload your presentation at the speaker table in the registration area onsite. Online Submission System: https://iawf.submittable.com/submit/40392

SIDE MEETINGS

We have a room available for impromptu side meetings throughout the week; Payette River. There is a schedule on the door, sign up at your desired time, please respect others by staying to your schedule time.

SPEAKER READY ROOM

A Speaker Ready Room is available for all conference presenters to preview their material prior to presentation. The Speaker Ready Room is located in the Perch room which is located off the foyer.

SUSTAINABILITY / RECYCLING

Boise Centre has taken many sustainable measures to move toward a more environmentally friendly venue. Boise Centre is equipped with a single stream recycle compactor for all recyclable materials. Recycle containers are located throughout the facility.
Some of our specific initiatives regarding energy and waste conservation are listed below.

ENERGY EFFICIENCY

- Upgrading fluorescent lighting systems from T-12 to T-5 and T-5 HO
- New lighting controllers that reduce output by 50% for move in/move outs
- Interactive Lighting and HVAC control systems send heating or cooling into setback mode when lights are turned off
- Building is heated with Boise City's geothermal water system
- Natural light in the main lobby areas provides for reduced lighting, particularly during set up and tear down
- Energy reducing motor control drive upgrades to the cooling tower and chiller

WASTE REDUCTION

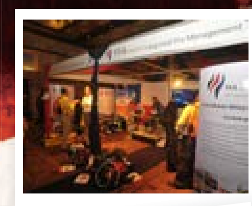
- Partners with Allied Waste and Western Recycling to recycle all forms of paper, plastic and metal materials
- Designated compactor for all recyclable materials
- Partner with Sustainable Futures, a nonprofit company specializing in sterilizing glass wine bottles and re-selling to local wineries
- Initiated a composting program with local neighborhood co-op farms to provide composting materials
- All plastic cups, flatware, and "to go" boxes are made from corn products
- All paper cups, plates, and napkins are made from recycled, compostable paper products
- Individual water bottles are replaced with filtered water stations in public areas
- Reduce paper waste by replacing traditional guest signage inside the facility with new digital technology

Boise Centre makes every effort to recycle all materials recyclable including donating surplus meals, compostable food waste, and wine bottles. Water stations are equipped with bottle fillers.

QUESTIONS AND INFORMATION

If you have any questions or need any assistance please visit the registration desk which will be located in the foyer area outside of the ballroom. Boise area information has been provided by Boise Convention & Visitors Bureau.

As outbreaks of wildland fire are increasing due to global change, ecological disturbance and damage to local communities become serious. The conference provides a platform for 3,000 fire management experts and business officials to discuss fire management strategy and to share business opportunities.



The 6th International Wildland Fire Conference

12-16 October 2015
PyeongChang, Korea

Host city of the 2018 Pyeongchang Olympic Winter Games!

Theme **Fire of the Past, Fire in Future**

Registration at www.wildfire2015.kr

Sessions

- Plenary sessions
- Parallel sessions
- Global Network session
- Regional sessions
- Field study tour
- Student thesis presentation competition

Plenary Topics

- Legacy of fire
- Community and wildland fire
- Towards a cohesive global fire management strategy
- Application of technology to wildland fire management
- Protecting the global natural and cultural heritage from fire

Exhibition

- Wildland fire apparatus
- Aerial firefighting equipments
- Fire suppression instruments
- Protective gear
- Aircraft navigation system
- Fire surveillance cameras
- Fire danger forecast system
- Fire situation control system
- Fire dissemination forecast system

Participants Registration

Online registration is available now at (Home → Registration → Conference Registration) after sign-up for the 6th IWFC website.

Full Registration Fees

- **Regular/On-Site:** USD 550
- **Pre-registration:** USD 495 (10% discount)
- **Early-Bird:** USD 440 (20% discount)
- **Students:** USD 280

Exhibition Registration

- **Shell Scheme Construction:** USD 2,500
- **Raw Space:** USD 2,250/9m^2 (Available for more than 18m^2)

* **Early-Bird Discount Rate:** 10%

Host

KOREA FOREST SERVICE
Gangwon Province

Main Partner Organizations

UNISDR, FAO, GFMC, afac, AFoCO, WORKING ON FIRE

SOCIAL EVENTS

TUESDAY – WEDNESDAY

SILENT AUCTION

Expo Hall – Tuesday, 10:00 am - Wednesday, 6:00 pm

Check out and bid on the silent auction items which will be displayed in the exposition hall until 6:00 pm on Wednesday. All proceeds from the auction will be divided between the National Fallen Firefighter Foundation; Wildland Firefighter Foundation and International Fire Relief Mission.

MONDAY

AFTER HOURS NETWORKING

Monday, April 20th 7:00 pm

10 BARREL BREWING COMPANY

830 W Bannock St.
http://www.10barrel.com
10 Barrel started back in 2006 with three guys in Bend Oregon who shared one simple mindset; brew beer, drink beer, and have fun doing it! Since that time their brewery has grown, but they will always be the same. Cheers!

TUESDAY

IDAHO REGIONAL RECEPTION

Tuesday, April 21st • 5:00 -7:00 pm
Boise Centre – Expo Hall

The Chef at the Boise Centre has prepared for us a special menu featuring various delicious Local/Regional Foods.

Visit the "Boise" Table to learn information about what Boise has to offer. Materials provided by the Boise Convention and Visitor Bureau.

Check out and bid on the Silent Auction Items. All proceeds from the auction will be divided between the National Fallen Firefighter Foundation; Wildland Firefighter Foundation and International Fire Relief Mission.

MUSIC PROVIDED BY DAN COSTELLO

Blending classical, bluegrass, funk, rock, jazz, and folk may be difficult, even hazardous, but singer-songwriter and guitarist Dan Costello is up to the challenge. His performance experience ranges from hard rock bands to jazz ensembles to medieval instrumental troupes. He earned a Bachelor of Music degree in classical guitar in 2001 and works both in and out of the scholastic realm as a performer, accompanist, editor, composer, arranger, lyricist, teacher, and producer. Costello is an outspoken advocate of local grassroots music.

WEDNESDAY

Wednesday, April 22nd
5:15-6:30 pm
Boise Centre – Expo Hall

Don't miss this opportunity to network with your fellow conference participates. We've kept the hors d'oeuvres simple tonight so you can plan a fun evening out on the town afterward. Boise has many wonderful eating establishments within walking distance of the Boise Centre.

The Silent Auction will end at 6:00 pm tonight, don't forget to check out and bid on the Silent Auction Items. All proceeds from the auction will be divided between the National Fallen Firefighter Foundation; Wildland Firefighter Foundation and International Fire Relief Mission.

THURSDAY

AFTER HOURS NETWORKING

Thursday, April 23rd 6:00 pm

PROTO'S PIZZERIA NAPOLETANA

345 South 8th Street
http://www.protospizza.com/site/#protos-boise

Proto's will be donating 10% of their proceeds back to our three charities for business conducted at that location throughout the day on Thursday.

Proto's Pizza has been recognized in many publications including Bon Appetit magazine. The Pizza experience had been elevated to table service, linen napkins, and delicious wines with a full bar to make it a true dining experience.

Proto's has been tossing pizza for a long time now. Pam has gone on to open several more locations. No matter which Proto's you choose as your favorite, one thing will never change, and that is their passion to create and bake for you the best pizza you will ever eat.

FEATURED PRESENTERS

OPENING SESSION

BOISE FIRE DEPARTMENT HONOR GUARD

The Boise Fire Department Honor Guard appeared at their first public ceremony in February 1999. The team proudly displays colors at departmental events such as the Annual Fire Safety Symposium, Recruit Academy graduation ceremonies, award banquets, parades and funerals.

BOISE FIRE DEPARTMENT PIPES & DRUMS

Through the support of the Fire Chief, Fire Department and Local 149, the Boise Firefighters Pipes and Drums established in March of 2008. With eight founding members, Boise Firefighters Pipes and Drums began to spread talent and good-will throughout Boise, the Treasure Valley, and as far away as Alaska, Texas, and both east and west coasts. Members dedicate a substantial amount of personal time to improving musical performance. Boise Firefighters Pipes and Drums recently celebrated their 200th performance and continue to honor fellow brothers and sisters in the fire service while upholding the values of the Boise Fire Department: Integrity, Dedication, and Service.

PLENARY SESSION

DISASTER, DEVASTATION, RESILIENCE AND RECOVERY: THE JOURNEY OF STRATHEWEN PRIMARY SCHOOL

Jane Hayward, Principal, Strathewen Primary School, Victoria, Australia

Strathewen Primary is a small school, just over one hour north east of Melbourne. Located at the base of a wooded valley and adjacent to National Park forests, preparation for the fire season had always been a priority. The school was in a vulnerable position, in a high fire risk area. The state of Victoria had been experiencing drought conditions for almost ten years and the risk of bushfire was higher than ever. We thought we knew what to expect of a bushfire and had prepared accordingly.

In taking on the position of teaching Principal in 2007, I assumed leadership of a school which had experienced long term staffing stability was recognised for high performance and boasted a dedicated and involved community. This was a school setting in which the village was genuinely raising the children. My role as teaching Principal, though challenging, was a very special one. No one could have predicted the disaster which was to impact the school and its community only two years later.

The Black Saturday bushfires in 2009 made headlines around the world. On that day, as temperatures soared, fires burned across the entire state. The conditions were ideal for a fire storm and that was what struck Strathewen.

The loss across the State of Victoria was significant. The loss in Strathewen itself was devastating. Our school was destroyed. Local homes, properties, businesses and infrastructure were gone. Livestock and pets were lost. Strathewen, with its population of just over 200, suffered the highest loss of human life.

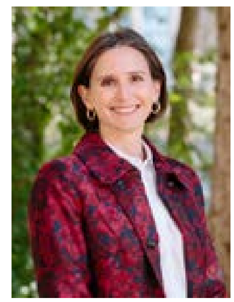
There is no preparation for educational leadership following such extensive trauma and loss. Promptly relocating to a temporary school site was vital. All members of both the school and wider community were impacted by this disaster. The school's journey through the years following Black Saturday has been difficult one. The human side of disaster is challenging and often heartbreaking. Dealing with post trauma issues in children and families has been a lengthy process and continues today.

Six years on, we have returned to Strathewen valley, to a purpose built, fire rated school and our recovery journey continues.

Bio: Jane lives in rural Kinglake, Victoria, Australia with her husband Paul and has two adult children who are off on their own adventures- most of the time. Jane began teaching at age 20 in a small, rural school in northern Victoria and has since worked in a variety of school and education settings. With almost 30 years of teaching in Victorian primary schools behind her, she is passionate about education, learning and the small school setting. Jane's focus on student welfare and well-being underpins all that she does.

Prior to Black Saturday, Jane taught at Middle Kinglake Primary School for ten years, before taking on the position of teaching Principal at Strathewen Primary School in 2007. Both Middle Kinglake Primary School and Strathewen Primary School were destroyed in the 2009 bushfires. The local area, farms, homes, community infrastructure and many of the surrounding townships were also devastated. Jane has led her school community through some very challenging times. As the Principal of a small school, Jane continues to teach the school's senior class of 8-12 year olds, four days per week.

PLENARY SESSION



WILDFIRE POLICY AS A SOCIO-ECOLOGICAL PROBLEM

Toddi Steelman, Executive Director and Professor,
School of Environment and Sustainability, University of Saskatchewan

There are fundamental spatial and temporal disconnects between the policies that have been crafted to address our wildfire challenges and the scales at which the problems occur. The biophysical changes in fuels, wildfire behavior and climate have created a new set of conditions for which our existing policies are poorly suited. To address these challenges, a re-orientation of goals is needed to focus on creating an anticipatory wildfire governance regime focused on social and ecological resilience.

Bio: Dr. Steelman's research focuses on improving the governance of environmental and natural resources, emphasizing science, policy, and decision-making interactions. She places special emphasis on the role of the public and community in decision-making. She is Co-director, with Dr. Branda Nowell, of the Fire Chasers project at North Carolina State University (research.cnr.ncsu.edu/blogs/firechasers/).

PLENARY PANEL SESSION

GLOBAL WILDLAND FIRE PERSPECTIVES: AGENCY PERSPECTIVES OF FIREFIGHTER SAFETY AND HUMAN DIMENSIONS IN WILDLAND FIRE MANAGEMENT AND THE EMERGING IMPORTANCE OF THIS AREA

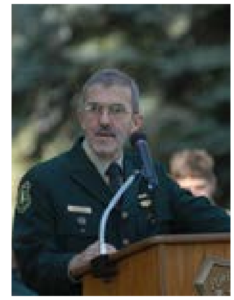
MODERATOR: Marjie Brown, Consultant, ScienceFire Communications, Inc

PANELISTS:

- **Jim Karels,** President, National Association of State Foresters (NASF) and State Forester, Florida, USA;
- **Tom Harbour,** Director of the Fire and Aviation Management program for the US Forest Service. National Headquarters in Washington, D.C., USA
- **Dick Bahr,** Deputy Director Management & Programs, DOI, Office of Wildland Fire, USA
- **Alan Goodwin,** Chief Fire, Officer Department of Environment, Land, Water and Planning, Australia
- **Marc Castellnou,** Fire Manager, Catalan Fire Service, President of Pau Costa Foundation, Spain

Jim Karels, State Forester, has been the Director of the Florida Forest Service since 2008. He oversees all wildland fire and land management activities and also has held the positions of Fire Chief and Assistant Director. He began his career with the division as a Forest Ranger and firefighter suppressing wildfires in 1985. He has more 30 years of experience in wildfire and emergency response and land management with the U.S. Forest Service and the Florida Forest Service.

Jim has coordinated the department's Emergency Response Program since 1995 through numerous hurricanes, floods, tornadoes, wildfire outbreaks and other emergencies. He is currently the president of the National Association of State Foresters, representing all 50 states on wildland fire issues. He also represents all states on the Wildland Fire Executive Council with the U.S. Forest Service and Department of Interior. He received his Bachelor of Science in Forest Management from the University of Minnesota.



Tom Harbour's first experience with wildfire was firefighting in central California in 1970. Since then, Tom has been involved in wildland Fire and Aviation Management his entire career. Beginning as a firefighter, Tom has had opportunities to fight, prescribe, and manage fires across the United States and internationally. His emergency management experiences have included fires, hurricanes, earthquakes, riots, floods, and other types of disasters all across America. His prescribed fire experience includes opportunities across the United States. He has been a Burn Boss, an Incident Commander, and Area Commander at the highest levels of complexity. He has a Bachelor of Science degree in civil engineering from the University of California Davis and a Bachelor of Science degree in forest management from Washington State University. He graduated summa cum laude from the University of California at Davis and with Presidential Honors for a 4.0 GPA from Washington State University. He has done post-graduate work at the JFK School of Government, Harvard University and the Kenan-Flagler School of Business at the University of North Carolina. He served with faculty and leaders at the Marine Corps University, Quantico, Virginia. The US Forest Service Fire and Aviation Management program employs over 10,000 firefighters and has a budget over $2 billion (US). He has been happily married for over 35 years, and is a proud Father and Grandfather.

Dick Bahr works in the Department of the Interior, Office of Wildland Fire where he is the Deputy Director, Management and Programs. He coordinates the fuels, preparedness, response, emergency operations and wildland fire information technologies programs providing guidance, policy and oversight of the Interior Bureaus (Bureau of Indian Affairs, Bureau of Land Management, US Fish & Wildlife Service, and National Park Service) implementation of wildland fire. Prior to this he had made a career working with the National Park Service beginning in Glacier National Park as a microbiologist monitoring water and wastewater quality in 1977. He made the move into Fire Management in 1981 as a Fire Control Aide doing structural fire, fire and life safety inspections, and wildfire control. In 1984 he chose wildland fire as a career path and accepted a permanent position as fire cache manager in Everglades National Park. In 1987 he was westward bound to Yellowstone National Park working there in wildland fire and aviation until 1997. He then went to the Midwest-Regional Office as the Prescribed Fire Specialist building a program that treated over 30,000 acres a year. In the summer of 1999 he headed to the Fire Management Program Center in Boise as the Fire Use Specialist overseeing the fuels and wildland fire use program at the National level. Dick stepped up to the NPS Fire Science and Ecology program lead job in 2005. In 2014 he took his present position with the DOI, Office of Wildland Fire.

Alan Goodwin is the Chief Fire Officer, a role he has held since October 2012. Previously, Alan was the Regional Director for the North West region of the former Department of Sustainability and Environment. Alan has 20 years' experience working in the forest and fire industry, including roles with Forestry Tasmania. Alan's previous roles for the Victorian Government also include Assistant Chief Fire Officer and Director Planned bunting. He has been involved in several wildfire response deployments from Australia to the United States. In 2008 / 2009 Alan and his family spent 12 months living in the United States spending time at the National Interagency Fire Center in Boise, Idaho and the Office of Wildland Fire at the US Department of Interior, Washington DC. In addition to being on the IAWF Board of Directors he is a fellow of the Australian Rural Leadership Foundation and received the Australia Fire Service Medal in 2012.

Marc Castellnou Ribau, Forest Area Chief (GRAF). Strategical Fire Analyst, Catalan Fire Service Marc Castellnou is a fireman with over 25 fire seasons and over 60 large fires in Spain, France, Greece, Scotland and USA. He has extended experience in incident strategy, operation commandment and forest fire management. He introduced the concept of fire analysis in Europe, and has developped it extensively. Marc is the Forest Area Chief inside the Catalan Fire Service, where he introduced the Prescribed Burning Program. He promoted a lessons learned culture, and a shift towards fire management and strategical decision-making in forest fires.Marc has been working in fire management projects all over Europe.Marc is founder and Chairman of Pau Costa Foundation, a platform on forest fire management, as well as an instrument to divulgate and investigate in fire ecology.

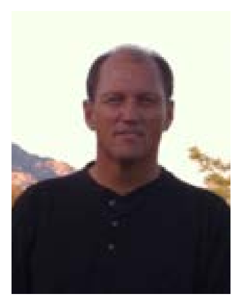
PLENARY PANEL SESSION
THE CHANGING FACE OF INCIDENT MANAGEMENT

MODERATOR: Larry Sutton, Risk Management Officer, US Forest Service

PANELISTS:
- **Robert R. Maynes,** Deputy Assistant Chief Retired, Fire Department City of New York, Queens Borough Commander, FDNY IMT Incident Commander
- **Jim Manahan,** Former Assistant Chief of Operations, FDNY and current FEMA, IMT IC (NYRegion)
- **Pruett Small,** Training Officer, Groom Creek Fire District, Prescott, Arizona

Robert Maynes recently retired from the FDNY Staff as The Queens Borough Commander and was in this position during super Storm Sandy. In this capacity he was responsible for operations, policy, training and administration for the 96 units assigned to the Borough of Queens. As a Staff Chief he served as citywide Incident Commander on a rotating schedule. He also served as a collateral assignment as Incident Commander on the FDNY Incident Management Team. He had been in this position since 2008 after serving five years as The Operations Section Chief. Additionally he possesses national qualifications as an Type-II Incident Commander, Type-I Operations Section Chief, Liaison Officer, and Type-II Safety Officer. He served for two years on a National Type-One Incident Management Team based in the Southwest. Maynes has deployed nationally to 15 incidents including the FDNY IMT response to New Orleans following Hurricane Katrina. He has thirty-four years of experience as a first responder. Maynes has a BA from Stonybrook University.

Jim Manahan worked for the FDNY for over 35 years, retiring in July 2014. During his time in the Department he has held multiple ranks. Starting as a firefighter In Brooklyn he has held the ranks of Lieutenant, Captain, Battalion Chief, Deputy Chief, Deputy Assistant Chief and Assistant Chief. As an Assistant Chief he was second in command of FDNY Operations. During his last 12 years in the Department Jim has participated in advanced training programs that were the direct result of 9/11. Working on recommendations from the McKinsey Report and the Federal Government Jim assisted in incorporating the National Incident Command System into day to day operations of the Fire Department. He attended National Training programs to further develop his leadership skills and understanding of the National Incident Management System. Jim operated as the FDNY Incident Management Team's Planning Section Chief in New Orleans during the crisis created by hurricane Katrina. He was also the Deputy Incident Commander during the FDNY Incident Management Team deployment to Baton Rouge Louisiana and Broome County New York. During Superstorm Sandy he was deployed for 55 days as the Incident Commander for the IMT. He has lectured in Chicago, Phoenix, New York, San Diego, France, and England on large scale incident management. Jim is currently one the Emergency Manager Specialists at Brookhaven National Laboratory on Long Island, New York.



Pruett Small started his fire service career in 1979 as a wildland firefighter on the Cleveland National Forest in San Diego, California on a type 3 engine company. In 1980 he moved to Prescott, Arizona where he worked three fire seasons on the Prescott Hot Shot crew and three fire seasons on the Prescott Helitack crew. In 1985 he joined the Central Yavapai Fire District where he worked for 26 years and retired as the Training Chief, coordinating a regional training academy. In 2011 Pruett joined the Groom Creek Fire District and works as a training officer. Pruett has attended numerous National Fire Academy courses and is a graduate of Arizona State University's Fire Service Institute. He has an A.A.S. degree in Fire Science and a Bachelor's degree in Fire Service Management. He has been a member of Type 1 and 2 incident management teams for the past 20 years and is qualified as a type 1 Incident Commander and as a type 1 Operations Section Chief. He has performed on over 85 Type 1 and 2 incidents. He travels nationally and internationally teaching ICS and All-Hazard incident management team courses and develops and conducts incident management team simulations/exercises. Pruett has been married to Karen for 32 years and they live in Prescott, Arizona.

CLOSING PRESENTATION

THE DOCTRINAL ROAD TO RISK MANAGEMENT - WHERE WE'VE BEEN, WHERE WE ARE HEADED

Tom Tidwell, Chief, US Forest Service, Washington, DC, USA

Tom Tidwell has spent 33 years in the Forest Service. He has served in a variety of positions at all levels of the agency, including as district ranger, forest supervisor, and legislative affairs specialist in the Washington Office. As deputy regional forester for the Pacific Southwest Region, Tom facilitated collaborative approaches to wildland fire management, roadless area management, and other issues. As regional forester for the Northern Region, Tom strongly supported community-based collaboration in the region, finding solutions based on mutual goals and thereby reducing the number of appeals and lawsuits.

In 2009, after being named Chief, Tom set about implementing the Secretary's vision for America's forests. Under his leadership, the Forest Service is restoring healthy, resilient forest and grassland ecosystems—ecosystems that can sustain all the benefits that Americans get from their wildlands, including plentiful supplies of clean water, abundant habitat for wildlife and fish, renewable supplies of wood and energy, and more.

Such benefits are at risk from the effects of climate change, and Tom has led the way in forging a national response. Under Tom's leadership, the Forest Service has charted a national roadmap for addressing climate change through adaptation and mitigation. The Forest Service is taking steps to help ecosystems adapt to the effects of a changing climate while also taking action to mitigate climate change, partly by reducing greenhouse gas emissions.

Tom has facilitated an all-lands approach to addressing the challenges facing America's forests and grasslands, including the overarching challenge of climate change. Such challenges cross borders and boundaries; no single entity can meet them alone. Under Tom's leadership, the Forest Service is working with states, Tribes, private landowners, and other partners for landscape-scale conservation—to restore ecosystems on a landscape scale.

FIRESCIENCE.GOV

Research Supporting Sound Decisions

Funding wildland fire research and distributing results to support sound policy and management decisions

Your Program at work - recently completed research includes

- *Firefighter Safety Zones: Review of Past Science & Summary of Future Needs*
- *Characterizing the Effect of Terrain Slope on Firefighter Safety Zone*
- *Public Perceptions of Smoke and Agency Communication*
- *A Synthesis of Research Perspectives on the Public and Fire Management*
- *Advancing Knowledge about Citizen—Agency Trust: A Collaborative Assessment Framework for the U.S., Australia, and Canada*

Fire Science Exchange Network — Accelerating awareness, understanding, and adoption of wildland fire science information

Connect and learn through

Field Tours

Workshops

Conferences

Webinars

Syntheses

Fact Sheets

Newsletters

Social Media

International Association of Wildland Fire

Managing Fire, Understanding Ourselves: Human Dimensions in Safety and Wildland Fire

13th International Wildland Fire Safety Summit & 4th Human Dimensions of Wildland Fire Conference

Boise Centre, Boise, Idaho, USA

April 20-24, 2015

PROGRAM SCHEDULE

Monday, April 20, 2015

7:00 am-8:00 pm	**Conference Registration/Information Desk Open** - ***Meadow (Boise Centre Foyer)***						
	WORKSHOPS						
	Willows	**Pines**	**Firs**	**Cottonwoods**	**Salmon River**		**Snake River**
8:30 - 12:30	Assessing Residential Wildfire Hazards *Instructor: Pat Durland*	The Fire that Burns Within: Fire Service Suicide – The Reality *Instructor: Mary VanHaute*	Building Capacity to Collaborate in Natural Resources Management *Instructors: Susie Kocher, Kim Ingram*	Annual Fire Refresher – RT-130 *Joel Welch-Lead Instructor, Mike Elles-Unit Lead, Matt Ziegler-Unit Lead, Rob Smolczynski-Unit Lead, Tim Garity- Unit Lead, Jeremy Schwandt- Unit Lead*	Improving Risk Assessment through Fire Behavior Analysis *Instructors: Dan Mindar, Erin Noonan-Wright, Tami Parkinson, Laurie Kurth*		Wildland Fire Smoke Health Effects Research and Tools to Inform Public Health Policy and Recommendations *Instructors: Ana Rappold, Susan Stone, Pete Lahm, Wayne Cascio, Sarah Henderson, Angela Jiayun Yao, Catherine Elliott, Joseph Domitrovich, Ian Gilmour, Brian Reich, Sim Larkin, Susan O'Neill, Paul Garbe*
12:30-1:30 PM	**Lunch - on your own**						
	WORKSHOPS (cont.)						
	Willows	**Pines**	**Firs**	**Cottonwoods**	**Salmon River**	**Merlins**	**Snake River**
1:30 - 5:30 PM	(continued...) Assessing Residential Wildfire Hazards	(continued...) The Fire that Burns Within: Fire Service Suicide – The Reality	(continued...) Building Capacity to Collaborate in Natural Resources Management	(continued...) Annual Fire Refresher – RT-130	US National Grid (USNG) and Wildland Fire *Instructors: Rich McCrea, Al Studt*	Competency in Crisis *Instructor: Christophe FRERSON*	Stress First Aid for Firefighters and Emergency Medical Services Personnel *Instructors: Kim Lightley, Dr. Patricia Watson*
5:00-8:00 PM	**Vendor Set up *(Eagle - Boise Centre)***						
7:00 pm	**After Hours Networking** - 10 Barrel Brewing Company, 826 W Bannock Street						

Tuesday, April 21, 2015

7:30 am-5:00 pm	**Conference Registration/Information Desk Open** - ***Meadow (Boise Centre Foyer)***
8:30-9:00	**OPENING REMARKS AND WELCOME** - ***Peregrines*** *Tom Zimmerman, IAWF President and Conference Co-Chair* **Presentation of Colors**: *Boise Firefighters Pipes and Drums & Boise Fire Department Honor Guard*
9:00 - 10:00	**GENERAL SESSION** - ***Peregrines*** **Disaster, Devastation, Resilience and Recovery: The Journey of Strathewen Primary School** ***Jane Hayward,*** *Principal, Strathewen Primary School, Victoria, Australia*
10:00 - 10:30	**NETWORKING BREAK with Exhibitors** - ***Eagle***

	CONCURRENT SESSIONS				
	Willows	**Pines**	**Firs**	**Cottonwoods**	**Merlins**
	Measurement and Fire *Moderator: Toddi Steelman*	***Risk*** *Moderator: Anne-Lise Velez*	***New Development in Wildland Firefighting*** *Moderator: Lily Konantz*	***Fire Adapted Communities*** *Moderator: Adam Gossell*	***People, Climate and Landscapes*** *Moderator: Cassandra Moseley*
10:30-10:40	Announcements and Introductions	Announcements and Introductions	Announcements and Introductions	Announcements and Introductions	Announcements and Introductions
10:40-11:00	1. Do we have an acceptable loss in Wildland Fire? *Ivan Pupulidy*	4. Wildfire risk management in Europe: the challenge of seeing the "forest" and not the "trees" *Fantina Tedim*	8. Changing cultures/attitudes in aerial firefighting - Pre determined dispatch of aircraft *Wayne Rigg*	12. Measuring Community Adaptive Capacity and Wildfire Risk in the American West: Coupling Results from Key Informant Surveys and Biophysical Risk Analysis *Max Nielsen-Pincus*	16. Investigating the Impacts of Surface Temperature Anomalies Due to Wildfires in Northern Sub-Saharan Africa *Trisha Gabbert*
11:00-11:20	2. Network Management and Performance on Complex Fire Events *Branda Nowell*	5. Localized Risk Perception on Wildfire Hazard *Voravee Chakreeyarat*	9. Fire and Aviation Management Enterprise Geospatial Portal *Jill Kuenzi*	13. Creating a Culture of Adaptation: A Learning Network Approach to Fire Adapted Communities *Michelle Medley-Daniel*	17. How society and climate will combine to affect wildfire in the U.S. South, 2015-2060 *Jeffrey Prestemon*
11:20-11:40	3. Towards metrics of success in residential preparedness for wildfire *James Absher*	6. Fire and Fuel Management in Banff National Park; Balancing Risk and Sustainability *Robert Osiowy*	10. Military Veterans in the Wildland Fire Service – Issues, Obstacles, and Benefits *Alexis Lewis Waldron*	14. Enhancing Community Response - Utilising existing information networks during bushfires *Kathy Overton*	18. Spatial Pattern of Fire With Respect to Human Settlements in a Tropical Dry Forest Landscape *Narendran Kodandapani*
11:40-12:00	Q&A	7. Risk - Risk Tradeoffs in Wildfire Management – The Ranch Fire Case Study *David Calkin*	11. Organizational response to incidents and accidents *Ivan Pupulidy*	15. You Mean It might Burn? Embarking on Austin's Journey to Become Fire Adapted *William Conrad*	Q&A
12:00-1:30	**Lunch (On your own)**				
	CONCURRENT SESSIONS				
	Willows	**Pines**	**Firs**	**Cottonwoods**	**Merlins**
	Special Session One: Indigenous People and Wildland Fire *Moderator: Amy Christianson*	***Risk*** *Moderator: Hannah Brenkert-Smith*	***Management and Goverance of Wildfire*** *Moderator: Vita Wright*	***Collaborative Approaches*** *Moderator: Tony Jarrett*	***Different Ways of Understanding Fire*** *Moderator: Gene Rogers*
1:30-1:40	Announcements and Introductions	Announcements and Introductions	Announcements and Introductions	Announcements and Introductions	Announcements and Introductions
1:40-2:00	19. Wildfire evacuation experiences of a First Nations community in Alberta, Canada *Tara McGee*	23. Inducing Private Wildfire Risk Mitigation: Experimental Investigation of Measures on Adjacent Public Lands *Joseph Little*	28. Wildland Fire Governance: Strategies of Effective Suppression Firms *Cassandra Moseley*	33. Building Capacity for Wildfire Mitigation Through Collaborative Partnerships *Jerry McAdams/Julia Kertz-Grant/Jennifer Tomlinson*	38. Radio Technology Opportunities and Constraints: Using Dramaturgy as an Analytic Tool *Jennifer Ziegler*
2:00-2:20	20. In their words: how a wildfire evacuation affected residents of a Northern Alberta First Nation community *Kyla Mottershead*	24. Mitigation Behavior to Reduce Wildfire Risk: What Motivates Homeowners to Mitigate Wildfire Risk? *Hari Katuwal/ Tyron Venn*	29. Fire Manager or Market Manager? Administrative Practices for Large Fire Suppression *R. Patrick Bixler*	34. Increasing Capacity for Collaboration by Training Natural Resource Management Agencies, Scientists and Stakeholders *Susie Kocher*	39. The Storyteller's Role In Accident Investigations ~ Naturalistic Learning From Unintended Outcomes *Steve Holdsambeck*
2:20-2:40	21. Using Historical Photographs to Identify Indigenous Burning Patterns *Rick Arthur*	25. Is the whole greater than the sum of its parts? Homeowner wildfire risk mitigation and community heterogeneity *Hannah Brenkert-Smith*	30. The Influence of Incident Management Teams on Suppression Resource Use *Michael Hand*	35. Collaborative Implementation for Ecological Restoration on US Public Lands: Implications for Legal Context, Accountability and Adaptive Management *Sarah McCaffrey*	40. Australian volunteer rural fire brigades: the value of historical perspective *Sandra Lauer*
2:40-3:00	22. Māori use of fire: traditional use of fire to guide wildfire management in New Zealand *E.R. (Lisa) Langer*	26. Potential for Disseminating SAWTI Risk Information: Understanding Information Seeking and Wildfire Preparedness in Southern California *Anne-Lise Velez*	31. Social "Watch Out" Situations for Incident Management Teams *Toddi Steelman*	36. Fires of Change: An Art and Science Collaborative *Andrea Thode*	41. Making Every Word Count: Teaching Wildland Fire in the Brazilian Amazon *Matthew Carroll*
3:00-3:20	Q&A	27. LiDAR based risk assessment in the WUI: An analysis of pre-fire conditiosn of the Black Forest Fire *Andrew Karlson*	32. What Cohesive Strategy Looks Like on the Ground *Katie Lighthall/Steven Hawkins*	37. Local perceptions of forest management and wildfire risk in Northeast Oregon *Angela Boag*	42. Optimal forest management: A dynmanic analysis to promote healthy forests and economic development *Kara Walter*

3:20-3:50	**NETWORKING BREAK with Exhibitors - *Eagle***				
3:50-4:50	**GENERAL SESSION - *Peregrines*** **Wildfire Policy as a Socio-ecological Problem** *Toddi Steelman, Executive Director and Professor, School of Environment and Sustainability, University of Saskatchewan*				
5:00-7:00 PM	**Social Reception with Exhibitors - *Eagle***				
Wednesday, April 22, 2015					
7:30 am-5:00 pm	**Conference Registration/Information Desk Open - *Meadow (Boise Centre Foyer)***				
8:00-8:15	**WELCOME BACK AND DAILY ANNOUNCEMENTS *(Peregrines)*** *Larry Sutton, US Forest Service, Conference Co-Chair*				
8:15-9:45	**GENERAL SESSION** **Global Wildland Fire Perspectives Panel Session: Agency Perspectives of Firefighter Safety and Human Dimensions in Wildland Fire Management and the Emerging Importance of this Area** Facilitator: **Marjie Brown,** *Consultant, ScienceFire Communications, Inc* ***Jim Karels,*** *President, National Association of State Foresters (NASF) and State Forester, Florida, USA;* ***Tom Harbour***, *USFS Director of Fire and Aviation Management, USA;* ***Dick Bahr,*** *Deputy Director Management & Programs, DOI, Office of Wildland Fire, USA;* ***Alan Goodwin***, *Chief Fire Officer, Department of Environment, Land, Water and Planning, Victoria, Australia;* ***Marc Castellnou,*** *Fire Manager, Catalan Fire Service, President of Pau Costa Foundation, Spain*				
9:45-10:15	**NETWORKING BREAK with Exhbitors - *Eagle***				
	CONCURRENT SESSIONS				
	Willows	**Pines**	**Firs**	**Cottonwoods**	**Merlins**
	Models and Methods for Safety *Moderator: Chuck Bushey*	***Decision Making and Fire*** *Moderator: Rebekah Fox*	***Evacuation and Sheltering*** *Moderator: Tony Jarrett*	***People, Climate and Landscapes*** *Moderator: Alen Slijepcevic*	***Fire Adapted Communities*** *Moderator: Toddi Steelman*
10:15-10:20	Announcements and Introductions	Announcements and Introductions	Announcements and Introductions	Announcements and Introductions	Announcements and Introductions
10:20-10:40	43. Suppression of forest fires by the drop water flows interspaced in time and space *Pavel Strizhak*	47. The Protective Action Decison Model: It's Application in an Australian Bushfire Context *Ken Strahan*	51. Do I stay or do I go? The role of risk tolerance in evacuation decisions during a wildfire event *Sarah McCaffrey*	54. Spatial allocation of landscape values *Jose Sanchez*	58. Developing fire adapted communities: The importance of interactions among elements of place-dependent local context *Travis Paveglio*
10:40-11:00	44. A Proposed Experimental Methodology for Assessing the Effects of Water and Dry Matter Content on Live Fuel Flammability *Oleg Melnik*	48. Connecting Science and Decision-Making in Wildland Fire Management *Melanie Colavito*	52. Sheltering practices during bushfires: lessons from the 2009 Black Saturday fires *Joshua Whittaker*	55. People's Perceptions of Post-Wildfire Landscape Recovery *Chad Kooistra*	59. Reducing Structural Losses from Wildfire: Are Regulations the Answer? *Cheryl Renner*
11:20-11:40	45. Interacting with Wildfire Simulations and Historical Wildfire Analysis *James Gattiker*	49. Power and Decision Making: A Foucaultian Analysis of Wildland Decision Making *Van Miller*	53. Establishing wildfire evacuation zones—a coupled human-environment system approach *Dapeng Li*	56. Lessons from a Legacy of Wilderness Fire: Benefits, Challenges, and Tools for Success *Vita Wright*	60. Wildfire policy after structure loss: how does regulation alter rebuilding and residential growth after wildfires? *Miranda Mockrin*
11:40-12:00	46. Wildland Firefighter Safety and Fire Behavior Prediction in the Field *Martin Alexander*	50. Nudging Wildfire Managers – Taking Advantage of Behavioral Economics in Decision Support and Performance Management *David Calkin*	Q&A	57. How effective is wildfire communication to New Zealand communities and how can it be improved? *E.R. (Lisa) Langer*	61. Fire Adapted Communities in the Real World: Community Perspectives on What Actions and Processes Are Needed for Diverse Communities to Become More Resilient to Wildfire *Sarah McCaffrey*
12:00-1:30	**LUNCHEON - *Hawk*** *Featuring: Wildland Fire Safety Award Presentation* *Presentations by National Fallen Firefighter Foundation; Wildland Firefighter Foundation and International Fire Relief Mission* *IAWF Annual Membership Meeting*				
1:30 -2:30	**POSTER SESSION *(Meadow - Boise Centre Foyer)***				

POSTER PRESENTATIONS

P1. Forest Fire Safety Handbook: updating training literature for the Spanish spoken community, *Presenter: Raul Quilez*

P2. Interactive 911 Program
Presenter: Sandra Inman-Carpenter

P3. The Role of Departments of Transportation in Wildfire Response
Presenter: Wesley Kumfer

P4. Gender and Leadership in Wildfire Suppression: Women Leaders on the Fireline,
Presenter: Rachel Reimer

P5. The Sounds of Wildland Firefighting in Action: Communication Research Study
Presenter: Elena Gabor

P6. Social "Watch Out" Situations for Incident Management Teams
Presenter: Toddi Steelman

P7. Australian volunteer rural fire brigades: the value of historical perspective, *Presenter: Sandra Lauer*

P8. Fire Adapted Communities Learning Network, *Presenter: Michelle Medley-Daniel*

P9. Knowledge for Wildfire; improving management of UK wildfire through knowledge exchange
Presenter: Julia McMorrow

P10. Student of Fire: Local actions to support global issues,
Presenter: Kelsey Gibos

P11. The Incident Risk Console (RisC) – A Risk Assessment Synopsis for Wildland Fires,
Presenter: Lisa Elenz

P12. Fire in Southern Ecosystems
Presenter: Adam Kent

P13. What We Talk About When We Talk About Fire: Words, Media, and Wildfire
Presenter: Alexandra Weill

P14. Big questions, local answers: Awareness and preparedness of unprepared people in Idaho
Presenter: Elise Thiel

P15. Collaborative Landscape and Community-Level Wildland Fire Management Planning and Implementation within the Resort Municipality of Whistler, British Columbia, Canada, *Presenter: Nicholas Soverel*

P16. Bringing the Fire Adapted Message to Ada County, *Presenter: Jerry McAdams*

P17. Ranching with Fire: Livelihoods, Resiliency and Adaptive Capacity of Rural Idaho, *Presenter: Kyle McCormick*

P18. Enhancing Community Response-Utilising existing information networks during bushfires, *Presenter: Kathy Overton*

P19. Fires of Change: An Art and Science Collaborative, *Presenter: Andrea Thode*

P20. We all play a part- Bushfire Ready Neighbourhoods, *Presenter: Peter Middleton*

P21. Boulder County Wildfire Partners- Home Ignition Zone, Education, Certificates, Case Studies, and iPads
Presenter: Ryan Ludlow

P22. First Nations Wildfire Evacuation Partnership
Presenter: Tara McGee/Amy Christianson

P23. INSIGHT + ACTION = RESILIENCE Proven Results from Wollombi Australia
Presenter: Glenn O'Rourke

P24. Assessment of the Barriers to Wildland Firefighters' Fitness Training
Presenter: Aria Mangan

P25. Polycyclic Aromatic Hydrocarbon Exposure from Prescribed Fire
Presenter: Kathleen Navarro

P26. Impact of a Flame Resistant Synthetic Material Base Layer on Heat Stress
Presenter: Matthew Dorton

P27. Preliminary evaluation of factors affecting inhalation exposures among wildland firefighters
Presenter: Tim Reinhardt

P28. Rethinking the Fire Shelter
Presenter: Vincent Homer

P29. Fire and Debris Flows at the Boise Front,
Presenter: Katherine T Gibble

P30. Modeling Potential Fire Behavior Changes Due to Fuel Breaks in the Monterey Ranger District, Los Padres National Forest, California
Presenter: Stacy Drury

P31. Fuel Treatment Research and Technology Transfer – How to Better Support Practitioners' Needs
Presenter: Thomas Zimmerman

	CONCURRENT SESSIONS				
	Willows	**Pines**	**Firs**	**Cotton Woods**	**Merlins**
	Health *Moderator: Alan Goodwin*	***Special Session Two:*** ***Wildfire management in coupled human and natural systems: integrating biophysical and socioeconomic information***	***Special Session Three:*** ***Rethinking Awareness, between firefighter safety and safety strategy***	***Leadership*** *Moderator: Jennifer Ziegler*	***Resilient Responses*** *Moderator: Rebekah Fox*
2:30-2:35	Announcements and Introductions	Announcements and Introductions	Announcements and Introductions	Announcements and Introductions	Announcements and Introductions
2:35-2:55	62. Preliminary evaluation of factors affecting inhalation exposures among wildland firefighters *Tim Reinhardt*	68. A conceptual framework for coupling the biophysical and social dimensions of wildfire to improve fireshed planning and risk mitigation *Jeffrey D. Kline*	73. Rethinking Awareness, between firefighter safety and safety strategy *Marc Castellnou & Al Beaver*	74. Resonant Relational Leadership *David Christenson*	80. Building agency and community capacity for successful engagement – lessons learned from agency programs in Victoria, Australia *Tamara Beckett/Owen Gooding*
2:55-3:15	63. Adaptation of physical training and task performance to wildland firefighting in Spain. Improving firefighters wellness, capabilities and safety *Elena Hernandez*	69. The dynamics of fire-prone coupled human and natural systems (CHANS) and the emergence of wicked problems *Patrick Bourgeron*		75. Transfer of Knowledge, Skills, and Abilities from Leadership Development Training *Michael DeGrosky*	81. Climate Wise Communities: enhancing traditional wildfire risk management using a community multi-hazard resilience program in Sydney, Australia *Jennie Cramp*
3:15-3:35	64. A Review of Wildland Fire Smoke Exposure and Its Health Effects on Wildland Firefighters and the Public *Olorunfemi Adetona*	70. Impacts, trade-offs, and cross-scale connections between wildfire and ecosystem services in the Colorado Front Range *Jelena Vukomanovic*		76. The relationship of mindfulness and self-compassion to desired wildland fire leadership *Alexis Lewis Waldron*	82. Wildfire Resilience: The Development and Validation of the Bushfire Psychological Preparedness Scale (BPPS) *Jessica Boylan*
3:35-4:05	**NETWORKING BREAK with Exhbitors - *Eagle***				
4:05-4:10	Announcements and Introductions	Announcements and Introductions	Announcements and Introductions	Announcements and Introductions	Announcements and Introductions
4:10-4:30	65. Assessment of the Barriers to Wildland Firefighters' Fitness Training *Aria Mangan*	71. Linking Forest Management and Fire Hazard Conditions in the Eastern Cascades Ecoregion *Susan Charnley*	*Movie about Horta St. Joan accident in 2009. The movie will comunicate the complexity of the decisions made and the uncertainty faced by all the firefighters.*	77. Stockholm vs Woodstock: Risks Associated with Leadership *Bill Arsenault*	83. Increasing Community Resiliency by Promoting the Use of Prescribed Fire in the Southeastern United States: The Fire in Southern Ecosystems Program *Adam Kent*
4:30-4:50	66. An Alternative Way to Estimate Wildfire Smoke Health Costs? A Case Study of a Southwestern US "Mega-Fire" using the Benefits Mapping and Analysis Program – Community Edition (BenMAP-CE) *Benjamin Jones*	72. Predicting WUI homeowners' fire risk mitigation behavior under different landscape management and climate scenarios *Christine Olsen*		78. Leadership, Accountability, Courage and Knowledge *Victor Stagnaro*	84. INSIGHT + ACTION = RESILIENCE Proven Results from Wollombi Australia *Glenn O'Rourke*
4:50-5:10	67. Impact of Flame Resistant Synthetic Material Base Layer on Heat Stress Factors *Matthew Dorton*	Discussion and Q&A		79. Practicing as a Student of Fire: Local actions to support global issues *Kelsy Gibos*	85. Listening for Resilience: Expert Fire Managers Share Crucial Experience *Rebekah Fox*
5:15-6:30 PM	**Social Reception - *Eagle***				
6:30-7:30 PM	**HOSTED WORKSHOP - *Merlins*** **COP's, Cowboys and Geeks – A Round-up for Realtime Wildfire SA** Sponsored by Intterra and Sierra Nevada Corporation *Sign up at the Intterra Booth to reserve your space!*				

Thursday, April 23, 2015

	Willows	Pines	Firs	Cottonwoods	Merlins
7:30 am-5:00 pm	**Conference Registration/Information Desk Open - *Meadow (Boise Centre Foyer)***				
8:00-8:30	**Coffee with the IAWF Board of Directors - *Meadow***				
	CONCURRENT SESSIONS				
	Willows	**Pines**	**Firs**	**Cottonwoods**	**Merlins**
	Special Session Four: Comprehensive Wellbeing and Resiliency	***Special Session Five: Competency in Crisis***	***Special Session Six: Keeping Fire on the Mountain*** *Moderators: Henry Bastian, Laurie Kurth, Frankie Romero*	***Assessing and Mitigating Firefighter Risk*** *Moderator: Albert Simeoni*	***Risk*** *Moderator: Chuck Bushey*
8:30-8:40	Announcements and Introductions	Announcements and Introductions	Announcements and Introductions	Announcements and Introductions	Announcements and Introductions
8:40-9:00	86. Comprehensive Wellbeing and Resiliency takes each participant on on a personal and introspecitve journey, focusing on the whole person to include physical, mental, emotional and spiritual wellbeing through an interactive and hands-on approach to life. *Bequi Livingston and Michelle Reugebrink*	87. This special session is designed to move participants to a higher level of competency in crisis management by the use of case study, facilitated dialogues and interactive exercises. *Commander Christophe Frerson*	88. How We Decide: Research on fire management decision making and risk *Sarah McCaffrey*	93. Efficient calculations of optimum paths and travel time for firefighters *Joaquin Ramirez*	99. Marrying Strategic and Tactical Risk *Ivan Pupulidy*
9:00-9:20			89. Defining the Risks and Opportunities: An Agency Administrator's Perspective *Chuck Mark*	94. A comprehensive survey of the long-term health of current federal wildland firefighters *Erin Semmens*	100. The Incident Risk Console (RisC) – A Risk Assessment Synopsis for Wildland Fires *Lisa Elenz*
9:20-9:40			90. Making the Tough, but Right Decision: Review of the 2014 Fire Season on the Kaibab National Forest *Art Gonzales*	95. Quantifying Aviation Accident Risk in Wildland Fire Suppression *Crystal Stonesifer*	101. Developing a strategic wildfire risk assessment tool for the UK rural-urban interface *Julia McMorrow*
9:40-10:00			91. Decision Making for Multiple Fires, with Multiple Objectives, Across Multiple Units: A Geographic Area Fire Managers Perspective *Patti Koppenol*	96. Bald Sisters Fire *Brian Bishop*	102. Reducing the Risk of High Intensity Prescribed Fire *Rick Arthur*
10:00-10:20			92. Using wildland fire to protect, maintain, and enhance resources: A National Perspective *Dick Bahr*	97. De Soto Aviation Incident *Danny Bryant*	103. Dutch Creek Mitigation Measures: Successes & Failures *Bill Arsenault*
10:20-10:40			Q&A	98. Human Dimensions in Wildland Fire Management - Perspectives on the Past, Thoughts on the Future *Tom Harbour*	104. Rethinking the Fire Shelter *Vincent Homer*
10:40-11:00	**Networking Break - Eagle**				
	Willows	**Pines**	**Firs**	**Cottonwoods**	**Merlins**
	Special Session Seven: Wildland Firefighter Health and Safety at MTDC	***Mitigation*** *Moderator: Adam Gossell*	***Tragedy, Death and Recovery*** *Moderator: Lily Konantz*	***Firefighter Safety*** *Moderator: Victor Stagnaro*	***Climate/Weather/Fire Extremes*** *Moderator: Tim Brown*
11:00-11:20	105. This special session will give an overview of the projects at MTDC and how they are all interconnected to improve wildland firefighter safety and health. *Joseph Domitrovich, Tony Petrilli and Joe Sol*	106. Too Late When The Wildfire Is At The Mines Gate *Greg Bartlett*	109. Wildland Fire Fighter Deaths in the United States: A Comparison of Existing Surveillance Systems *Corey Butler*	112. Assessing Firefighter Safety Zone Characteristics *Phillip Dennison*	115. Adding to fire fighter safety through modeling of thunderstorm-induced windshifts: A case study with the 30 June 2013 Yarnell Hill Fire *Gary Achtemeier*
11:20-11:40	*Physiological Job Demands and Heat Stress*	107. We all play a part- Bushfire Ready Neighbourhoods *Peter Middleton*	110. Common Denominators on Tragedy Fires - Updated for a New Fire Enviornment *Matthew Holmstrom*	113. LiDAR mapping of firefighter safety zones: A comparison of flame height- and vegetation height-based guidelines *Michael Campbell*	116. Prototype Fire Weather Impact Based Performance Metric *Robyn Heffernan*

11:40-12:00	(cont…) Special Session Seven	108. Impact of federal fuels treatments on community firesheds in the Deschutes National Forest *Cody Evers*	111. Embracing Recovery: Establishing a Chaplaincy Service for the Wildland Fire Community *Matthew Carroll*	114. Evaluation of a Safety Zone Digital Calculator *Joaquin Ramirez*	117. Understanding effects of heat dosage on soils from slash pile burning in a Piñon-Juniper system (Pinus edulis-Juniperous monosperma) *Elyssa Durán*
12:00-1:30	**LUNCH (On your own)**				
1:30-2:30	**GENERAL SESSION - *Peregrines*** **The Changing Face of Incident Management Panel Discussion** Facilitator: **Larry Sutton,** *US Forest Service, Conference Co-Chair* **Robert R. Maynes,** *Deputy Assistant Chief Retired, Fire Department City of New York, Queens Borough Commander, FDNY IMT Incident Commander;* **Jim Manahan,** *Former Assistant Chief of Operations, FDNY and Current FEMA, IMT IC (NYRegion);* **Pruett Small,** *Training Officer, Groom Creek Fire District, Prescott, Arizona*				
2:45-3:00	**Break /Transition to Concurrent Sessions**				
	CONCURRENT SESSIONS				
	Willows	**Pines**	**Firs**	**Cottonwoods**	**Merlins**
	(continued..) **Special Session Seven: Wildland Firefighter Health and Safety at MTDC**	***Mitigation*** *Moderator: Adam Gossell*	***Fuels Management*** *Moderator: Marjie Brown*	***Firefighter Safety*** *Moderator: Victor Stagnaro*	***Climate/Weather/Fire Extremes*** *Moderator: Tim Brown*
3:00-3:05	Announcements and Introductions	Announcements and Introductions	Announcements and Introductions	Announcements and Introductions	Announcements and Introductions
3:05-3:25	*Fitness Standards, Nutrition and Hydration*	118. Cost-effective fuel treatment planning *Jason Kreitler*	121. Description of Firebrand Generation in a Pine Stand Fire *Albert Simeoni*	124. Yarnell Hill Entrapment: Additional lessons that could be learned *Richard McCrea*	127. Fire Extremes and the Triangle of Climate, Fuels and People (Part 1) *Tamara Wall*
3:25-3:55	*Fire Shelter Update*	119.. Left out from wildfires mitigation: Does university's population think different? *Thomas Wuerzer*	122. Fuel Treatment Research and Technology Transfer – How to Better Support Practitioners' Needs *Tom Zimmerman*	125. Distilling and disseminating new scientific understanding of wildfire fire phenomena and unfolding of large wildfires to prevent wildland firefighter entrapment *Janice Coen*	128. Fire Extremes and the Triangle of Climate, Fuels and People (Part 2) *Tim Brown*
3:55-4:15		120. Boulder County Wildfire Partners-Home Ignition Zone, Education, Certificates, Case Studies, and iPads *Ryan Ludlow*	123. Modeling Potential Fire Behavior Changes Due to Fuel Breaks in the Monterey Ranger District, Los Padres National Forest, California *Stacy Drury*	126. Listening Up, Down, and Around: Sound Studies and Wildland Firefighter Situational Awareness *John Widman*	Q&A
4:15-:4:20	**Break/Transition to General Session**				
4:20-5:20	**GENERAL SESSION - *Peregrines*** **The Doctrinal Road to Risk Management - Where We've Been, Where We Are Headed** **Tom Tidwell**, *US Forest Service Chief*				
5:20-5:30	**Conference Adjournment**				
6:00 -	**After Hours Networking** Proto's Pizzeria Napoletana, 345 South 8th Street *(10% of the proceeds collected throughout the day will be donated to our fundraising efforts)*				
Friday, April 24, 2015					
	Post Conference Tours and Field Trips				
9:00-12:00	**Oregon Trail - 6 Years of Post-Fire Mitigation** *Sponsored by Fire Adapted Community Learning Network (Meet at 9:00 am Boise Centre - Cottonwoods)*				
9:00-11:30	**National Interagency Fire Center** *(Meet at 8:45 am in the Boise Centre Foyer)*				
9:00-12:30	**Boise City Tour and Botanical Gardens** *(Meet at 8:45 am in the Boise Centre Foyer)*				
1:00-3:30	**National Interagency Fire Center** *(Meet at 12:45 am in the Boise Centre Foyer)*				

WORKSHOPS

FULL DAY WORKSHOPS

BUILDING CAPACITY TO COLLABORATE IN NATURAL RESOURCES MANAGEMENT

Instructors: Susie Kocher, Natural Resources Advisor, California Registered Professional Forester #2874, University of California Cooperative Extension – Central Sierra (El Dorado, Amador, Calaveras and Tuolumne Counties) and Kim Ingram, Community Education Specialist, , University of California Cooperative Extension Outreach Specialist for the Sierra Nevada Adaptive Management Project

This workshop is for scientists, public land managers and stakeholders to build their capacity to collaborate in adaptive management. UC Cooperative Extension has developed training modules for all levels of natural resource management staff and stakeholders interested in developing these skills. Using a train the trainer model, we review best practices for, framing collaborative projects, meeting logistics, group dynamics, understanding interactions, dealing with difficult behaviors and reducing conflict. Over 150 staff from federal and state forestry, fire, wildlife and research agencies, local conservation districts, non-profits and irrigation districts affiliated with the Sierra Nevada Adaptive Management Project have attended this workshop in 2013 and 2014 and report that the workshops are timely and relevant addressing collaboration issues with which they are currently dealing.

Bios: Susie Kocher is a county-based academic who conducts outreach, education and applied research for UCCE focusing on forest resilience and wildfire issues, most recently as part of the California Fire Science Consortium. She has coordinated public outreach for the Sierra Nevada Adaptive Management Project (http://snamp.berkeley.edu/) for the past six years.

Kim Ingram is an outreach specialist who has represented the 8 year, 13 million dollar University of California study of fuels reduction projects on Sierra national forests for the last six years including presenting project progress to community groups, hosting science meetings with stakeholders, organizing field trips and communicating through blogs, videos and emails. She led development of the Facilitation Skills for a Collaborative Adaptive Management Process workbook written to help train SNAMP participants available on line at http://snamp.cnr.berkeley.edu/documents/574/.

THE FIRE THAT BURNS WITHIN: FIRE SERVICE SUICIDE – THE REALITY

Instructor: Mary VanHaute, Coordinator/Trainer, St. Petersburg College Center for Public Safety Innovation

There is a growing concern that suicides may be occurring in the fire service at higher levels than in the general population. The Center for Public Safety Innovation at St. Petersburg (FL) College has been grant funded to develop suicide prevention awareness programs to address the issue and reduce the risk of suicide among firefighters. This eight-hour course provides an overview of the suicide issue globally, in the United States, and within the profession. The suicide prevention workshop is broken into five modules that include information about suicidal behaviors and communication, prevention efforts, protocol and policy development, issues revolving stigma and how to care for survivors of suicide loss.

ASSESSING RESIDENTIAL WILDFIRE HAZARDS

Instructor: Pat Durland, NFPA Instructor & Principal, Stone Creek Fire LLC

Assessing Residential Wildfire Hazards is a new and popular NFPA workshop and discussion of the physical science of heat transfer required for structure ignition by wildfires. The session topics evolve to the social science processes and models that facilitate behavior change and lead to successful WUI mitigation action at residential and community levels.

- Provide a summary of the major issues that contribute to wildland/urban fire losses.
- Discuss the science and research of how landscape fires ignite structures.
- Identify the features & mitigation applications of structural ignition zones.
- Examine the social aspects of understanding and applying pre-event mitigation actions.
- Discuss the process of moving from residential to community mitigation successes.

Bio: Pat has 40 years of experience in all phases of wildland fire management. He is nationally recognized for his expertise in modern-day wildfire mitigation methods and training.
He has assisted numerous federal, state and local agencies, non-profit organizations and insurance companies in developing and implementing successful wildfire mitigation programs.
Pat assisted NFPA with the development of this program and instructs it throughout the US.
As a 20-year resident of the Boise foothills, Pat understands WUI wildfire danger both personally and professionally.

ANNUAL FIRE REFRESHER – RT-130

Instructors: Joel Welch-Lead Instructor, Mike Elles-Unit Lead, Matt Ziegler-Unit Lead, Rob Smolczynski-Unit Lead, Tim Garity- Unit Lead, Jeremy Schwandt- Unit Lead

Attendance at an RT-130 is required for designated positions in order to maintain currency, and for all personnel assigned to positions with fireline duties and for any position assigned to the fireline for non-suppression tasks.RT-130 training will focus on mandatory core content subjects and not on a minimum time frame standard (number of training hours).

MORNING WORKSHOPS (8:30-12:30)

IMPROVING RISK ASSESSMENT THROUGH FIRE BEHAVIOR ANALYSIS

Instructors: Dan Mindar, WFM RD&A (DOI NPS), Erin Noonan-Wright, WFM RD&A (USDA FS) Tami Parkinson, WFM RD&A (USDA FS), Laurie Kurth, Applied Fire Ecologist (USDA FS)

The workshop will focus on the interaction between Line Officers (decision makers) and Fire Behavior Specialists, such as Fire Behavior Analysts (FBAN), Long Term Analysts (LTAN) Geospatial Analysts (GSAN), and Technical Specialists (THSP) during wildfire risk assessments. Through short case study presentations and panel discussions we will explore how we can better work together to develop more complete risk assessments and better utilize the tools of science and technology in risk-informed decision-making on wildland fires. We will demonstrate what and how fire behavior information can influence a decision and lead to improved resource management as well as explore opportunities to develop additional information that currently is not available.

Target Audience: Fire Behavior Specialists and Line Officers involved in risk assessments and decision making on wildland fire incidents.

WILDLAND FIRE SMOKE HEALTH EFFECTS RESEARCH AND TOOLS TO INFORM PUBLIC HEALTH POLICY AND RECOMMENDATIONS

Instructors: Ana G. Rappold, Susan Stone, Pete Lahm, Wayne E Cascio, Sarah Henderson, Ph.D., Angela Jiayun Yao, Catherine Elliott, MD, PHPH, Joseph W Domitrovich, Ian Gilmour, Brian Reich, Sim Larkin, Ph.D., Susan O'Neill , Dr. Paul Garbe

Due to a predicted increase in the number and severity of wildfires, new research has focused on identifying the health effects associated with both public and firefighter exposure to wildland fire smoke and spatiotemporal prediction of smoke exposures. In the last several years the Joint Fire Science Program (JFSP) funded research proposals for estimating the health impacts of wildfires and exposures to smoke. The goal of this workshop is to bring together health researchers, including those funded by JFSP, together with federal, state, and local agencies who develop public health policies, as well as the technology by which relevant information can be transferred. In the first part of the workshop we will discuss health research and how it can be used to inform public health policy. The second part of the workshop will focus on guidelines and recommendations to reduce the public health impacts of smoke exposure, and the new tools for forecasting smoke. As a result of the workshop, researchers will gain further insight on the knowledge needed to improve public health practice and related gaps, as well as gain understanding of the latest technologies and how they can be used to transfer useful information.

Bios: Ana G. Rappold, Ph.D. -Dr. Rappold is a Statistician with EPA, Office of Research and Development, Environmental Public Health Division, and the task lead on North Carolina Wildfire Health Study. Dr. Rappold conducts clinical and epidemiological research of health effects from air pollution at EPA. She is the lead author on three studies of impacts of smoke on communities in rural North Carolina and an author of wood smoke controlled human exposure study. Dr Rappold is also a co-investigator of 2014 JFSP grant "Estimating fire smoke related health burden and novel tools to manage impacts on urban populations".

Susan Stone, MPH - Susan Stone is a Senior Environmental Health Scientist with EPA, Ambient Standards Group, Health and Environmental Impacts Division, and is the leader of the team reviewing the national ambient air quality standard for ozone. Ms. Stone is also the Air Quality Index (AQI) team leader, has coauthored many of EPA's public information documents about the AQI, the health effects of criteria pollutants, and the multi-agency document Wildfire: A Guide for Public Health Officials. She is an author of two studies of the health impacts of smoke from a fire in Eastern North Carolina and one wood smoke controlled human exposure study. Susan Stone has an M.S. from the School of Public Health at the University of North Carolina at Chapel Hill.

Pete Lahm - Pete Lahm is an Air Resource Specialist for the USDA Forest Service, Fire and Aviation Management in Washington, DC. Program manager for the Wildland Fire Air Quality Program which addresses smoke from wildfires and prescribed fires. His focus has been national smoke policy, training and development of smoke impact and forecasting tools.

Wayne E Cascio, MD - Dr. Cascio is the Director of the Environmental Public Health Division, EPA and has an adjunct clinical appointment at the UNC School of Medicine in the Department of Medicine, Division of Cardiology. Dr Cascio is board certified by the American Board of Internal Medicine in Internal Medicine and Cardiovascular Diseases. His current research interests include the study of the cardiovascular health effects of air pollution including wildfire smoke for the purpose of informing risk assessment and mitigation strategies; improvement of public health and quality of life through increased environmental health communication and literacy; and decreased environmental risks particularly among vulnerable and high-risk populations.

Sarah Henderson, Ph.D. - Sarah Henderson is an environmental engineer turned environmental epidemiologist. Her research interests lie at any intersection between public health and environmental exposures. Sarah leads the data analyses and study design for a wide variety of projects in Environmental Health Services at the BCCDC. Her current work is related to surveillance modeling, hot weather morbidity and mortality, the health impacts of forest fire smoke, provincial radon exposure, and food safety. Together with colleagues at UBC and the University of Tasmania, she also continues to collaborate on academic projects related to air pollution from forest fire smoke.

Angela Jiayun Yao - Angela Yao completed her master's degree in environmental health at University of British Columbia in 2012 and has been working at the British Columbia Centre for Disease Control since graduation. She has been involved in several studies assessing forest fire smoke exposure and its health effects, as well as the development of public health surveillance system for forest fire smoke exposure. She recently returned to the School of Population and Public Health at UBC to pursue her PhD.

Catherine Elliott, MD, PHPH - Catherine Elliott is a physician epidemiologist with Environmental Health Services at BC Centre for Disease Control and the National Collaborating Centre for Environmental Health since 2008. She earned a Bachelor of Science in Ecology and Environmental Science from McGill University, a medical degree and residency in rural family medicine, as well as a Master's degree in Health Sciences and a fellowship in Public Health and Preventive Medicine (PHPM) at UBC. Recently, Dr. Elliott led an international work group to develop guidelines for public health decision-making during wildfire smoke events. Dr. Elliott's current research at BCCDC/NCEEH includes health effects of air pollution including wildfire smoke, health impact assessment, heavy metals exposures in population subgroups and environmental health surveillance.

Joseph W Domitrovich, Ph.D. - Joe is an exercise physiologist at MTDC and a Pulaski motor. He completed his Ph.D. at the University of Montana, Missoula in Interdisciplinary Studies with an emphasis in exercise physiology. He received his Master's also at the University of Montana, and his Bachelors' at Cal Poly San Luis Obispo. Joe's work at MTDC includes hydration, nutrition, health effects of smoke, heat related illnesses, stress and fitness. Dr Domitrovich is a principal investigator for JFSP funded grant tilted "Wildland Fire Smoke Health Effects on Wildland Firefighters and the Public".

Ian Gilmour, Ph.D. - Ian Gilmour is Chief of the Cardiopulmonary and Immunotoxicology Branch of the U.S EPA's Office of Research and Development in RTP. He received an Honors degree in Microbiology from the University of Glasgow, and a doctorate in Veterinary Science from the University of Bristol in 1988. After post-doctoral work at John Hopkins University and the University of North Carolina he joined the EPA in 1998. He holds adjunct faculty positions with the UNC School of Public Health and the Curriculum in Toxicology, and at NC State Veterinary School. He has published over 80 articles on the composition and toxicity of air pollutant mixtures and their influence on the development of infectious and allergic lung disease. Dr Gilmour is the principal investigator for 2014 JFSP grant titled "The role of composition and particle size on the toxicity of wildfire emissions".

Brian Reich, Ph.D. - Brian Reich is an Associate Professor in the Department of Statistics at North Carolina State University. He obtained his Ph.D. in Biostatistics from the University of Minnesota in 2005. His research focuses on spatiotemporal modeling of complex processes in ecology and atmospheric science, methods for high-dimensional data, and extreme value analysis. He has published over 70 papers on these topics, and in 2013 was awarded the Young Researcher's Award by the American Statistical Association's Section on Statistics and the Environment. Dr Reich is the principal investigator of 2014 JFSP grant "Estimating fire smoke related health burden and novel tools to manage impacts on urban populations"

Sim Larkin, Ph.D. - Sim Larkin is a research scientist and team leader with the U.S. Forest Service's AirFire Team in Seattle, Washington. He works extensively with fire management to transition science into operationally useful decision support systems. He is the original architect and designer of the BlueSky Smoke Modeling Framework which is now used in daily smoke predictions and smoke management tools such as BlueSky Playground.

Susan O'Neill, Ph.D. - Susan O'Neill is a Research Air Quality Engineer with the USDA Forest Service Pacific Northwest Research Station, AirFire Team, and has a Ph.D. from the Laboratory for Atmospheric Research at Washington State University. She is an original developer of the BlueSky smoke modeling framework and research interests extend to all aspects of modeling fire emissions, smoke dispersion and transport, and smoke plume chemistry.

Paul Garbe, DVM, MPH - Paul Garbe is Chief of the Air Pollution and Respiratory Health Branch, National Center for Environmental Health at the Centers for Disease Control and Prevention. He directs CDC's National Asthma Control Program, which supports 23 state health departments for comprehensive asthma control activities. Dr. Garbe leads CDC efforts to assist state health departments with public health response to air pollution exposures, including wildland fire smoke exposures.

AFTERNOON WORKSHOPS (1:30-5:30)

US NATIONAL GRID (USNG) AND WILDLAND FIRE

Instructors: Rich McCrea, IAWF member, Wildfire Magazine Vice-Chair, Owner of LarchFire LLC Wildland Fire Consulting and Al Studt. Communications & Structures Specialist with Florida Task Force 4, Lieutenant with Cape Canaveral Fire Rescue, Cape Canaveral, FL.

This workshop entails basic training on the U.S. National Grid (USNG) with hands on demonstrations of GPS and web tools. USNG provides a nationally consistent language of location that has been optimized for local applications. The USNG expands the utility of topographic, street and other large-scale maps by adding several powerful features: It provides a grid reference system that is seamless across jurisdictional boundaries; it provides the foundation for a universal map index; and it enables user-friendly position referencing on appropriately gridded paper and digital maps, global positioning systems (GPS) receivers, and other map portals.

USNG is easy to learn and use and is interoperable with multiple agencies including the US Military. There are many potential applications of USNG in wildland fire operations including tracking firefighting resources, planning and implementation of daily fire operations, and tracking fire behavior across the landscape. USNG grid coordinates can be quickly articulated over a radio, using an identification that totals 6 numbers — the basic, truncated numbers that define any location to an area 100 meters by 100 meters. The potential uses of USNG will be discussed as well as how this system could be implemented.

Bios: Rich works as a wildland fire management consultant and freelance writer. During his career, he worked 32 years with the Department of Interior in fire management and forestry. Outfitted with a degree in Forestry, he started his career as a seasonal employee with the Forest Service as a forestry technician and member of the Helena Hotshot Crew, then moved on to permanent positions with the Bureau of Indian Affairs as a Forester and Fire Management Officer. Rich has considerable experience working with incident management teams including over 23 years' experience as a qualified fire behavior analyst.

Al is a Certified Fire Protection Specialist and Florida Fire Instructor III that is in his 32nd year of fire service and 12th year of urban search & rescue service with deployments to areas ravaged by Hurricanes Andrew and Katrina. Since 2007, Al has worked on implementation and training of US National Grid on local, state and federal levels and has authored numerous articles. He also edited multiple documents for State of Florida requirements regarding US National Grid use during emergency operations. In 2014, he authored an article related to Yarnell Hill fatalities that recommended use of truncated US National Grid as an expedited means to report position on wildfire scenes.

STRESS FIRST AID FOR FIREFIGHTERS AND EMERGENCY MEDICAL SERVICES PERSONNEL

Instructors: Kim Lightley and Dr. Patricia Watson

Stress First Aid (SFA) is a National Fallen Firefighters Foundation program supporting Firefighter Life Safety Initiative #13, "Firefighters and their families must have access to counseling and psychological support." It is designed to reduce the risk for stress reactions in fire and rescue personnel and to help recognize individuals who are reacting to a wide range of stressors in their work and personal lives and who are in need of interventions. SFA offers a spectrum of one-on-one or group interventions to ensure safety, reduce the risk for more severe stress reactions, and promote recovery. SFA monitors the progress of recovery to ensure return to full function and well-being. The principles of peer teams in the fire service and how they can be organized to promote healing are also discussed.

COMPETENCY IN CRISIS

Instructors: Christophe FRERSON, MSc, Commander, French Fire Service

This workshop is designed to move participants to a higher level of competency in crisis management by the use of case study, facilitated dialogues and interactive exercises. Learners will virtually visit the Southern France Crisis Center and experience a 2014 day of Corsican multiple crises (simultaneous wildfires, evacuations, village fires, main roads blocked and a fire engine rollover accident) through interactive media with some of the French operations leaders. You will see firsthand how they consciously use High Reliability Organizing processes to support competency during this multi-crisis day and learn how to bring the salient parts together to "up your game." Competency in this context is an amalgamation of critical thinking, time pressure decision making, and of course leadership. You will have the opportunity to learn and practice new skills in a safe environment with expert guidance. A library of case studies, in addition to the Corsican crisis, will be available after the special session to demonstrate key learning concepts with Saddleback and Yarnell Hill fatality fires as well as other international incidents.

Bio: Since 2012 **C. FRERSON** works as Civil Protection Advisor in the Ministry of Interior, General Directorate of Civil Protection and Crisis Management, at the Southern Inter-ministry Headquarters. He is responsible for planning and is head of the Zonal Emergency Operation Center. In this position, he covers all kind of risks in 16 counties with 22,000 firefighters and a population of about 9 million citizens. C. FRERSON has presented at several international conferences and has published some papers about crisis management. Christophe FRERSON holds a Master's degree in "RISK and Crisis Management." Since 1998, he has worked as an officer in several Fire Departments in various positions, such as, Battalion Chief, Head of Fire Station, Incident Commander, Air Attack Supervisor, designer and head of Research & Technology for operations. During his posting as head of R&T service, he was maintaining international and university partnerships to focus on, share or disseminate lessons learned.

Wednesday, April 22, 6:30-7:30 pm
Location: Merlins
Sign up at the Intterra table to reserve your space!

COP'S, COWBOYS AND GEEKS – A ROUND-UP FOR REALTIME WILDFIRE SA

Sponsored by Intterra and Sierra Nevada Corporation

Situational Awareness is about personal safety, better decisions, effective resources, and improved efficiency. Come learn how to round-up the necessary parts and players that make Wildfire SA a reality for your organization. From a Common Operating Platform to integrated imagery, the geeks that make the data work and the cowboys (and cowgirls) that are bold enough to try new tech will share what we know about realtime SA.

Attendees will learn about:

- Common Operating Platforms – what are they, how do they work, how to select one.
- Geospatial technology – beyond Google, how do you make maps work hard to answer your questions.
- Remote Sensing – Infrared, aerial, satellites, drones, fuels, what is the latest imagery available.
- Data Interoperability – how to share with one another. Nicely.
- Components of tech-supported SA systems – hardware, bandwidth, AVL/CAD, software, data, users - everything has a planned need.
- Current System Examples – see what is out there and in use today.

This fun and interactive session will not only discuss the above, but teach users that bring their tablets how to use tools, access and share data, make mobile maps, and publish critical map info to the media.

FIELD TRIPS

OREGON TRAIL - 6 YEARS OF POST-FIRE MITIGATION (9:00-12:00)

The tragic fatal Oregon Trail fire on October 25, 2008 has led to numerous wildfire mitigation activities centered around the Oregon Trail area and throughout the city, and has led to numerous cooperative partnerships. This tour will highlight the Oregon Trail fire with video clips and a PowerPoint and will also inform attendees about partnerships built over the last several years as well as mitigation initiatives citywide that have occurred since that time, to include lessons learned.
Field Trip Led by: Jerry McAdams, Julia Grant, Jennifer Tomlinson, Brett Dumas, Josh Renz

FIRE ADAPTED COMMUNITIES LEARNING NETWORK

The Oregon Trails Tour is supported by Promoting Ecosystem Resilience and Fire Adapted Communities Together, a cooperative agreement between The Nature Conservancy, USDA Forest Service and agencies of the Department of the Interior Bureau of Indian Affairs, Bureau of Land Management, National Park Service and U.S. Fish & Wildlife Service through a subaward to the Watershed Research and Training Center.

NATIONAL INTERAGENCY FIRE CENTER (9:00-11:30 & 1:00-3:30)

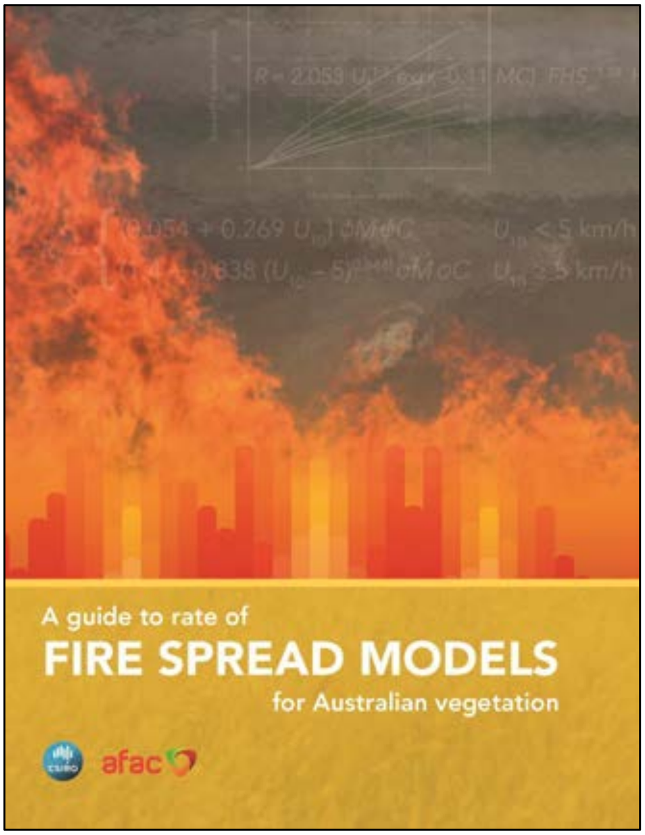
Tour of the National Interagency Fire Center (NIFC), home to national offices of all federal wildland fire management agencies including US Forest Service, Bureau of Land Management, National Park Service, US Fish and Wildlife Service, and Bureau of Indian Affairs; national representatives of the National Association of State Foresters (NASF), United States Fire Administration, Department of Defense, National Weather Service, the National Interagency Coordination Center (NICC), and operational facilities that include a national radio cache, fire engine development center, geographic area equipment cache, smokejumper base, aerial retardant base, and Wildland Firefighter Monument. The tour will specifically provide information on: NICC and an overview of the three tiered dispatch system and four functional coordination areas (equipment, aviation, overhead/crews and predictive services) and a discussion of the National Multi-Agency Coordinating Group (NMAC), overview of eight divisions of the radio cache, a walk-through of the Great Basin equipment cache, an overview of the Smokejumper base and program, an overview of the retardant base, and a walk through of the WFF Monument.

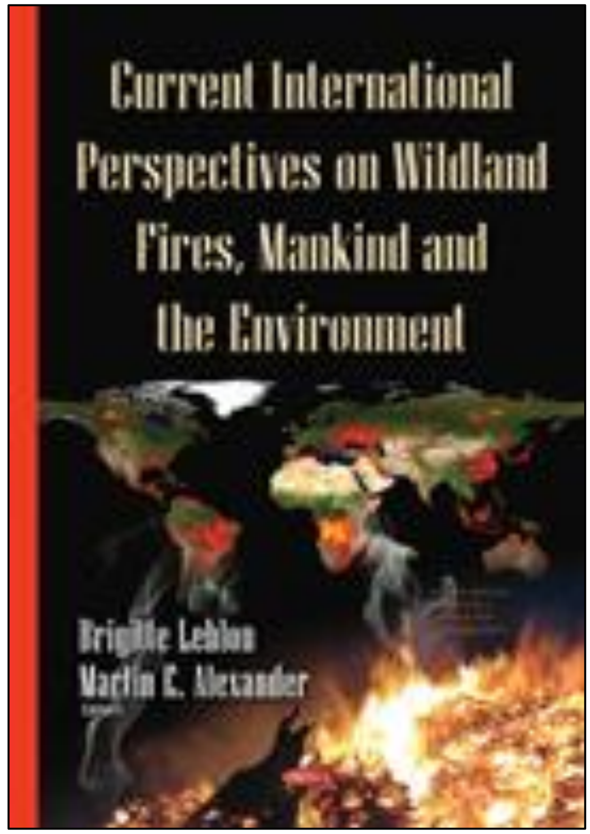
BOISE CITY TOUR AND BOTANICAL GARDENS (9:00-12:30)

This trip will be led by a local guide; guests will visit the following sights in Boise.
The tour will begin and end at the Boise Centre:

- Old Oregon Trail sites
- Downtown Boise
- Boise Basin/Idaho Gold Rush history
- Irrigated Agriculture development
- Idaho Botanical Gardens & Firewise Gardens
- Boise Greenbelt
- Boise Depot
- Old Boise and Warm Springs Avenue
- M-K Nature Center
- Idaho State Capitol
- Boise State University
- Anne Frank Human Rights Memorial

HOT OFF THE PRESS!





Australia Releases New Guide to Predicting Bushfire Rate of Spread
The Australasian Fire and Emergency Service Authorities Council (AFAC) and the Commonwealth Scientific and Industrial Organisation (CSIRO) of Australia have released a new guide to help predict bushfire spread according to Issue 40 (January 2015) of AFAC-news. To order see http://www.afac.com.au/ProductCatalog/Product?ID=1469

Nova Science Publishing Adds to Suite of Wildland Fire Books
This book is the latest contribution dedicated towards the scholarship surrounding the subject of wildland fires to be published by NSP. It consists of a collection of nine chapters covering topics that support the management of wildfires and prescribed fires written by authors based in the northern and southern hemispheres. To order see https://www.novapublishers.com/catalog/index.php

EXHIBITORS

Aviation Specialties Unlimited
www.asu-nvg.com

Since 1994, Aviation Specialties Unlimited (ASU) has been known for launching the FAA's endorsement for the use of night vision technology in civil aviation. The direct beneficiaries of these efforts include EMS, Law Enforcement, and Search and Rescue operations, but also encompass communities across our nation protecting public safety, natural resources, and the welfare of those executing critical missions.

ASU has earned a reputation as a leading innovator in aviation night vision imaging system design, manufacturing, installation, certification, sales, training and service. ASU continues to invest in the development of innovative products and solutions. In 2014, ASU expanded its corporate headquarters and staff to better serve customers around the world who operate in the air, on land, and by sea.

Today's society is demanding smarter technology and a safer environment without compromising quality or efficiency. ASU is accepting that challenge with our continued Innovation for a Safer Tomorrow.

Boise State University
https://www.boisestate.edu/

Boise State University researchers have come together from many disciplines to investigate aspects of natural hazards in southwestern Idaho, in order to better communicate with agencies and policy makers, and prepare our communities and citizens for risks in the future. We conduct research on wildfires, flooding, and related hazards, currently including dust emissions, post-fire debris flows, and the spread of invasive species. Housed in the Departments of Geosciences, Community and Regional Planning and the Public Policy Research Center, professors and students work to cross disciplines in order to establish a meaningful understanding of fire hazards at the wildland urban interface (WUI) and within the Great Basin region, where the threat of climate induced hazards continues to grow and must become more well understood. Our policy researchers are currently seeking to understand wildfire risk perception at the WUI and are conducting a policy network assessment of urban flooding in the Treasure Valley. Our geoscientists work to identify and predict areas prone to fire-related flooding and debris flows, synthesize long-term records of fire and debris flows, and model fuels and resulting burning conditions for the Boise WUI. Our regional planners apply GIS and visualization to analyze and portray wildfire and hazards impact on the landscape. Come to our booth and meet our researchers to learn more about the exciting work currently taking place here at Boise State University!

Bridger Aerospace
http://www.bridgerenterprises.com/aerospace-2/

Bridger Aerospace provides capable, cost-effective, and user friendly intelligence, surveillance, and reconnaissance products and services. Combining a team with years of operational experience with innovative technnology partners, we provide capabilities previously accessible only to those with government or military budgets at a fraction of the cost. From gimbal camera systems and unmanned aerial platforms to full-service ISR flights and custom systems, Bridger Aerospace will work with you to provide the capability you need.

Dragonslayers, Inc
www.dragonslayers.com

Dragonslayers.com does two specific things:
First we consolidated and advanced the traditional wildfire hand tools. They are stronger, wider, longer, more versatile, safer and by far much more effective. These were engineered so that each fire fighter can have their own tool that breaks down and lays flat for mobilization to an incident with their own personal gear. One Universal handle and a Magnum Pulaski, and a Troop Tool weighs 7 lbs. So versatile and responsive is this simple set of tools is that it allows each fire fighter to have a stand upright better angled McLeod scraping tool, an angled shovel for digging and throwing dirt, a better mop-up stand erect tool, a safety staff for negotiating bad ground, and a really better Pulaski that is twice as wide a grub-hoe, balanced, center of mass and longer.

EnviroVision Solutions USA
http://www.evsolutions.biz/

The ForestWatch® early Wildfire Detection and Monitoring System was developed by EnviroVision Solutions (EVS), a South Africa technology firm founded in 2002. Using color image based smoke detection software it provides state of the art situational awareness to fire managers. In 2009 the USA division of EVS was established in Roseburg, Oregon providing service and support for the USA and Canada. EVS has multiple Wildfire Detection and Monitoring Centers around the world including 9 in South Africa covering 4 million acres with 167 towers. The Roseburg, Oregon monitoring center has 30 cameras covering 10 million acres partnering with several wildland fire agencies working together to provide mutual support for early detection of wildfire. Partnering agencies at the Roseburg operations center are the Oregon Department of Forestry, United States Forest Service, Bureau of Land Management, and two local Wildfire Associations, including Douglas Forest Protective Association and Coos Forest Protective Association. In 2013 EVS installed a 42 tower system with one monitoring center in Saskatchewan Canada for the Ministry of Environment. In 2014 EVS USA installed a system in Minnesota for the Department of Natural resources as well as installing the ForestWatch® system at 18 tower sites and 7 monitoring centers in California.

ForestWatch® is a wildfire detection and monitoring system integrating real world data into a powerful decision support and emergency management system that can significantly reduce the time between fire ignition, discovery and dispatch. The ForestWatch® software enables an interface with highly programmable "off the shelf" cameras capable of pan, tilt, and up to 36X optical zoom, in automatic and fully manual modes, providing panoramic color images, Geo-referencing, and smoke detection yielding real time fire intelligence. Night time detection, utilizing near-infrared, provides for 24/7 protection. Camera footage is date and time stamped and archived for investigations and after action reviews. Integrated Geo-referencing pinpoints fire start locations and displays latitude, longitude, distance and bearing on the image, utilizing standard ESRI GIS compatibility. ForestWatch® Online provides web access to near real time and stored images allowing fire mangers to view new fire starts or ongoing incidents.

Fire Science Exchange Network
http://www.firescience.gov/JFSP_exchanges.cfm

The Joint Fire Science Program's Fire Science Exchange Network is actively working to accelerate the awareness, understanding, and adoption of wildland fire science information by federal, tribal, state, local and private stakeholders within ecologically similar regions. The network of 15 regional exchanges provides timely, accurate, and regionally relevant science-based information to assist with fire management challenges. Regional activities, through which the exchanges engage fire managers, scientists and private landowners, include online newsletters and announcements, social media, regionally-focused web-based clearinghouses of relevant science, field trips and demonstration sites, workshops and conferences, webinars and online training, and syntheses and fact sheets.

The 15 Regional Fire Science Exchanges
Check out your local Fire Science Exchange at the Joint Fire Science Program website – FireScience.gov – to connect with fire managers, practitioners, and scientists in your region.

FRAMES - Fire Research & Management Exchange System

www.frames.gov

FRAMES provides searchable fire-related information, a platform for data sharing and storage, development of new tools, and support to federal wildland fire management agencies in the United States throughout the various stages of wildland fire, including planning, operation, and post-fire monitoring. This online resource was developed for wildland fire managers, researchers, and other stakeholders by the University of Idaho in collaboration with the USFS Rocky Mountain Research Station. FRAMES offers an array of services and features including:

- The Resource Cataloging System (RCS), a searchable online database of data, documents, web pages, tools, projects, and programs. The RCS houses thousands of records and provides access to the Tall Timbers E.V. Komarek Fire Ecology Database
- The FRAMES Emissions and Smoke Portal with educational materials on air quality and smoke management developed by the National Wildfire Coordinating Group's (NWCG) Smoke Committee (SmoC) and the University of Idaho
- Online training for wildland fire managers developed by National Interagency Fuels Technology Transfer (NIFTT) and the National Wildland Fire Coordination Group (NWCG)
- Archived fire videos and webinars from IAWF, the Wildland Fire Lessons Learned Center, and JFSP regional consortia
- Conferences, Meetings, Webinars, Workshops, Training, Announcements, and Job Postings

Grainger

http://www.grainger.com/
@grainger

Grainger with 2013 Sales of 9.4 Billion is North America's leading broad-line supplier of maintenance, repair and operating (MRO) products, with an expanding global presence. Grainger helps customers save time and money by providing the right products and solutions to keep facilities up and running.

International Fire Relief Mission

www.ifrm2007.com

The International Fire Relief Mission is a 501(c)(3) nonprofit corporation that provides humanitarian aid to fire and EMS first responders in developing countries by recycling serviceable fire fighting and EMS equipment. IFRM dispatches teams to the receiving countries to demonstrate and provide the necessary information to safely and effectively use the donated gear. Founded by retired firefighters and medics in 2007, IFRM is propelled by monetary, equipment and in-kind donations from corporate partners and individuals; its field staff is all-volunteer. IFRM maximizes its donors' gifts by operating with a 98% efficiency rating, as measured by the Charity Navigators and the Better Business Bureau. The International Fire Relief Mission is firefighters helping firefighters.

Interagency Joint Fire Science Program

http://www.firescience.gov/
@FireScienceGOV

The Joint Fire Science Program funds scientific research on wildland fire and distributes results to help policymakers, fire managers, and practitioners make sound decisions, by-

- providing credible research tailored to the needs of fire and fuel managers
- engaging and listening to clients and then developing focused, strategic lines of new research responsive to those needs
- soliciting proposals from scientists who compete for funding through a rigorous peer-review process designed to ensure the best projects are funded
- focusing on science delivery when research is completed with a suite of communication tools to ensure that managers are aware of, understand, and can use the information to make sound decisions and implement projects

The Joint Fire Science Program is uniquely positioned to tailor wildland fire research in response to the emerging needs of policymakers and fire managers. An annual cycle of proposal solicitation, review, and funding ensures timely response to evolving conditions. Research projects complement and build on other federal research programs, such as those in the Forest Service Forest and Rangeland Research Stations, U.S. Geological Survey, and National Fire Plan. Synthesis of research findings and targeted delivery to managers are essential components of the Program.

More than 90 colleges and universities have collaborated on and partnered with JFSP sponsored research projects. By engaging masters and doctoral candidates in these projects, we are training the next generation of resource managers and scientists. This collaboration extends to private, non-profit organizations and tribal, state, county, and local governments as well. In all, nearly 200 organizations have become partners in JFSP-sponsored research.

National Cohesive Wildland Fire Management Strategy

http://www.forestsandrangelands.gov/strategy/index.shtml
@US_Wildfire

The National Cohesive Wildland Fire Management Strategy is a strategic push to work collaboratively among all stakeholders and across all landscapes, using best science, to make meaningful progress towards Resilient Landscapes, Fire Adapted Communities, Safe & Effective Wildfire Response. The result of larger and more destructive fires that have led to increasing costs to lives, natural resources, communities, economies, and fighting fires, Congress called for a Cohesive Strategy in the 2009 FLAME Act. No one agency or organization can act alone to resolve these issues. It is only through "working better together" that we can achieve real change on the landscape level. Through an "all hands, all lands" approach, the Cohesive Strategy is providing the framework for collaborative success towards each of the three tenets above. The vision of the Cohesive Strategy is to safely and effectively extinguish fire when needed; use fire where allowable; manage our natural resources; and as a nation, to live with wildland fire.

National Fallen Firefighter Foundation

www.FireHero.org

In 2004, The National Fallen Firefighters Foundation held an unprecedented gathering of the fire service leadership occurred when more than 200 individuals assembled in Tampa, Florida to focus on the troubling question of how to prevent line-of-duty deaths and injuries. Every year approximately 100 firefighters lose their lives in the line of duty in the United States; about one every 80 hours. Every identifiable segment of the fire service was represented and participated in the Summit.

The first Firefighter Life Safety Summit marked a significant milestone, because it not only gathered all the segments of the fire service behind a common goal but it also developed the 16 Firefighter Life Safety Initiatives. The summit attendees agreed that the 16 Firefighter Life Safety Initiatives serve as a blueprint to reduce line of duty deaths and injuries. In 2014 a second Life Safety Summit was held and more than 300 fire service leaders gathered. At the second Firefighter Life Safety Summit, the 16 Firefighter Life Safety Initiatives were reaffirmed as being relevant to reduce line of duty deaths and injuries.

16 Firefighter Life Safety Initiatives
1. Cultural change.
2. Accountability.
3. Risk management.
4. Empowerment.
5. Training and certification.
6. Medical and physical fitness.
7. Research agenda.
8. Technology.
9. Fatalities, injuries, and near-miss investigations.
10. Grant support.
11. Response policies.
12. Violent incident response.
13. Behavioral health.
14. Public education.
15. Codes enforcement and sprinklers.
16. Apparatus design and safety.

NFPA Firewise

www.firewise.org

NFPA's Firewise Communities program encourages local solutions and personal responsibility for wildfire safety by involving firefighters, residents, community leaders, planners and others by adopting a long-term, proactive approach to protecting homes from the risk of wildfire. The program provides access to training resources, online learning center, print and audiovisual materials.

NOVELTIS

www.noveltis.com

NOVELTIS is a French private company that was created in 1998. We perform innovative scientific engineering studies and implement customized end-user solutions in the fields of Space, the Environment and Sustainable Development. NOVELTIS' staff have strong expertise in: remote sensing data processing (satellite and aerial data), environmental modelling (fire, weather, vegetation and ocean), geographic information systems and integrated decision support systems.

NOVELTIS focuses its activities on innovation, in close relations with international research laboratories. Our company supplies end-to-end services to governmental bodies and industries, including emergency management stakeholders. We also coordinate and participate in large-scale European and international projects.

NOVELTIS is certified to the ISO 9001(2008) / ISO 14001 (2004) / OHSAS 18001 (2007) standards and has been granted "Confidential-Defence" status by the French Defence Ministry.
Regarding forest fires, NOVELTIS develops and provides innovative operational services supporting tactical firefighting. Our most recent service, TechForFire, offers real-time information concerning:

- The current situation regarding the fire theatre: precise positions of the active fires, burnt areas, position of the involved firefighting forces, and positions of elements of interest;
- The risk forecast for the coming hours: forecasts of the fire propagation and evaluation of the vulnerable areas to be defended.

The service is based on the latest scientific and technical advances in aerial and satellite monitoring as well as real-time fire propagation modelling and risk forecasting.

The TechForFire service is accessible via four means:

- 24/7 secure user-friendly interactive web application requiring no prior software installation.
- Mobile application for Android smartphones and tablets providing the essential functionalities for use in the field where internet access may be intermittent.
- The application can also upload information to the crisis management centre including fire positions, sensitive elements, firefighting actions, in-situ photos and textual observations.
- Cartographic PDF output, providing high-quality topographic maps of the current and future fire situation, suitable for hardcopy output
- GIS layers for use in 3rd party GIS software packages.

The TechForFire service can be customized according to different end-user needs.
For further information please contact us at: contact@noveltis.fr

Phos-Chek (Mobile App Sponsor)

www.phos-chek.com

For over 50 years PHOS-CHeK has provided the world's leading chemical solutions for management of wildland and structural fires. PHOS-CHeK Long-Term Fire Retardants, Class A & B Foams, Gels, and Fuel Gelling Agents are the safest, most effective and environmentally friendly fire chemicals available and are fully qualified by the USDA Forest Service. PHOS-CHeK Fire Retardants are available in powder and liquid form.

MVP-Fx is the "flagship" all-phosphate retardant. This new formulation is highly visible on the fuel and in the air when dropped and is widely used in the airtanker industry. Our 259F is another formulation which is the only fire retardant that is helicopter fixed-tank qualified by the USFS.

PHOS-CHeK has several Class A foam formulations with WD 881 being the premier product. It is highly concentrated providing superior foaming capability for all applications and is the most cost effective product on the market.

We offer two Gels: PHOS-CHeK INSUL-8 and PHOS-CHeK Aquagel-K, These use super absorbant polymer technology to thicken water. Thickened water stays where you put it, even on vertical surfaces, making nearly all of the water used available to stop fire.

Phos-Chek INSUL-8 is a liquid concentrate that can be deployed from ground equipment or aircraft. It can be mixed on demand and makes superior gel at low use rates.

Phos-Chek Aquagel-K is a dry powder that is ideal for batch mixing and is targeted toward aerial application.

Flash 21 is the premier fuel gelling agent used for prescribed burning. Flash 21 is now the product of choice to be used with aerial ignition devices such as Helitorchs, flame throwers, terra-torches and blivet applications.

For our new Home Defense Program, the same long-term fire retardant, without the red dye, is now available in ¾ gallon jugs of concentrate and 5 gallon buckets of ready to use retardant, giving individuals the power to protect their own property and belongings long before a wildfire threat is imminent.

Sierra Nevada Company/Intterra

Sierra Nevada Corporation (SNC) is a world-class prime systems integrator and electronic systems provider known for its rapid, innovative, and agile technology solutions. Fast-growing and widely diversified, SNC is a high-tech electronics, engineering, and manufacturing corporation that continues to expand our impressive portfolio of capabilities, programs, products and services.

Intterra has developed tools to support work end-to-end. From risk mitigation, pre-planning, and citizen education, to incident management, performance metrics, and public information management, Intterra provides comprehensive tools for your needs. Intterra's SituationAnalyst loads the data you need with analytical tools so you have easily useable real-time data when and where you need it. Integrated tactical mapping and the optional Data Collector App give you additional data in the field and Command Center simultaneously.

Together, SNC & Intterra have designed a program to greatly improve firefighter safety & efficiency through the use of the Colorado Wildfire Management System which incorporates the PC-12 and Intterra's SituationAnalyst software tool. Currently in use in Colorado, the Colorado Wildfire Management System is an ideal solution to support the State's firefighting efforts because it is affordable, fast, can remain airborne for long periods of time, & can be operated from almost any airfield.

SimTable
www.simtable.com
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Add @simtable

Simtable provides digital sandtables to the wildfire and emergency management communities. Combining existing GIS data with next generation agent-based modeling and ambient computing SimTable provides a straightforward easy to use approach in incident response and training. Interactive simulations and realtime maps can be distributed across the web and mobile devices.

Simtable is based in Santa Fe, New Mexico. Current research and development includes LiveTexture which coordinates mobile, aerial and social media videos and photos into one 3D texture of an ongoing incident.

Technosylva, Inc.
http://technosylva.com/

Solutions for Wildfire Protection Planning & Operational Response from San Diego (CA).

Technosylva has developed the only specific wildfire management tools in the market, used in agencies since 1997.

FIRESPONSE: Unique Decision Support System for Wildland firefighting from the dispatching to the incident management, available in desktop, web and mobile platforms.

WILDFIRE ANALYST: the ultimate tool for analyzing real-time Wildfire Behavior.

Our team has a rich legacy in conducting fuels mapping, fire behavior analysis and wildfire risk assessments, focused on integrating analysis results into usable applications to support fire professionals for protection and mitigation planning, as well as response and suppression.

US Forest Service - Stress Control and Resiliency
The wildland fire community, which includes the Forest Service, wildland firefighters, emergency medical service (EMS) and law enforcement personnel, and their families, may experience traumatic stress due to the nature of their work. A healthy mind and body are essential to individual and unit readiness. Resilience combines mental, emotional, spiritual and physical skills to generate optimal performance (i.e. readiness) - in combating wildland fires, in healing after injury, and in managing your work and home life. Fatigue, nutrition, stress control, purpose and values, and total well-being are all facets of resilience. The USFS is promoting resiliency through means of managing stress for optimal health and productivity.

Wildland Firefighter Foundation
http://www.wffoundation.org/

The role of the Wildland Firefighter Foundation is to honor past, present, and future wildland firefighters by helping maintain and grow the national monument established for those who have lost their lives, operate a financial fund providing assistance to the families of fallen and wildland firefighters and to injured firefighters, and partner with private and interagency organizations to educate the public about wildland fires and promote excellence and safety in firefighting.

We provide financial assistance, immediate and ongoing emotional support, advocacy, and recognition to fallen and injured wildland firefighters. We present program information and in some instances, onsite crisis support, to government and private fire agencies and other organizations.

Survivor family members are forever a part of the Foundation's purpose. We continue to provide emotional support and in some cases financial support many years after a firefighter's death. Additional support may include holiday sponsorships for families with young children, travel expenses to attend survivor gatherings and recognition programs, and counseling for immediate family members.

ORAL PRESENTATIONS

MEASUREMENT AND FIRE

1. Do we have an acceptable loss in Wildland Fire?

Presenter(s): Ivan Pupulidy, Director of the USFS Office of Learning

Additional Author(s):
Matt Carroll
Curtis Heaton

Do we have an acceptable loss of life in the wildland fire service? This question is fundamental to the development of strategy and tactics, but it appears to be largely unexplored. One primary reason for this may be that posing this question leads towards a binary impasse. If we accept a certain number of fatalities then we can continue to fight fire as we always have. Alternatively, if we have no acceptable loss (e.g. zero fatality) we must stop fighting fires altogether. The choice seems to be all or nothing, 0 or 1. Moving this discussion forward is essential for the wildland fire community, but will require language, concepts and processes for navigating the grey space in-between the binary extremes.

Exploring the space between these two extremes may allow the community to discover a new way to achieve a wider set of goals. The first step may be to understand that the act of engaging in this conversation does not have to lead to either extreme. This frees us to challenge deeply held cultural beliefs, language and behaviors without fear of inadvertently undermining the community's existence.

Avoiding the question of whether we have an acceptable loss of life is not possible, because it is not a question of whether it will be discussed, and may instead be a question of who will enter into the discussion; the stakeholders abound and they include the wildlland fire community, the public we serve, leadership, the environment, to name a few.

The Forest Service Office of Learning (OOL) is committed to this challenge. In this session we will discuss the intent, approach and placement of the OOL in the hopes of generating broad collaborative support for understanding and facilitating these and other vital conversations.

Keywords: Acceptable loss, risk, dialogue

Bio: Ivan Pupulidy is the Director of the USFS Office of Learning. In 1995, Ivan became a USFS Lead Plane Pilot and later a Regional Aviation Safety Manager. Ivan completed several internationally recognized programs in safety program management and accident investigation and is currently completing a PhD program at Tilburg University in the Netherlands. Ivan also flew HU-25 Falcon Fan-Jets at Coast Guard Air Station Corpus Christi, Texas and subsequently HC-130 Hercules aircraft, at Air Station Sacramento. Following the US Coast Guard, Ivan flew for the US Air Force Reserves in Iraq and Afghanistan and humanitarian support missions throughout central Africa.

2. Network Management and Performance on Complex Fire Events

Presenter(s): Branda Nowell

Additional Author(s):
Toddi Steelman,Executive Director & Professor School of Environment and Sustainability, University of Saskatchewa

Complex wildfire events in the wildland urban interface (WUI) necessitate the involvement of a range of responders representing fire operations, emergency response operations, local government, and the media. Effective communication and coordination among these different actors is critical to an effective response. A network perspective can provide a valuable lens for both understanding and assessing relational risk for problematic communication and coordination to occur on an incident. Incident response networks represent the collection of organizations and agencies who have a formal responsibility to respond during a fire event. When a network perspective is adopted, the focus is not on the effectiveness of any single agency but rather on the performance of the incident response network as a whole. In this presentation, we present a framework for assessing performance of incident response networks during complex fire events. This framework was applied to assess the network performance of incident response networks on 21 WUI fires. Findings from this research shed light on the network structure of incident response and offers several key lessons in how responders can better manage networks in order to better manage wildfires.

Keywords: relational risk, social networks, network management

Bio: Branda Nowell, is an organizational-community psychologist specializing in inter-organizational relationships, social networks, and community capacity for multi-agent collaboration and coordination within complex problem domains. She teaches courses in organizational behavior, change management, organizational theory, and program evaluation. As an interdisciplinary scholar, she integrates community and organizational psychology with public management to better understand community-based networks of public and nonprofit agencies working in a common problem domain. She currently co-leads a research team (firechasers.ncsu.edu) focused on advancing the science of adaptive capacity toward more disaster resilient communities. Since 2008, this team has worked in collaboration with incident management teams on research aimed to improve inter-agency coordination and communication during large scale wildfire events.

3. Towards metrics of success in residential preparedness for wildfire

Presenter(s): James D. Absher, Ph.D.

Additional Author(s):
Jerry J. Vaske, Ph.D., Professor, Colorado State Univeristy
Katie M. Lyon, Graduate research assistant, Colorado State University

Wildfire preparedness ranges from simple defensible space (DS) actions to more complex structural or landscape changes. Programs like Fire Adapted Communities, FireSafe Councils, CWPPs, communication/outreach and regulations for individual clearance and preparation programs stand on solid reasoning, and provide a basis for hope to achieve residential loss mitigation. Both scientific surveys and anecdotal reports have examined the relationship of beliefs and attitudes through to expectations and intentions to comply. Missing are outcome focused metrics based on actual success. Data from a social survey of wildfire preparedness in Colorado (n=863; 65% mail, 35% internet) was combined with actual on-site assessments (conducted post-survey) for a subsample of respondents (n=75). Site inspections used a standardized form with 25 aspects rated on a 1 to 3 scale. This presentation compares the expectations and intentions to do DS actions with actual site conditions. About half of the inspections (53%) had "excellent" DS completion scores, and the remainder were in the "average" category. Respondents who participated in the site inspections were generally higher than their survey cohort on scores for DS belief, intention, and risk variables. The challenge is to understand the full reach of firewise programs from awareness of risks, changing attitudes and perceptions, and intentions to take actions. We conclude with an open discussion of the standards for success metrics and the data needed to implement them in various settings.

Keywords: defensible space, residents' actions, behavior change, success metrics

Bio: Dr. Absher is a research social scientist with over 40 years in the field. He holds degrees in statistics, human biology, natural science and wildland resource science. Initially he held university faculty positions (1978-1995), then worked with the US Forest Service's Pacific Southwest Research Station (1995-2015). His work on wildland fire has focused primarily on residential compliance with firewise actions, community preparedness and policy/program support in California and Colorado. He has authored numerous reports and publications on aspects of this problem area and, although now retired, strives to continue this line of work with various colleagues.

RISK

4. Wildfire risk management in Europe: the challenge of seeing the "forest" and not the "trees"

Presenter(s): Fantina Tedim, PhD, Assistant professor, University of Porto, Portugal

Additional Author(s):
Vittorio Leone, Full Professor, University of Basilicata (retired)
Gavriil Xanthopoulos, Researcher, Institute of Mediterranean Forest Ecosystems and Forest Products Technology

In Europe, after decades of fire exclusion policies, it has been recognized that fire suppression alone is not able to solve wildfire problems. Firstly, it is able to mitigate the fire consequences but it is unable to reduce man-induced ignitions. Secondly, suppression capabilities are reaching their budgetary limits. Thirdly, very restrictive legal frameworks aggravated wildfire problems mainly in rural societies where fire was almost criminalized, applying constraints inspired by an anti-fire bias, irrespective of the role of fire as a traditional tool.

In a context of climate change, with expected scenarios of frequent and extreme fires the reinforcement of preventive actions is mandatory to reduce wildfire severity. Prevention must focus on diminishing fire hazard frequency and intensity as well as reducing vulnerability both related with different social processes.

Signs of change in European wildfire policies are already going on but they still focus on "trees" missing the" forest", i.e. they focus on discrete elements that influence fire occurrence and severity rather than on the whole human-fire-landscape system. Without understanding the complex interdependencies in this system it is hard to develop efficient prevention strategies to contain fire risk, and to avoid the possibility that fire from beneficial element can became a detrimental one.

To avoid the pitfalls of treating human-fire-landscape system components as oversimplified black boxes, the behavior of the "forest" not just the "trees" should be explained and predicted. This perspective is important in Europe, where the small size of scale, the presence of cultural landscapes and heritage of the past, the high density of conservation areas and the relatively reduced extent of forests co-exist with new trends in settling, lifestyle, and recreation demand that play complementary roles in the development of wildfire risk.

The purpose of this paper is to reply to the current wildfire risk management challenge as a contribution towards developing a framework for fire management based on a holistic knowledge of the interrelationships between environment and social dynamics to support effective wildfire prevention policies. The integration of physical, biological, social, and cultural fire paradigms is mandatory to develop coherent nature and social based fire prevention solutions.

Keywords: Fire exclusion, fire hazard, fire suppression, human systems, prevention, risk management

Bio: Fantina Tedim is Assistant Professor in the Geography Department at the University of Porto, Portugal. She received her Ph.D. in Human Geography from University of Porto in 2000. Her current research focuses on disaster risk reduction, vulnerability and resilience assessment using a multi-hazard approach (e.g. wildfires, floods, coastal erosion, tsunamis). Her research in wildfires focuses on understanding the complex interdependencies in the human-fire-landscape system. In the last three years she published several works on large fires, megafires, wildfires causes, and vulnerability assessment.

5. Localized Risk Perception on Wildfire Hazard

Presenter(s): Voravee Chakreeyarat, Department of Environment and Society at Utah State University

Additional Author(s):
Mark W. Brunson
Peter D. Howe

The need to protect lives and property in the expanding wildland-urban interface (WUI) across the American West increases the pressure to reduce risks of wildfires. As wildfire hazard continues to accelerate, state and federal agencies and local fire departments are challenged to create local risk reduction, either through individual landowner decisions or collective action within the community. A community's perception of exposure to wildfire risk plays the important role for landowner decisions to protect private lands from wildfire hazard. However, in order for community members to be mobilized against wildfire hazard they must perceive that a risk exists. In this presentation, we address the association between landowners' risk perceptions and actual measured wildfire risk that varies across hazard zones in three states (Arizona, California, and New Mexico), testing whether local wildfire risk perception is significantly associated with scientifically measured wildfire risk. This study employed a spatial stratified random sampling scheme based on respondents' hazard zone and proximity to the WUI. This technique ensures a consistently representative sample of perceived risk relative to objective risk over the study area. Employing a multilevel model of responses from community public opinion surveys combined with the wildfire risk potential map, we investigate a pattern of risk perception and the relationships between individual perceived wildfire risks in multi-scales. Results suggest that respondents who reside in a location with high exposure to wildfire describe their risk slightly consistent with the objective hazard measure. The respondents' perception tends to be optimistic about their particular local areas compared to the areas at the broader scale.

Keywords: wildfire, risk perception, multilevel analysis, survey methods

Bio: Voravee is a graduate student in the Department of Environment and Society at Utah State University. She is interested in the interface of human perceptions related to risk of wildland fire. Her research examines the adaptation of human behaviors subject to environmental changes and the spatial relationship of risk perceptions and a process of decision-making. She explores how spatial location affects human decision and behaviors using quantitative approaches including spatial analysis, multilevel modeling, and the application of remotely sensed imagery.

6. Fire and Fuel Management in Banff National Park;Balancing Risk and Sustainability

Presenter(s): Robert Osiowy,Msc., Restoration Specialist ,Parks Canada Agency, Banff National Park, IAWF member

Additional Author(s):
Jane S. Park, Msc.,Fire and Vegetation Specialist,Parks Canada Agency,Banff National Park

Montane forests in Banff National Park's Bow Valley historically experience wildfire events at intervals of less than 100 years. The Town of Banff and the Bow Valley are the most heavily populated areas of Banff National Park, receive more than 3.5 million visitors per year and contain critical infrastructure. Due to wildfire protection, continuous forest stands with significant forest fuel accumulation exist adjacent to major values at risk and within ecologically sensitive areas. These stands may support the development of rapidly moving, high intensity crown fires under frequently occurring fire weather conditions (i.e. 80th percentile conditions). A two-year study found two major fire management needs: 1) Managing the threat of large wildfires; 2) Reducing fuel loading, flammability and potential fire intensity in interface zones.

Fire management in Parks Canada is conducted within a national framework of legislation, policies, and management directives. The Agency's dual fire mandate directs that wildland fire be managed from the perspective of maintaining ecological integrity while protecting public and infrastructure from wildfires. Banff National Park is creating a 'Fire-Smart' landscape using a combination of fuel reduction at the urban-wildland interface and landscape-scale firebreaks to facilitate the use of prescribed fire and support indirect confinement of wildfires. The approach utilized in Banff National Park ensures that fire is managed in a socially acceptable, fiscally responsible and ecologically sustainable manner.

Since 2002, the Banff National Park Fire Management program has completed 128 hectares (316 acres) of fuel treatment adjacent to the town of Banff and more than 200 hectares (500 acres) within the Bow Valley at the landscape scale. These fuel management units will require continuous and ongoing maintenance to remain as effective fuel breaks over time. Maintaining these fuel breaks, will continue to facilitate fire use to achieve larger ecological objectives. This presentation discusses how the Banff National Park Fire Management program balances dual objectives of wildfire protection and ecosystem sustainability in Banff National Park's Bow Valley.

Keywords: National Parks, Fire Management, Fuel Management,Fuel accumulation,Ecologically sensitive areas,Wildfire Risk, Ecosystem Sustainability,Infastructure,Community Protection

Bio: Robert Osiowy has been with Parks Canada Agency for 13 years in various capacities within the National Fire Management Program. Most recently,he has taken the team leader role for the Restoration Program within Banff National Park.Robert has been a member of a Parks Canada National Incident Management Team since 2007 in both the Plans and Operations sections.Robert has a Master's degree in Environmental Management and worked with Dr. Brad Hawkes of the Canadian Forest Service on his thesis project : " FUEL LOAD AND FIRE BEHAVIOUR IN MONTANE RIPARIAN WHITE SPRUCE FORESTS OF BANFF NATIONAL PARK; STRATEGIES FOR COMMUNITY PROTECTION AND ECOSYSTEM SUSTAINABILITY"

7. Risk - Risk Tradeoffs in Wildfire Management – The Ranch Fire Case Study

Presenter(s): Dave Calkin, PhD, Research Forester, USDA Forest Service Rocky Mountain Research Station

The primary objective of federal wildland fire management is community and fire fighter safety. Alternative wildfire management strategies vary in terms of potential damage to human communities and highly valued natural resources, the amount of future risk reduction achieved by a wildfire, and the type, quantity and quality of firefighting resources that are exposed to the hazards of the wildfire environment. Given the tragic outcome on the Yarnell Hill fire in 2013, fire managers are currently particularly sensitive to the conditions under which ground based firefighting crews work. Given this sensitivity, managers may be less likely to select aggressive ground based suppression strategies compared to strategies that rely more heavily on aviation resources, or select more indirect "big box" strategies. In this presentation I review the complicated decision making environment and describe the relative tradeoffs among the quantity and quality of firefighter exposure as well as the potential outcomes to highly valued resources and future risk reduction. These tradeoffs will be discussed relative to the 2014 Ranch Fire in the Sequoia National Forest, California.

Keywords: Risk-Risk Tradeoffs, Wildfire Suppression

Bio: Dave Calkin is a Research Forester in Human Dimensions Program at the US Forest Service Rocky Mountain Research Station in Missoula, Montana, USA. Dave is the team lead of the Fire Economics group of National Fire Decision Support Center, a joint agreement between Fire and Aviation Management and Research intended to improve risk based fire management decision making through improved science application and delivery. Dave's research incorporates economics with risk and decision sciences to explore ways to evaluate and improve the efficiency and effectiveness of wildfire management programs.

NEW DEVELOPMENT IN WILDLAND FIREFIGHTING

8. Changing cultures/attitudes in aerial firefighting - Pre determined dispatch of aircraft

Presenter(s): Wayne Rigg, Operations Officer - CFA AViation Officer

Pre-determined Dispatch (PDD) of aircraft was developed in response to the Victorian Bushfire Royal Commission (VBRC).

Recommendation 20:-

- Establish a system that enables the dispatch of aircraft to fires in high-risk areas without requiring a request from an Incident Controller or the State Duty Officer.

A team was established and trial objectives set:-

- Rapid initial attack.
- Have processes in place that utilise aircraft in a safe, efficient and cost effective manner.
- Collect trial data that enables determination of trial outcome.

A number of operational gains were identified during the trial:-

- The deployment of the aircraft via pager resulted in rapid initial attack of fires and did not have to rely on ground crews arriving on scene and undertaking a size up before requesting aircraft.
- Within suppressible limits, fire size and duration were significantly reduced, with a large reduction in cost, damage and committed resources.
- Immediate intelligence from the Air Attack Supervisor to the fire ground enabled faster and more accurate decisions. This assisted with the issuing of community warnings and decisions around resource requirements.

The average dispatch time from pilot notification to aircraft airborne was 8.4 minutes, compared to an average of 34 minutes via conventional methods.

Since the successful 2012/13 trial PDD was expanded to 5 locations throughout Victoria in 13/14 and is in the process of being expanded into 10 locations for the 14/15 bushfire season.

PDD has shown that traditional methods of dispatching aircraft can be improved, however a range of issues need to be addressed when changing deeply embedded systems and cultures.

Regardless of the benefits resistance remains within some ranks and changing attitudes and demonstrating the benefits of rapid deployment of aircraft in support of ground crews continues to be a challenge.

Demonstrating the cost benefit analysis by investing in aircraft early in the fire require further in depth research and modelling to demonstrate what the use of aircraft in support of ground crews saved rather than what they cost.

Keywords: Aircraft Operations

Bio: Operations Officer Wayne Rigg is the CFA Aviation Officer responsible for the planning and delivery of the aviation program for CFA in Victoria.
Wayne has been a career firefighter since 1995 and is an accredited Air Operations Manager, Air Attack Supervisor, Air Observer and 1 of 4 State Aircraft Coordinators within Victoria.
Wayne is the CFA lead on the implementation of PDD and will speak on the challenges faced in changing systems, ideas and opinions within a deeply imbedded aviation culture within Victoria.

9. Fire and Aviation Management Enterprise Geospatial Portal

Presenter(s): Jill Kuenzi. Geospatial Coordinator, US Forest Service Fire and Aviation Management

Additional Author(s):
Sean Triplett. Geospatial Manager, US Forest Service Fire and Aviation Management
Jill Kuenzi, Geospatial Coordinator, US Forest Service Fire and Aviation Management

The U.S. Forest Service Fire & Aviation Management (FAM) program continues to innovate in the management and suppression of wildland fires. The FAM Enterprise Geospatial Portal (EGP) project was undertaken to improve the delivery, display, and analysis of geospatial information to support the wildland fire management decision-making process. The EGP provides a web-based mapping interface that allows users to access common wildfire data layers on a common interface. The EGP allows for a continuous feed of data, and the ability to combine it with other information. Users also have access to data stored in a central data repository to facilitate the exchange of information within and between land management agencies. The EGP is comprised of two systems of web-mapping and database components utilizing up-to-date Google and Esri technologies. These two systems organize data into View States, of like datasets based on common fire business areas. The data within the View States provide access to fire management personnel, dispatchers, and coordination centers with up-to-date fire information including fire perimeters, satellite fire detections, currently assigned resources, and the availability of other resources. The EGP tool allows for the continued improvement in fire management by bringing data and cooperating partners together.

Keywords: Wildfire, EGP, web-mapping, geospatial, database

Bio: Jill earned BS degrees in Mathematics and Natural Science, and an MS in Wildlife Biology. Jill has worked for the federal government for 22 years, primarily with the National Park Service and U.S. Forest Service, in areas of wildland and prescribed fire, many of the natural sciences, and GIS. Jill currently works as the U.S. Forest Service Geospatial Coordinator for the Fire and Aviation Management's Information Technology (FAM IT) at the National Interagency Fire Center (NIFC) in Boise, ID. Jill spends much of her time supporting work with agency and interagency data standards, and supporting a variety of wildland fire applications including the Enterprise Geospatial Portal (EGP).

10. Military Veterans in the Wildland Fire Service – Issues, Obstacles, and Benefits

Presenter(s): Alexis Lewis Waldron, PhD, Post Doctoral Scholar, Oregon State University

Additional Author(s):
Vicki Ebbeck, Associate Professor, Oregon State University

Forbes Magazine (February, 2014) recently wrote that military veterans entering the US workforce have many untapped, transferable skills – especially regarding leadership – that are often overlooked by their employers. A high number of returning service members are seeking employment on their return from duty with land agencies – one main area is with wildland fire. It is imperative that the fire service gains an understanding of obstacles veterans face, discover untapped, and transferrable skills, and best utilize these skills to increase overall performance and develop and enhance working relationships with fellow crewmembers and supervisors.

In an effort to investigate this process one solo, and two group exploratory interviews were conducted with recent military veterans. The aim of these interviews was to explore veterans experiences in the military and current positions as employees of land agencies in order to gain a baseline understanding of veteran experiences, knowledge, abilities, future developments, and areas for more formal research. Five major themes were explored, including fire service entry, obstacles, attitude, leadership, and training. Results indicate that successfully integrating veterans into the fire service is a complex process. It is one that involves educating and communicating clearly with veterans on what to expect, and educating and communicating clearly with supervisors on how to best utilize veteran skillsets. More detailed results that discuss the five themes will be explored in the presentation.

Keywords: Veterans, Education, Wildland Firefighters, Supervisors, Communication, Obstacles, Attitude, leadership, training

Bio: Dr. Waldron has been a wildland firefighter for 10 seasons on hand crews, engine crews, helitack crews, and heli-rappel crews, and has served as a human factors specialist for fatality incidents. Based on hers and others near misses/ accidents and leadership experiences in fire she has developed a drive to build and enhance fire trainings and tools based on what firefighters have expressed is important. Dr. Waldron has used the tools developed with firefighters not only to develop firefighters personally and professionally, but also various athletes, challenge course facilitators, and other outdoor professionals.

11. Organizational Response to Incidents and Accidents

Presenter(s): Ivan Pupulidy, Director of the USFS Office of Learning

The Coordinated Response Protocol and Learning Review: Our approach to accident reviews embraces the idea that knowledge resides in a large number of places, both inside and outside the organization. The Coordinated Response Protocol (CRP) is an effort to unify or coordinate the numerous investigative interests following a fatality event. The Learning Review is inclusive of multiple approaches of analysis, perspectives and sources of information. This means that those engaged in a Learning Review must be humble enough to recognize that they may not have the answers to complex questions and that learning is a fundamental way to prevent accidents.

This process recognizes that accident prevention is a shared goal that transcends organizational boundaries and hierarchies and may result in revealing hard truths.
This presentation is designed to explain the purpose and intent of the CRP/LR

Keywords: Learning, accident prevention, prevention, group sensemaking

Bio: Ivan Pupulidy is the Director of the USFS Office of Learning. In 1995, Ivan became a USFS Lead Plane Pilot and later a Regional Aviation Safety Manager. Ivan completed several internationally recognized programs in safety program management and accident investigation and is currently completing a PhD program at Tilburg University in the Netherlands. Ivan also flew HU-25 Falcon Fan-Jets at Coast Guard Air Station Corpus Christi, Texas and subsequently HC-130 Hercules aircraft, at Air Station Sacramento. Following the US Coast Guard, Ivan flew for the US Air Force Reserves in Iraq and Afghanistan and humanitarian support missions throughout central Africa.

FIRE ADAPTED COMMUNITIES

12. Measuring Community Adaptive Capacity and Wildfire Risk in the American West: Coupling Results from Key Informant Surveys and Biophysical Risk Analysis

Presenter(s): Max Nielsen-Pincus, PhD, Assistant Professor, Portland State University

Additional Author(s):
Travis Paveglio, Assistant Professor, University of Idaho
Alan Ager, Operations Research Analyst, United States Department of Agriculture Forest Service, Western Wildland Environmental Threat Assessment Center

New approaches for managing wildfire risk are needed as uncharacteristically large wildfires in the western United States (US) and elsewhere strain government capacities for suppression. Although federal policy and local planning for wildfire risk have improved during the past decade, continued and growing wildfire losses in the wildland urban interface (WUI) suggest that existing policies and programs to mitigate risk are insufficient or require more efficient strategies for implementation, including the Community Wildfire Protection Planning (CWPP) process. Recent literature has identified a number of community archetypes with different potential fire-adaptation pathways and case studies of local communities have identified community adaptive capacity to wildfire as a critical determinant of effective risk mitigation, where adaptive capacity is commonly defined as the ability for a community to self-organize to reduce the undesired consequences that might otherwise occur from wildfire. However, biophysical characteristics also play an important role in determining community fire adaptation pathways. We use the term fireshed to define the area of the landscape most likely to transmit wildfire risk to a community. A community fireshed can be mapped to identify both the degree of risk and the sources of risk (e.g., public lands, private lands, or lands with management restrictions such as wilderness or other reserves). In this project we combined data about community adaptive capacity from structured interviews with key informants (n=114) in 70 unique communities in the western US that had recently experienced a large wildfire with fireshed mapping to examine the degree and sources of risk for each community in addition to each community's capacity to manage that risk. Results help to empirically identify different types of communities with different potential pathways to wildfire resiliency, and can assist with prioritizing different strategies to mitigate wildfire risk in an environment of limited resources (e.g., fuels treatments on nearby federal lands versus grants to communities for preparation or infrastructure upgrades). We discuss the implications of our findings for local community self-assessment as well as for achieving the fire-adapted communities objective in the National Cohesive Wildland Fire Management Strategy.

Keywords: Adaptive capacity, community, fireshed, mitigation, wildfire risk

Bio: Dr. Nielsen-Pincus is an assistant professor of environmental science and management at Portland State University's School of the Environment. His research on social-ecological systems includes a focus on wildfire social science. He has contributed to and led projects related to landowner fuels management behaviors, community-based wildfire risk mitigation planning, and the effects of large wildfires on local labor markets. Dr. Nielsen-Pincus teaches graduate and undergraduate students in the Department of Environmental Science and Management about environmental management and policy. Prior to joining the faculty at Portland State University, Dr. Nielsen-Pincus was a faculty research associate at the University of Oregon.

13. Creating a Culture of Adaptation: A Learning Network Approach to Fire Adapted Communities

Presenter(s): Michelle Medley-Daniel, Fire Adapted Communities Network Program Manager, The Watershed Center

The Fire Adapted Communities Learning Network (FAC Network) is an innovative approach to accelerating wildfire adaptation efforts across the US. Modeled after the Fire Learning Network, which has been operated by The Nature Conservancy and their federal and community partners for nearly a decade, the FAC Network connects communities that are working to create more resilient landscapes, communities and institutions.

The multi-scalar, cross-sector approach to adaptation that is being demonstrated by FAC Network participants offers lessons about resilience, community relationships to fire, and varied organizational cultures and approaches. Brief case stories profiling several of the communities participating in the FAC Network will offer attendees insight into how these communities are learning, adapting and sharing innovations and best practices.

This session will also offer lessons about how to connect grassroots and community leaders with regional and national partners and institutions to spread innovation. Insights into how to develop and manage an effective learning network including creating and maintaining remote dialogue and workspaces, cultivating relationships, and effective "net weaving" will be covered.

Participants in this session will also preview the fire adapted community self-assessment tool (currently in beta testing within the FAC Network) and other emerging tools and resources being used by the FAC Network to adapt to living more safely with wildland fire.

Keywords: Fire Adapted Communities, Learning Network, Culture, Resources, Case Studies

Bio: Michelle Medley-Daniel is the Watershed Research and Training Center's Fire Adapted Communities Learning Network Program Manager. In her role she both manages the network's operations for the organization, and also acts as a liaison in the network—directly working with communities throughout the west to improve their wildfire resilience. She holds bachelor's degrees in English and Studio Art from Humboldt State University. For the past ten years Michelle has been coordinating networks of environmental educators and rural communities, as well as providing communications and development services to non-profits.

14. Enhancing Community Response-Utilising existing information networks during bushfires

Presenter(s): Kathy Overton, Director, Kathryn Overton Consulting

Inquiries undertaken after major bushfires in Victoria Australia invariably mention difficulties with information flow to and throughout communities during bushfires, as well as highlighting that a significant number of people continue to be unprepared for bushfires when they occur.

Considerable improvements in the timing and dissemination of warnings and information during bushfires have occurred since the Black Saturday Bushfires of 2009. Emergency Service Organisations (ESOs) have given increased priority to the provision of information to communities under threat of bushfire. Great emphasis is placed on planning for bushfires, both at personal and community level by fire agencies.

However, people without bushfire plans and people getting helpful, reliable, timely, and tailored information, when and how they need it during bushfires, continue to be major challenges. Understanding how communities communicate and disseminate information outside of times of disasters will help develop strategies that will assist during times of disaster. Connecting existing emergency structures and processes with existing community networks and processes during bushfires and other emergencies must be considered if we are to increase the effectiveness of community response.

Building on a project undertaken in 2011, this presentation discusses ways that local governments and communities (including ESOs), may work together to better utilise existing information networks within communities during disasters. It will also encourage discussion on how new approaches may enhance community response and resilience when bushfires threaten, as well as barriers to changing perspectives.

Keywords: existing, networks, connecting, barriers, trust, complexity, support

Bio: As a result of training as a firefighter during her time as an environmental educator, Kathy Overton went on to work as a fire educator and community engagement specialist for Victorian fire agencies for 12 years. During that time Kathy was responsible for the coordination of the early development of the AIIMS Information Officer role and training for the Victorian Government's forest firefighting organisation. More recently she has supported fire agencies in the improvement of warnings and community information dissemination during emergencies. For the past three years her foremost interest has been community response during bushfires, primarily the importance of community networks in dissemination of information.

15. You Mean It might Burn? Embarking on Austin's Journey to Become Fire Adapted

Presenter(s): William A. Conrad CPRM

In September of 2011 Central Texas experienced its worst fire season in recorded history. On Labor Day the Bastrop Complex Fire ignited, eventually consuming 34,000 acres of woodlands and communities involved in the Wildland Urban Interface, razing 1700 homes, and taking two lives. That same day the Spicewood Fire ignited in western Travis County in a similar Wildland Urban Interface. More than 6,000 acres burned and thirty six homes were lost. Simultaneously, a small fire started in an electrical distribution right-of-way. It quickly jumped a major highway spread rapidly into a wildland and spotted in to the densely populated Steiner Ranch Community resulting in the loss of twenty one homes with the evacuation of thousands of residents. Until that day Austin, Texas and communities in surrounding Travis County prided themselves in their green infrastructure. parkland, preserves, water quality management areas, and green belts were all viewed by residents as sacred community assets to be protected from any disturbance. However, local fire officials and land managers had long understood risks to life and property, as well as to those urban Wildlands, posed by potential wildfire. But they struggled to engage the community. The events of September 4, 2011 served as the catalyst to engage communities in Austin and Travis County in efforts to become the Fire Adapted Community that fire and public officials had been striving to advance for more than a decade. However, now those officials had to work with various stakeholders to overcome a new found fear, and focus on the nature of Wildland fire in a complex Wildland Urban Interface. Today, stakeholders from all facets of the communities and fire agencies collaborate through the Austin Travis County Joint Wildfire Task force, with a mission of making our communities fire adapted.

Keywords: Wildfire, Fire Adapted, WIldland Urban Interface,Collaboration

Bio: Willy Conrad has been responsible for managing Austin Water Utility's Wildlands since July 19, 1999. He is a 1978 graduate Of Stephen F. Austin State University with a Bachelor of Science in Forestry.
He serves as an Environmental Policy Program Manager for Austin Water Utility and is charged with management of the Utility's Wildland Conservation Division, assuring mission oriented management of more than 42,000 acres of urban Wildlands.

Willy is a member of the International Association of Wildland Fire, Society for Range management, Natural Areas Association, and the Soil and Water Conservation Society of America.

PEOPLE, CLIMATE AND LANDSCAPES

16. Investigating the Impacts of Surface Temperature Anomalies Due to Wildfires in Northern Sub-Saharan Africa

Presenter(s): Trisha Gabbert, Student, South Dakota School of Mines and Technology

Additional Author(s):
Charles Ichoku, Research Physical Scientist, National Aeronautics and Space Administration (NASA)
Toshi Matsui, Research Associate, National Aeronautics and Space Administration (NASA) and Science Systems and Applications, Inc. (SSAI)
William Capehart, Atmospheric and Environmental Sciences Program Coordinator and Associate Professor, South Dakota School of Mines and Technology

The northern Sub-Saharan African region (NSSA) is an area of intense study due to the recent severe droughts that have dire consequences on the population, which relies mostly on rain fed agriculture for its food supply. This region's weather and hydrologic cycle are very complex and are dependent on the West African Monsoon. Different regional processes affect the West African Monsoon cycle and variability. One of the areas of current investigation is the water cycle response to the variability of land surface characteristics. Land surface characteristics are often altered in NSSA due to agricultural practices, grazing, and the fires that occur during the dry season. To better understand the effects of biomass burning on the hydrologic cycle of the sub-Saharan environment, an interdisciplinary team sponsored by NASA is analyzing potential feedback mechanisms due to the fires. As part of this research, this study focuses on the effects of land surface changes, particularly albedo and skin temperature, that are influenced by biomass burning. Surface temperature anomalies can influence the initiation of convective rainfall and surface albedo is linked to the absorption of solar radiation. To capture the effects of fire perturbations on the land surface, NASA's Unified Weather and Research Forecasting (NU-WRF) model coupled with NASA's Land Information System (LIS) is being used to simulate some of the fire-induced surface temperature anomalies and other environmental processes. In this presentation, we will report the strategy for these simulations, and show some preliminary results.

Keywords: sub-Saharan Africa, biomass burning, albedo, skin temperature, NUWRF modeling

Bio: Trisha Gabbert is currently a graduate student working towards a MS in Atmospheric and Environmental Sciences at the South Dakota School of Mines and Technology (SDSM&T). She completed her undergraduate degree specializing in Atmospheric Sciences at SDSM&T as well. During her undergraduate program, she gained experience through two internships at NASA Goddard Space Flight Center. Within one of her internships she was introduced to current research regarding fire emissions and numerical modeling, which she is continuing in her graduate research. She is actively interested in fire weather, fire emissions, and how fire weather will affect our changing climate.

17. How society and climate will combine to affect wildfire in the U.S. South, 2015-2060

Presenter(s): Jeffrey P. Prestemon, Resarch Forester, USDA Forest Service, Southern Research Station

Additional Author(s):
Uma Shankar, Research Associate, Center for Environmental Modeling for Policy Development, UNC-Chapel Hill
Karen L. Abt, Research Economist, USDA Forest Service, Southern Research Station
Ernest Dixon, IV, Forester, USDA Forest Service, Southern Research Station
Aijan Xiu, Research Associate Professor, Center for Environmental Modeling for Policy Development, UNC-Chapel Hill
Keith Talgo, Research Associate, Center for Environmental Modeling for Policy Development, UNC-Chapel Hill
Dongmei Yang, Research Associate, Institute for the Environment, University of North Carolina, Chapel Hill

The long-run effects of climate, land use, demographic, and economic changes will work together to produce wildfire activity in the coming decades. Information on wildfire trends can be used for making investments into wildfire preparedness and can improve our understanding of the long-term consequences of these changes on human health, including air quality. We estimate wildfire production models for the counties of thirteen southeastern U.S. states, with separate models by broad cause category and Ecoregion province These production functions are estimated over historical data from 1992-2010 and then used to project wildfire under nine separate models of the future. These nine models were from three IPCC based-emission/economic-demographic scenarios and three general circulation models used in the 2010 Resources Planning Act Assessment. The nine models are combined in Monte Carlo simulation to provide overall uncertainty in projected wildfire activity. Results show that projected annual areas burned generally increase for lightning but decline for human-ignited wildfires, in aggregate but that projected trends vary widely by state and Ecoregion province.

Keywords: lightning-caused, human-caused, climate change, societal change

Bio: Jeff Prestemon is a forest economist doing research in the area of the economics of natural disturbances and timber product markets and trade. Specific research topics include understanding and predicting arson, quantifying the net benefits of fire prevention and fuels management, the impacts of hurricanes and insect and disease epidemics on forest product markets, and evaluating the effects of international trade policy. He began work with the Forest Service in 1995. Education is from University of Wisconsin-Madison (Ph.D.), North Carolina State (M.S.), and Iowa State (B.S.).

18. Spatial Pattern of Fire With Respect to Human Settlements in a Tropical Dry Forest Landscape

Presenter(s): Narendran Kodandapani, Associate Professor, Administrative Staff College of India

Additional Author(s):
N. Satheesh, District Forest Officer, Tamil Nadu Forest Department
A.S.Singhar, Additional Principal Chief Conservator of Forests, Tamil Nadu Forest Department

The large dependence by humans on tropical forests to meet livelihood and natural resource needs makes it imperative to quantify and understand the effects of forest degradation. Disturbances such as forest fires are annual events in several tropical forests. We combined information from semi-structured social surveys from 20 villages, with vegetation data on forest disturbance from 341 circular plots from the Sathyamangalam Tiger Reserve (STR). We examined in detail one forest disturbance, forest fires in relation to human settlements. The study also analyzed the effects of landscape structure at multiple spatial scales on forest burnt area. 16 yr of remote sensing data were applied to delineate burned areas, determine fire size characteristics, and to estimate fire-rotation intervals. Fire wood was the most common natural resource extracted from the forest, 98% of the households extracted fire wood from the forests. Between 28% and 52% of households collected a variety of NTFPs (Non timber forest products) from the forests. Forest disturbance index in the STR ranged between 0.1 and 0.5 (minimum of 0 to maximum of 1), with a mean of 0.25 ± 0.09. Annual fire frequency was 159 ± 115 for the STR, mean fire rotational intervals (mFRI), the time required to burn the equivalent of the total forest area, was 44.1 yr. A small percentage of fires account for the bulk of area burned, 10 % of fires accounted for 86 % of the burned area. Small fires ≤ 10 ha are abundant, mean fire size was 10 ha, the largest fire size was 2 425 ha. The spatial pattern of burnt pixels in the STR was explained by distance from the village edges, (R2 = 0.59, Adjusted R2=0.53, F2,14 = 10.28, p < 0.001). the proportion of total burnt area increased with increasing spatial scale in the tropical dry thorn (f1,11=18.67; r2=0.62; p<0.001), and in the tropical moist deciduous forests (f1,11=7.05; r2=0.39; p<0.05). understanding these spatial patterns and drivers of forest change is important for alleviating the impacts of forest degradation in the tropics.

Keywords: Forest degradation, disturbance index, fire regimes, fire size, fire-rotation interval, conservation, tropical forests, spatial pattern, remote sensing

Bio: Narendran Kodandapani is an Associate Professor at the Administrative Staff College of India. His research interests include tropical forest conservation, landscape ecology, and human dimensions of conservation. He completed his PhD from Michigan State University. His dissertation research examined forest fire regimes in seasonally dry tropical forests in the Western Ghats of India.

SPECIAL SESSION ONE: INDIGENOUS PEOPLE AND WILDLAND FIRE

Moderator: Amy Christianson

Despite fairly extensive knowledge on traditional burning practices, little is known about how wildfire is currently managed in Indigenous communities worldwide. Indigenous communities are frequently at high risk from wildfire because they are often situated in isolated, remote locations in landscapes prone to fire. Indigenous populations are increasing rapidly compared with the general population and Indigenous communities often face a range of socioeconomic issues of increasing complexity and severity in some communities, making fire management a lower priority. Social science research with Indigenous populations on fire management can help to inform policy in the face of global changes such as climate change, biodiversity loss and economic change. This special session will host speakers from numerous countries discussing Indigenous People and contemporary wildland fire management.

Keywords: Indigenous, Aboriginal, fire management, social science

19. Wildfire evacuation experiences of a First Nations community in Alberta, Canada

Presenter: Tara McGee, PhD, Associate Professor, University of Alberta

Additional Author(s):
Amy Christianson, Fire Social Scientist, Natural Resources Canada, Canadian Forest Service

In this presentation, we will present results of research carried out as part of the First Nations wildfire evacuation partnership in Canada. The partnership includes eight First Nations in three provinces that have been evacuated due to recent wildfires, researchers, and government and non-government organizations involved in assisting during evacuations of First Nations communities. We will present findings from research carried out with Whitefish Lake First Nation (Atikameg) in Alberta, which was evacuated in the summer of 2011. Interviews were completed with community members who helped to carry out the evacuation, those who were evacuated, and those who stayed behind during the evacuation. In this presentation, we will describe how the evacuation was carried out, residents' evacuation experiences, and factors that positively and negatively influenced residents' evacuation experiences.

Keywords: wildfire evacuation, First Nations

Bio: Tara McGee is an Associate Professor in the Department of Earth and Atmospheric Sciences at the University of Alberta. For the past 15 years, her research has focused on the human dimensions of hazards, mainly focusing on wildfires. Tara leads the First Nations wildfire evacuation partnership.

20. In their words: how a wildfire evacuation affected residents of a Northern Alberta First Nation community

Presenter: Kyla Mottershead, MA Student, Human Geography, Department of Earth and Atmospheric Sciences, University of Alberta

In Canada, fire management agencies recommend the evacuation of a community when wildfires pose a threat to the health and safety of residents. This results in thousands of people being evacuated each year (Beverly & Bothwell, 2011). Although they make up only 4.3 percent of the Canadian population, almost one-third of the wildfire evacuations that took place between 1980 and 2007 involved an Aboriginal community (Beverly & Bothwell, 2011). The remote location and unique sociocultural characteristics of many Aboriginal communities can present challenges for residents and evacuation organizers. However, very little research has sought to understand how Aboriginal residents are affected by wildfire evacuations. This community-based, qualitative study explored how residents of Dene Tha' First Nation (Meander River, Alberta) were affected by a community-wide evacuation called in response to heavy smoke from a nearby wildfire. Data from interviews and focus groups with 31 participants illustrate that the community context and logistical characteristics of the evacuation determined how residents were affected. Three main themes are evident in the participant's discussions of their experiences. First, they focused on the loss of control they experienced over decisions affecting their personal and collective well-being. Second, participants focused on the psychological impacts they experienced. Third, the participants focused on how the evacuation altered their risk perception and desire to implement mitigation and preparedness efforts in relation to wildfires and other local hazards. The findings from this study point to the importance of reducing pre-existing vulnerabilities in order to minimize the negative impacts of wildfire evacuations on Aboriginal communities. This research confirms that evacuations can be difficult for some Aboriginal residents and organizers must develop plans to account for the distinct sociocultural characteristics and vulnerabilities of the communities with which they work.

Reference:
Beverly, J. L., & Bothwell, P. (2011). Wildfire evacuations in Canada 1980–2007. Natural Hazards, 59(1), 571–596. doi:10.1007/s11069-011-9777-9

Bio: Kyla Mottershead is a second year Master of Arts student in the Department of Earth and Atmospheric Science (Human Geography and Planning Program) at the University of Alberta. She has a BA in development studies and geography from the University of Calgary ('10). Her MA research focuses on how residents of a First Nation community were affected by a wildfire evacuation with the goal of mitigating and preventing any negative impacts experienced by First Nation communities during emergency evacuations.

21. Using Historical Photographs to Identify Indigenous Burning Patterns

Presenter: Rick, Arthur, RPFT, CEO Driptorch Consulting Inc.

Identifying historic disturbance patterns is a critical prerequisite before undertaking any ecological restoration or for that matter, planning for landscape or ecological management. Of equal or greater importance, is understanding how those disturbance patterns came into being or were maintained.
Indigenous fire has been recognized as a principle tool for a variety of multiple resource uses and benefits. While the scale of use has been debated, there is increasing consensus that frequent fire maintained certain ecosystems.

In latter stages of ecological succession, the historical use of frequent fire is very difficult to ascertain. There are ecological indicators that can be found through careful assessment and interpretation. Identifying low intensity fire patterns is difficult as it does not leave significant markers on the landscape. These are often lost over time thru successive vegetative types or expansion of coniferous forests.

Historic and repeat photographs often provide some insight but are usually, only a single image or a few images that may or may not represent the landscape. and as such have limited usefulness.
Early Canadian surveyors took systematic glass plate photographs as they surveyed the mountain regions of western Canada. These collections, representing over 140,000 glass plates, dating from 1861, captured landscapes across the entire survey area in a single season, inadvertently capturing a snapshot in time of what these ecosystems looked like, often from different view points.

Through the Mountain Legacy Project, these collections are being identified, digitized, and retaken in effort to explore change in Canada's mountain environments. MLP researchers seek to re-photograph these images as accurately as possible and make the resulting image pairs available for further investigation. With careful interpretation, these collections could represent the equivalent of the Rosetta Stone in understanding patterns and scale of indigenous fire use prior to European settlement as well as providing a baseline for landscape management and change.

This presentation will introduce the Mountain Legacy Project, highlighting some of the findings that these extremely high resolution images have provided to date. Perhaps fire exclusion has had greater impacts to ecological change than fire suppression.

Keywords: indigenous fire, fire patterns, ecological restoration, Mountain Legacy Project, ecological restoration, traditional land use

Bio: Rick's career began on a seasonal fire crew with the Alberta Forest Service in 1974. After graduating from NAIT as a Forest Technologist in 1975, he worked in numerous positions across Alberta until retirement in 2012. He has since started his own consulting company. He has worked on wildfire operations from British Columbia to Ontario, from Yellowstone to the Yukon. He is passionate about most everything he engages in, especially fire history and fire behaviour and uses these skills to reduce the threat of wildfire as well as to restore it to the landscape through the use of prescribed fire.

22. Maori use of fire: traditional use of fire to guide wildfire management in New Zealand

Presenter: E. R. (Lisa) Langer, Senior scientist and research leader, Scion

Additional Author(s):
Grace Aroha Stone, Researcher, Scion

New Zealand's landscape and history have been shaped by fire (te ahi). M ori, the indigenous people of New Zealand, and Europeans have contributed to both through planned and accidental use of fire. M ori had an established fire culture stemming from mythology with associated belief systems and rules surrounding the sacredness of fire and its uses before they arrived in Aotearoa/New Zealand. Fire was regarded the most important of the natural elements of putaiao Maori (natural environment) and was used in the propagation, storage and cooking of a number of crops in hangi and umu which contributed to their stable diet. Fire was also used to aid in the felling of selected trees to make waka (canoe), harden or aid the bending of wood for weapons, and eased shaping bark vessels or baskets used for carrying water or preserving food. European settlers from the early 1800s accelerated the use of fire to clear native forest for land settlement and pasture. Native forest cover has been reduced from approximately 80% to 24% of New Zealand's land cover.

Scion's Rural Fire Research Group has studied historical knowledge on the use of fire by M ori gathered from published literature. Interviews with kaumatua (elders in Maori society) in the eastern Bay of Plenty have added to this by drawing on personal experiences. The research focus has been on the effects of fire on the landscape and traditional use of fire as a primary resource and tool by rural Maori communities.

The events of the past, both written and oral, reveal pertinent background understanding to guide the design of some practical solutions to age-old issues regarding the use of fire. This lays the foundation to understanding current use of fire in rural communities. It also guides future prevention of wildfires resulting from the accidental use of fire by rural communities for land management, recreation or traditional methods cooking still used today especially for large gatherings (e.g. for funerals or celebrations such as weddings).

Keywords: Te Ahi; rural fire; Maori; traditional use

Bio: Lisa Langer has led Scion's social fire research since 2003. Her qualitative research has focused on community resilience and recovery following wildfires, fire danger warning communication, fire insurance, and mitigating the risk of human-caused fires. Recently she completed a contract for the Bushfire CRC leading the New Zealand component of the Effective Communication fire warnings and preparedness project. She has presented her research at international fire conferences in the US and Europe, as well as to Australian and New Zealand audiences.

RISK

23. Inducing Private Wildfire Risk Mitigation: Experimental Investigation of Measures on Adjacent Public Lands

Presenter(s): Joseph Little, Associate Professor of Economics, University of Alaska-Fairbanks

Additional Author(s):
Tyler Prante, Associate Professor, Los Angeles Valley College
Michael L. Jones, Associate Professor, Bridgewater State College
Michael McKee, Professor, Appalachian State University
Robert P. Berrens, Professor, University of New Mexico

Increasing private wildfire risk mitigation is an important part of the larger forest restoration policy challenge. Data from an economic experiment are used to evaluate the effectiveness of providing fuel reductions on public land adjacent to private land to induce private wildfire risk mitigation. Results show evidence of "crowding out" where public spending can decrease the level of private risk mitigation. Findings also indicate that spending on private mitigation efforts increase when information about individual expenditures are made available and spending on public land fuel reductions are conditioned upon a threshold level of private mitigation effort being achieved.

Keywords: Wilfire Urban Interface, risk mitigation

Bio: Dr. Little is an Associate Professor of Economics at the University of Alaska-Fairbanks. He specializes in the areas of environmental and natural resource economics with a particular focus on non-market valuation and applied analysis. Dr. Little is currently the Program Director for the M.S. in Resource and Applied Economics at UAF.

24. Mitigation Behavior to Reduce Wildfire Risk: What Motivates Homeowners to Mitigate Wildfire Risk?

Presenter(s): Hari Katuwal, PhD, Post-doctoral researcher, University of Montana and Tyron Venn, PhD, Associate Professor, University of Montana

Additional Author(s):
Tyron Venn, Associate Professor, University of Montana
Travis Paveglio, Assistant Professor, University of Idaho
Tony Prato, Professor Emeritus, University of Missouri

Homeowners in the wildland-urban interface can reduce wildfire risk by creating defensible space around their property. Research suggests that the likelihood of wildfire related damages can be significantly reduced by improving structural characteristics and removing vegetative fuels around homes. Even though some mitigation actions are relatively inexpensive, a significant number of homeowners in wildfire-prone areas do not take any mitigation action and do not prepare for wildfire. This study identifies and examines the determinants of mitigation actions to reduce wildfire risk using survey data (N=1155) from Flathead County in northwest Montana. We find that higher perceived risk and information seeking behavior is positively associated with mitigation behavior. Our results suggest that respondents who think mitigation to be ineffective, not their responsibility, costly, or that mitigation destroys natural aesthetics are less likely to take mitigation action. Results also indicate that community programs aimed at reducing wildfire risk and participation in the program designed to reduce wildfire risk have positive effect towards mitigation behavior. A better understanding of these determinants will enable land and fire managers to more effectively motivate homeowners to perform mitigation actions.

Keywords: Wildfire, Mitigation behavior, Home ignition zone, Wildland urban interface

Bio: Hari Katuwal is a Post-Doctoral Researcher in Wildfire Economics and Non-market Valuation at The University of Montana. His areas of specialization lie at the intersection of Econometrics and applied Microeconomics with a specific focus on Environmental Economics. Hari's research is focused on providing information to support public forestland management, particularly in wildfire economics and non-market valuation of natural resources. Hari's current research focuses on examining large wildfire suppression effectiveness and understanding public preferences and effectiveness of wildfire management program.

25. Is the whole greater than the sum of its parts? Homeowner wildfire risk mitigation and community heterogeneity

Presenter(s): Hannah Brenkert-Smith

Additional Author(s):
James Meldrum, Research Associate, University of Colorado
Patricia Champ, Economist, USFS Rocky Mountain Research Station
Chris Barth, Fire Mitigation & Education Specialist, Bureau of Land Management
Travis Warziniack, Economist, USFS Rocky Mountain Research Station

Adaptation to a fire-prone landscape requires action to mitigate the risk. Homeowner decisions to mitigate wildfire risk are complex, influenced by many factors, and are not made in isolation but are made within the context of a broader community. Many potentially relevant characteristics vary across communities, including: programs and approaches to wildfire risk mitigation, capacities to facilitate action (e.g. social capital, financial resources), social norms shaping the acceptability of different wildfire risk mitigation activities and programs, and histories with wildfire events.

In this presentation, we describe the framework the research team developed to investigate the conceptualization, measurement, and implementation of the concept of community level fire adaptedness. We focus on an on-going data collection effort across multiple diverse communities in fire-prone areas of western Colorado. The research expands on previous efforts to characterize the wildfire risk mitigation choices of homeowners by shifting the analytical focus from individuals to communities. We will highlight initial findings from the communities located on the western slope of Colorado to address the issue of how the combined wildfire risk mitigation efforts of community members relates to community level fire adaptedness.

Keywords: Homeowners, community characteristics, fire adaptedness

Bio: Hannah Brenkert-Smith is an environmental sociologist whose work examines social/environmental interactions in the face of environmental change, particularly in the American West. In the past ten years, Brenkert-Smith's work has focused primarily on household and community response to wildfire risk. In particular, this work has focused on risk mitigation decision-making and forest and wildfire hazard planning related to social interactions. Hannah earned her PhD in sociology from the University of Colorado and was a postdoctoral fellow at the Research Applications Lab of the National Center for Atmospheric Research.

26. Potential for Disseminating SAWTI Risk Information: Understanding Information Seeking and Wildfire Preparedness in Southern California

Presenter(s): Anne-Lise Velez, MArch, MPA, Research Assistant, North Carolina State University

Additional Author(s):
John Diaz, Program Evaluation Specialist, Forestry Extension, North Carolina State University
Tamra Wall, Assistant Research Professor Climatology, Desert Research Institute

Southern California is a particularly challenging environment in which to manage and adapt to wildland-urban interface fires. We examine relationships between wildfire knowledge and experience, readiness actions, and media choice to determine how best to integrate preparedness information and the recently developed Santa Ana Wildfire Threat Index (SAWTI) into public information dissemination. Integration of SAWTI into current Southern California wildfire risk communication is important as Meteorological Forest Fire Risk Indices are most effective when they are geographically specific, and SAWTI has been shown to generate accurate 6-day forecasts for Large Fire Potential, providing information that can both allow response agencies to position resources, and can enable the public to better understand and respond to wildfire risk. To best understand how to communicate risk to the public, it is important to understand sources from which the public seeks information both on a daily basis and when a wildfire is in the area. This includes understanding whether people use the same sources for daily and wildfire-specific information; whether they plan to use the same sources in the future; which sources they consider trustworthy and up-to-date; demographic and geographic differences in information seeking, and the relationship between information seeking and wildfire and evacuation preparedness actions. Data are from 459 surveys conducted in 2012 with select residents of San Diego (213) and Los Angeles (245) counties, in California. We find television is the most frequently used source for both daily news and wildfire information, and that most people intend to seek information from the same sources in future fires. We also find support for previous research indicating sources considered trust-worthy are not always those considered the most up-to-date. Wildfire knowledge, experience, and past preparedness actions influence the number of sources from which respondents report seeking information. We note significant differences in the information sources used before and during wildfire by geographic area, with higher percentages of those in more rural areas relying on television, radio, Reverse-911, and friends and family for information during a wildfire. Findings support previous studies recommending two-way communication for event-based and readiness information along with one-way sources like television.

Keywords: Information seeking, wildfire preparedness, risk index

Bio: Anne-Lise K. Velez has master's degrees in Architecture and Public Administration from North Carolina State University (NCSU), where she is currently a PhD candidate in Public Administration. She has been a member of the NCSU FireChasers team since 2010, studying how adaptive capacities such as communication efficacy during incidents relate to more disaster resilient communities. Anne-Lise is writing a dissertation focusing on the inclusion of built historic resources in disaster plans as part of a larger agenda to better understand policies and practices that affect the quality of the built and natural environments.

27. LiDAR based risk assessments in the wildland urban interface: an analysis of pre-fire conditions of the Black Forest fire

Presenter(s): Andrew Karlson, Boise State University

Additional Author(s):
Jason Kreitler, Research Geographer, USGS

Wildland fire risk assessments are an important tool for understanding and communicating risk from wildland fire to homeowners and communities. This is particularly true in the wildland urban interface (WUI) where private structures, available fuels, and a patchwork of land ownership types and governmental jurisdictions provide an opportunity for catastrophic fire losses under severe fire conditions. Aerial photos and satellite imagery are often used to assess the composition and configuration of vegetative fuels for risk assessments. However optical remote sensing cannot quantify the vertical structure of canopy and ladder fuels important for modeling fire behavior, and thus risk. LiDAR (Light Detection and Ranging) data have emerged as a promising remote sensing technology which can quantify the vertical structure in addition to the areal extent of fuels. LiDAR data can also be used to delineate the footprints of built structures, even under tree canopies. As a result, LiDAR data have great potential for risk assessments and in the analysis

of WUI home ignition zones. Here, we present research analyzing the Black Forest fire of June 2013, near Colorado Springs, CO, using pre-fire airborne LiDAR data covering the entire fire. We ask if significant differences emerge in fuel loads within the home ignition zone of destroyed (n=464) and non-affected structures (n~760) intersecting the burned area of the fire. We then compare and discuss how LiDAR data improve the ability to conduct risk assessments in WUI communities through the delineation of structures, and by quantifying the fine scale vertical and horizontal heterogeneity of wildland fuels within the home ignition zone.

Keywords: LiDAR, remote sensing, risk analysis, WUI

Bio: Andrew currently works for and attends Boise State University, studying geology. His work has been in cold regions research, with research focused on snow and icecore chemistry, remote sensing of snow and ice, and spatial and temporal variability within snow.

MANAGEMENT AND GOVERNANCES OF WILDFIRE

28. Wildland Fire Governance: Strategies of Effective Suppression Firms

Presenter(s): Cassandra Moseley, Diretor, Ecosystem Workforce Program and the Institute for a Sustainable Environment at University of Oregon

Additional Author(s):
R. Patrick Bixler, Faculty Research Associate, University of Oregon
Nathan Mosurinjohn, Faculty Research Assistant, University of Oregon
Eric White, Faculty Research Associate, University of Oregon

Understanding the "anatomy" of fire suppression businesses has rural community development implications as locally expended suppression resources positively impact employment and wages in affected communities. The number of local natural resource and fire suppression firms prior to a fire influences the amount of suppression funding that is spent locally during a large fire. However, we know relatively little about fire suppression firms and what drives their business decisions such as where they locate. Firms providing suppression contracting services vary in their size, geographic location, degree of dependency on fire suppression for revenue, specialization of services, and other characteristics. These characteristics, along with regional competition and federal procurement market management practices, likely impact local community business capacity to successfully bid on suppression contracts. This research summarizes the characteristics of fire suppression firms, as a first step toward understanding the drivers of business decisions regarding their participation in the fire suppression contracting market.

Keywords: Suppression, Expenditures, Contractors, Contractor Business Strategy, Local Business

Bio: Cassandra Moseley is the director of the Ecosystem Workforce Program and the Institute for a Sustainable Environment at University of Oregon. At the EWP, she developed applied research and policy education programs, focused on community-based forestry, federal forest management, and sustainable rural development. She is a former board member of the Flintridge Foundation and the Applegate Partnership, and participates in the McKenzie Collaborative. She chair of the USDA's Forestry Research Advisory Council. She has testified before Congress about rural green jobs, rural development, and the working conditions of forest workers. She received her Ph.D. from Yale University.

29. Fire Manager or Market Manager? Administrative Practices for Large Fire Suppression

Presenter(s): R. Patrick Bixler, Faculty Research Associate, Ecosystem Workforce Program, University of Oregon

Additional Author(s):
Cassandra Moseley, Associate Professor and Director of Ecosystem Workforce Program, University of Oregon

Private contractors play a major role in federal fire suppression activities, especially large fires, where spending on contracted resources may be half or more of expenditures. There are relatively small numbers of customers for wildland fire suppression services, with the Forest Service a dominant actor. The federal procurement literature suggests that agencies use strategies such as stimulating the market with competition and using relational contracting to manage weak vendors or market consolidation. We hypothesize that Forest Service administrative practices influence the structure of the wildfire suppression contracting market and the ability of local vendors to compete in that market. Through purposively derived semi-structured interviews with key personnel involved with fire procurement, operations, and dispatch at a variety of levels in the fire management system, we identify the major ways that Forest Service administrative practices influence the fire suppression market. We also examine the extent to which the Forest

Service influences those markets through institutional structures, organizational incentives, and social factors such as relationships and broader networks.

Keywords: Suppression, Markets, Market Management, Expenditures

Bio: R. Patrick Bixler is a Faculty Research Associate in the Ecosystem Workforce Program at the University of Oregon. His current research is focused on the intersection of ecology, economy, and governance across a range of issues relevant to forest disturbance and western public lands management. This includes wildfire suppression, bark beetle infestations, and collaboration. He is interested in the ways that networks and relationships facilitate conservation efforts and link local actions to landscape-level outcomes. He completed his PhD in Environmental Sociology at Colorado State University and was a post-doctoral research fellow at the Pinchot Institute for Conservation in Washington DC. He is currently a University Fellow at the Pinchot Institute.

30. The Influence of Incident Management Teams on Suppression Resource Use

Presenter(s): Michael Hand, Economist, USDA Forest Service, Rocky Mountain Research Station

Additional Author(s):
Hari Katuwal, Post-doctoral researcher, University of Montana
David Calkin, Research Forester, USDA Forest Service, Rocky Mountain Research Station

Wildfire incidents present complex management problems, even for experienced and highly trained management organizations. Each incident may require managers to quickly adapt strategies to existing conditions that present varying degrees of risk for firefighting personnel. This paper explores how managers of highly complex incidents - those requiring Type I or Type II incident management teams (IMTs) - adjust orders for available line-producing capacity in response to changing conditions. We gathered daily observations of suppression resource orders for 299 incidents between 2007 and 2011 where a Type I or Type II IMT was assigned. These orders were linked to at least one of approximately 90 IMTs assigned to the incident and daily fire conditions drawn from ICS-209 reports. A panel-data approach is used to model the amount of resources ordered with fireline-building capability as a function of daily incident conditions, regional differences, and individual IMT effects. Results indicate wide variation in the amount of suppression resources ordered by managers after controlling for observable fire conditions. Significant variation in resource orders exists between different regions and among different IMTs. This research may have implications for suppression cost models, where significant variation in expenditures cannot be attributable to observable geographic and landscape characteristics. The model may also be useful for system-wide decision support activities to identify circumstances where low-cost and low-exposure resource orders are warranted based on fire characteristics, and to assist managers in planning resource needs over the course of an incident.

Keywords: wildfire suppression, incident management teams, fixed effects

Bio: Michael Hand is an economist with the USDA Forest Service, Rocky Mountain Research Station. His research focuses on the tradeoffs associated with wildfire management, risk perception and response to natural hazard incidents, and the economics of climate changes to public lands.

31. Social "Watch Out" Situations for Incident Management Teams

Presenter(s): Toddi Steelman, Executive Director and Professor, School of Environment and Sustainability (University of Saskatchewan)

Additional Author(s):
Branda Nowell, Associate Professor, School of Public and International Affairs, North Carolina State University
Clare FitzGerald, School of Public and International Affairs, North Carolina State University
Mary Clare Hano, School of Public and International Affairs, North Carolina State University

In addition to managing the biophysical aspects of large wildfires, Incident Management Teams (IMTs) must also manage the social aspects of the fire. However, we have a much more sophisticated understanding of the biophysical risks related to wildfire than the social risks. Land cover type, topography, soil moisture, humidity, fuel loads, wind, and weather are common in the vocabulary of most fire managers. We are much less conversant in the language related to risks for problematic communication and coordination among responding agencies and how these risks can be assessed and managed. However, many experienced IMTs implicitly manage for these social or relationship risks during a wildfire. We harvested the experience of 24 highly experienced fire managers, which included US Forest Service and Bureau of Land Management Fire Staff, Fire Chiefs, State Forestry officials, Forest Supervisors, and Sheriffs, all of whom served on

IMTs in different capacities from across the United States (10 states) so that we might more explicitly and systematically understand those risks and share that knowledge. We further worked with Area Commanders, Incident Commanders, and Deputy Incident Commanders to identify and confirm the top most challenging social watch out situations faced by IMTs and the social watch out situations most commonly faced by IMTs. Articulating this list and providing some discussion about these situations and what can be done to effectively manage them could lead to better safety outcomes for IMTs.

Keywords: Social Watch Out Situations, Risk Management, Communication, Incident Management Teams

Bio: Toddi Steelman is Executive Director and Professor, School of Environment and Sustainability (University of Saskatchewan). Her research focuses on improving the governance of environmental and natural resources, emphasizing science, policy, and decision-making interactions. She places special emphasis on the role of the public and community in decision-making. She is Co-director, with Dr. Branda Nowell, of the Fire Chasers project at North Carolina State University (research.cnr.ncsu.edu/blogs/firechasers/).

32. What Cohesive Strategy Looks Like on the Ground

Presenter(s): Katie Lighthall, Coordinator, Western Region, Cohesive Wildland Fire Management Strategy
Steven B. Hawkins – Deputy Fire Staff/Fuels, US Forest Service, Wallowa Whitman National Forest

The National Cohesive Wildland Fire Management Strategy is not a new program but a core philosophy that focuses on collaboration that leads to meaningful progress towards its three goals: Resilient Landscapes, Fire Adapted Communities and Safe & Effective Wildfire Response.

There are many examples of Cohesive Strategy behaviors across the West and this presentation will highlight two, real-life, on-the-ground examples of collaboration leading to success to demonstrate some of the actions stakeholders can take to make progress towards the three goals.

The Western Klamath Restoration Partnership in Orleans, CA is a collaborative group of diverse stakeholders with strong ties to the landscape in northern California. This landscape is ravaged almost yearly by large, devastating and costly wildfires. A long history of mistrust and turbulence between the US Forest Service, the environmental community and local tribes however, has led to project-halting litigation and almost no restoration efforts in the last couple decades. The two-year old collaboration itself is already a giant step in the right direction. The WKRP has moved from agreement in principle with the adoption of six shared values, toward agreement in practice, now considering various treatment prescriptions to set the landscape on a trajectory toward realizing those six values and meeting the three goals of the Cohesive Strategy.

The East Face of the Elkhorn Mountains project is a similar endeavor in northeastern Oregon of federal, state and local agencies to identify, prioritize and treat large landscapes, across multiple jurisdictions including adjacent private lands. The stakeholders and values at risk are different on this landscape than the WKRP example, but the method to achieve consensus and movement toward the three goals is the same.

These real-life examples will be presented to encourage conference participants to ask questions and hear how two efforts are succeeding through a process of collaboration, and what steps participants can take to initiate or improve these efforts in their areas of concern.

Bio: Katie Lighthall – Prior to joining the Cohesive Strategy effort, Katie spent eight years as Program Director for Project Wildfire – a wildland fire mitigation partnership in Deschutes County. There she facilitated and managed seven Community Wildfire Protection Plans, managed a countywide fuels treatment program, secured millions in grant funding and served as PIO and communications director for a variety of fire related programs. Katie Lighthall enjoyed a rewarding career as a management consultant for non profit organizations before her position at Project Wildfire. She she became a structural and wildland firefighter in 1995 with Redmond Fire & Rescue, and later a fire inspector and prevention specialist. Katie holds a BA degree in Political Science and English from the University of Washington.

Steve began his career in 1981 fighting fire for the Burnt Powder Fire Zone, Wallowa-Whitman National Forest in Region 6. In 2008 he moved to his current position as Deputy Fire Staff on the Wallowa-Whitman National Forest. Steve has 33 years of experience working in fire and resource management. Steve is currently on the steering committee for the Blue Mountain Pilot Project of the Cohesive Wildfire Strategy and is the project coordinator on the East Face Project for the Wallowa-Whitman National Forest. Steve received his A.S. in Forest/Range Management from TVCC in 1982 and completed Technical Fire Management thru Colorado State University in 2007.

33. Building Capacity for Wildfire Mitigation Through Collaborative Partnerships

Presenter(s):
Jerry McAdams, Wildfire Mitigation Coordinator, Boise Fire Department
Julia Kertz-Grant, Former Foothills & Open Space Manager, Boise Parks Department
Jennifer Tomlinson, Park Planner, City of Boise Parks and Recreation Department

Wildfire mitigation efforts should focus on forming partnerships as well as coordinating resources and strategies to create mutually beneficial outcomes in communities. Longer wildfire seasons and increased development in wildland-urban interface (WUI) areas exemplify the need for new and effective wildfire mitigation ventures. It is not uncommon for stakeholders to work on similar types of projects, unbeknownst to one another, creating a duplication of efforts. In a time when agency budgets are shrinking, the need to identify stakeholders and create efficient cooperative partnerships has never been greater. The City of Boise has created an interdepartmental Wildfire Mitigation Team (WMT), comprised of individuals from Fire, Parks, Planning and Public Works. Boise City staff have successfully partnered with federal agencies, not-for-profits, local university research teams, local environmental study groups, volunteer organizations, civic groups, small businesses, developers, as well as homeowners' and neighborhood associations, to organize and manage multiple wildfire mitigation projects, reducing wildfire risk and increasing community awareness. Most recently, the Boise Fire Department has partnered with the Fire Adapted Communities Learning Network, acting as the local hub organization for the Ada County FAC. The City of Boise WMT helped develop and implement a cooperative MOU between the Boise District BLM, the City of Boise, the City of Eagle, Ada County and the Idaho Department of Fish and Game, to address mutual wildfire mitigation concerns and efforts. The City of Boise Wildfire Mitigation Team continues to identify stakeholders and to build new collaborative partnerships.

Keywords: Collaborative Partnerships Wildfire Mitigation Fire Adapted Communities FAC Community Outreach

Bio: Jerry McAdams is the Wildfire Mitigation Coordinator for the Boise Fire Department, where he has worked for 15 years. He serves on City of Boise and Multiagency Wildfire Mitigation Committees. He is a Board Member for the International Association of Wildland Fire and holds an NWCG certification as a Wildland Fire Investigator. Jerry has previously presented at Backyards & Beyond, a Ready, Set, Go! webinar, an Idaho Power luncheon and at the Southwest Idaho Wildfire Mitigation Forum. Jerry has a Bachelor of Science in Psychology from Boise State University. He enjoys working with communities and seeking new, cooperative partnerships.

34. Increasing Capacity for Collaboration by Training Natural Resource Management Agencies, Scientists and Stakeholders

Presenter(s): Susie Kocher

Additional Author(s):
Kim Ingram, Community Education Specialist, University of California Cooperative Extension
Anne Lombardo, Community Education Specialist, University of California Cooperative Extension
Kimberly Rodrigues, Director , UCANR Hopland Research & Extension Center

State and federal agencies are increasingly interested in and committing to managing natural resources through collaboration with other agencies, scientists, and stakeholders. One challenge of this approach is the need for land management agencies to develop the institutional capacity to collaborate with others. This presentation reports on an effort to assist agencies, scientists and stakeholders to increase capacity for collaboration through training in collaboration and facilitation skills by the University of California Cooperative Extension (UCCE).

UCCE became involved in supporting development of collaboration skills as part of the Sierra Nevada Adaptive Management Project (http://snamp.cnr.berkeley.edu), a cross disciplinary study of forest fuels reduction treatments on national forests in the Sierra Nevada of California. The 8-year, 13 million dollar study involved independent third party research by University of California scientists of the integrated effects of forest thinning on fire hazard, forest health, wildlife, water quality and quantity, and public participation.

Public participation and a collaborative process are cornerstones of the multi-agency project. UCCE has engaged in community and stakeholder education and engagement through multiple outreach methods including science meetings with researchers, agencies and public stakeholders; management workshops; presentations to community groups; field trips; and web-based tools for sharing the science of various natural resource fields. These methods allow for mutual learning, group discussion, information sharing, community involvement in the research process and face-to-face interaction between all parties.

In 2013/2014, UCCE hosted a series of collaboration workshops using a 'train-the-trainer' model with curriculum on process constraints, framing collaborative projects, meeting logistics, group dynamics, understanding interactions, dealing with difficult behaviors and reducing conflict. Over 115 staff from federal and state forestry, fire, wildlife and research agencies, and local conservation organizations have attended.

Participant pre and post-tests quantified changes in knowledge and attitudes as a result of the workshops. Participants reported increased comfort with collaboration and managing a collaborative process by improving communication, sharing information with the public and facilitation when needed. Collaboration training should clarify the roles / responsibilities of agency staff and include facilitation training to bolster understanding of when facilitation is needed and how to conduct it, especially under difficult circumstances.

Keywords: collaboration, training, resource management, extension

Bio: Susie Kocher is a county-based academic who conducts outreach, education and applied research for the University of California Cooperative Extension focusing on forest resilience and wildfire issues, most recently as part of the California Fire Science Consortium. She has done outreach with forest landowner on pre and post wildfire management through in person workshops, webinars and media. She has coordinated public outreach for the Sierra Nevada Adaptive Management Project (http://snamp.berkeley.edu/) for the past seven years.

35. Collaborative Implementation for Ecological Restoration on US Public Lands: Implications for Legal Context, Accountability and Adaptive Management

Presenter(s): Sarah McCafferey, Social Science Researcher, US Forest Service Northern Research Station

Additional Author(s):
William Hale Butler, Assistant Professor, Department of Urban and Regional Planning, Florida State University
Ashley Monroe, Doctoral Candidate, Department of Urban and Regional Planning, Florida State University

The Collaborative Forest Landscape Restoration Program (CFLRP), established in 2009, encourages collaborative landscape scale ecosystem restoration efforts on United States Forest Service (USFS) lands. CFLRP projects must aim to reduce wildland fire management costs, enhance ecological health, and promote the use of small-diameter woody biomass as well as engage in collaboration with multiple stakeholders throughout planning, implementation, and monitoring. The policy has been lauded as an innovative turn in forest management policy due to the focus on landscape scale restoration and requirements for collaboration in all phases of implementing the law. Although USFS employees have experience engaging in collaborative planning, CFLRP requires collaboration in implementation, a domain where little prior experience can be drawn on for guidance. The purpose of this research is to identify the ways in which CFLRP collaborative participants and agency personnel conceptualize how stakeholders can contribute to implementation on landscape scale restoration projects, and to build theory on dynamics of collaborative implementation in environmental management. This research uses a grounded theory methodology to explore collaborative implementation from the perspectives and experiences of participants in landscapes selected as part of the CFLRP in 2010. Interviewees characterized collaborative implementation as encompassing three different types of activities: prioritization, enhancing treatments and multi-party monitoring. The presentation will briefly describe the types of activities in each of these categories and how, within the context of CFLRP, collaborative implementation: 1) is both hindered and enabled overlapping legal mandates; 2) creates opportunities for expanded accountability; and, 3) offers the potential to create more robust feedback loops in adaptive management.

Bio: Sarah M. McCaffrey, Ph.D. is a Research Social Scientist for the USDA Forest Service, Northern Research Station. Her research focuses on the social aspects of fire management. This has included National Fire Plan and Joint Fire Science sponsored projects examining the characteristics of effective communication programs and the social acceptability of prescribed fire, thinning, and defensible space. More recently she has begun work on the social issues that occur during fires including alternatives to evacuation and community-agency interactions during fires.

36. Fires of Change: An Art and Science Collaborative

Presenter(s): Andrea Thode, PhD, Associate Professor, Northern Arizona University

Additional Author(s):
Barbara Satink Wolfson, Program Coordinator, Southwest Fire Science Consortium
Andrea Thode, Associate Professor, Northern Arizona University
Cari Kimball, Program Coordinator, Landscape Conservation Initiative, NAU
Collin Haffey, Ecologist, USGS Jemez Mountains Field Station

The Southwest Fire Science Consortium (SWFSC) has expanded its target audience to include the public and based on the success of a similar project in Alaska, we developed an art and science collaborative called Fires of Change. This is a collaborative project with the SWFSC, the Landscape Conservation Initiative and Flagstaff Arts Council. The goal was to create a stronger link among fire, landscape conservation and climate change; making the newest scientific ideas more accessible to non-science oriented audiences through novel media. Bringing science and art together is not a new concept, but perhaps more important in our current world view, considering the changes we face on a global scale. Artists bring unique perspectives which may lead the public to see science differently. As part of the project, we held multi-day field trips to areas around northern Arizona. We visited the North Rim of the Grand Canyon to learn about their successful fire program and we visited the Slide Fire to learn about the successes in promoting ecologically beneficial fire even during a suppression incident. During the field trips, artists, managers and scientists were all present and contributing to conversation about fire ecology, historical fire regimes, changes in the last century due to human intervention and changes occurring due to a shifting climate. Artists will have a year to produce artwork based on what they learned during the field trips.

Keywords: art, collaboration, fire science, public education

Bio: Andrea E Thode (Andi) is Associate Professor of Fire Ecology and Fire Science in the School of Forestry at Northern Arizona University. Andi completed her B.S. and later her Ph.D. in fire ecology through the Ecology Graduate Group at the University of California, Davis. Her research focuses on fire effects at the local and landscape scale. Andi has been heavily involved in the Association for Fire Ecology (AFE) since its inception as a founding board member, education committee chair and member and through development and planning of several regional and national level conferences. Andi has been the Principal investigator for the Southwest Fire Science Consortium since its inception in 2009.

37. Local Perceptions of Forest Management and Wildfire Risk in Northeastern Oregon

Presenter(s): Angela E. Boag Environmental Studies Program, University of Colorado, Boulder, CO

Additional Author(s):
Joel Hartter, Environmental Studies Program, University of Colorado, Boulder, CO Carsey School of Public Policy, University of New Hampshire, Durham, NH
Forrest R. Stevens, Department of Geography and Geosciences, University of Louisville, Louisville, KY Environmental Studies Program, University of Colorado, Boulder, CO
Lawrence C. Hamilton, Departmennt of Sociology, University of New Hampshire, Durham, NH Carsey School of Public Policy, University of New Hampshire, Durham, NH
Mark J. Ducey, Department of Natural Resources and the Environment, University of New Hampshire, Durham, NH Carsey School of Public Policy, University of New Hampshire, Durham, NH
Michael Palace, Earth Systems Research Center, Institute for the Study of Earth, Oceans and Space, University of New Hampshire, Durham, NH
Nils Chistoffersen, Wallowa Resources in Enterprise, Wallowa County, OR
Paul T. Oester, Oregon State University College of Forestry Extension, LaGrande, OR

Millions of acres of public forestland in the U.S. need treatment and restoration to reduce the risk of catastrophic fire. The ability for federal agencies to treat forests is constrained by limited capacity and funding, and therefore they have sought to develop collaborative partnerships with communities to bolster resources for forest restoration. Since this strategy depends on an informed and engaged public, we conducted telephone surveys during the fire seasons of 2011 and 2014 of residents in the Blue Mountains region of eastern Oregon to understand perceptions of forest health and management. Like many parts of the American West, this region is experiencing demographic change as more people arrive to retire or build second homes; its timber industry has dramatically declined since the early 1990s; and it has

experienced more frequent and larger wildfires in recent years. Our results revealed that residents claim to be informed about declining forest health on public lands and appear more informed in 2014 compared with 2011. In addition, a majority of respondents identified active forest management and prescribed burning on public lands as a high priority. However, only 39% identified commercial logging on national forestland as a high priority, indicating that the public may be less aware of the potential for commercial logging to contribute to restoration activities. There was low support for increasing public land use fees or local taxes to pay for forest restoration, so more creative policy solutions are likely needed to address the forest restoration funding gap. However, a significantly higher proportion of residents in 2014 believe that environmental rules have been good for their area compared with a 2011 survey. Communities may also be becoming more open to regulations and programs that address ecological goals, including a diversity of management actions designed to decrease wildfire risks on both public and private land that traditionally have had little buy-in such as controlled burning. However, the economic hardship faced by land owners and in northeastern Oregon and other rural Western communities means that such policies may also need to include economic development if they are to achieve full local support.

Bio: Angela Boag is a PhD student in the Environmental Studies Program at the University of Colorado Boulder and part of the Communities and Forests in Oregon Project. Her research focuses on the human dimensions of forest management, wildfire risk assessment and mitigation, and species distribution modelling in fire-prone landscapes in the Blue Mountains of eastern Oregon. She received her MS in Forestry from the University of British Columbia where she modeled species distributions of understory plant communities. She has also worked with organizations like the Association of Fish and Wildlife Agencies and the Colorado Coalition of Land Trusts.

DIFFERENT WAYS OF UNDERSTANDING FIRE

38. Radio Technology Opportunities and Constraints: Using Dramaturgy as an Analytic Tool

Presenter(s): Jennifer A. Ziegler, PhD, Associate Professor of Communication , Valparaiso University and Dean of Graduate School and Continuing Education

Additional Author(s):
Rebekah Fox, PhD, Assistant Professor, Texas State University
Elena Gabor, PhD, Assistant Professor, Bradley University
Dave Thomas, Consultant, Renoveling
Anne Black, Program Manager Human Performance Research, Development and Applications USDA Forest Service, Missoula, MT

Radio technology on the fireground has its limitations. While a statement like that is usually followed by comments about about dead spots, weak repeaters, and complicated tone guard programming, this paper and presentation begin with a more positive spin on such "limitations" by focusing on the features of conversation and interaction as they are shaped by technological constraints and cultural adaptation to them. Specifically, radio technology and culture may shape interactive distributed communication such that it is more highly patterned, stylized, and full of deliberate choices (including choices of omission) as compared to other kinds of work related talk on the fireground.

Dramaturgy is an analytic tool that has proved useful for understanding ritualized performances in organizational life (e.g., Rosen, 1985), and conversely, to understand organizing as "performance" more generally. We will report the usefulness of a dramaturgical perspective for helping us understand the nature of radio talk as performance on the fireground with implications for understanding operations, for fire management and culture, and for training. This paper and presentation will review three approaches to dramaturgy: the sociological perspective exemplified by Goffmann's school of impression management (e.g. 1959; 1981) a Burkean rhetorical perspective (1969), and a performance studies perspective (e.g., Schechner, 1988) to assess their potential usefulness for exploring specific questions and issues related to radio communication in fire, and (by the time of the conference) to illustrate the usefulness of the various perspectives by showing what can be gained through analysis of actual data.

Our initial results suggest that the Goffmannesque approach will be valuable for studying the fireground as scene for dramatic "scripted" performances. The Burkean perspective may be more helpful for understanding meanings that emerge for specific interchanges on the radio, in the moment and in retrospect for the people present, but also in subsequent official (and resistant) readings of those behaviors and events. Finally, the more contemporary performance studies approach, with the shaping role of the dramaturg, may prove most useful for training. We use this perspective to ask: As firefighters are taught "how" to perform on the radio, through formal training or informal interaction, what is the implicit dramaturgy of radio performance in wildland fire?

Keywords: Dramaturgy, radio communication, performance

Bio: Jennifer Ziegler, PhD is Associate Professor of Communication at Valparaiso University where she currently serves as Dean of Graduate School and Continuing Education. Throughout the last decade, Dean Ziegler's research has focused solely on communication in the management and practice of safety in wildland firefighting. Her work at the intersection of rhetoric, culture, and communication theory has helped the fire community to understand the history and cultural legacy of bureaucratic rules in accident investigations. She has consulted with agencies initiatives related to improving learning from unwanted outcomes, including highlighting cultural and organizational conditions in fire related work.

39. The Storyteller's Role In Accident Investigations ~ Naturalistic Learning From Unintended Outcomes

Presenter(s): Steve Holdsambeck Firefighter Safety Program Manager, US Forest Service, Intermountain Regional Office, Ogden, Utah

With the evolution of language, 'storytelling' became a primary human instinct. Cognitive scientists tell us humans are hardwired to use stories to place knowledge in context and to share experiences with one another. Educators almost universally exercise storytelling as a fundamental tool for teaching and reasoning. Stories transmit knowledge into wisdom.

Humans crave meaning and require context to understand facts. Lacking the story behind facts (such as a dry factual report that merely lists findings and causes) humans will intuitively place new facts within their own existing personal narratives. Little new learning occurs from new facts, outside of context, other than reinforcing beliefs already held. Learning new lessons from other's experiences requires sharing in their story; taking on a new story.

Creative non-fiction stories are actually more true than factual narratives. Stories (like real life) are multidimensional showing how the characters perceived, understood and felt about the facts. In this way, stories bind facts together to make them make sense. This is truth with a capital 'T'. Moreover, stories can illuminate paradox, a difficult subject to deal with in a factual narrative but ubiquitous to the human condition.

Does 'Storytelling' have a place in a Government's official report of an accident investigation? With the formal adoption of the Facilitated Learning Analysis process in 2014, the United States Forest Service officially endorsed creative non-fiction storytelling for accident investigation reports. This presentation shows that creative non-fiction storytelling is the preferred format and technique for accident investigations as well as other reports where learning from unintended outcomes is desired.

Keywords: Storytelling, Human Cognition, Learning, Risk Perception

Bio: Steve started his Forest Service career as a timber marker on the Talladega National Forest. After graduation from Auburn University, Steve worked positions in Silviculture, Timber Sales Administration, Law Enforcement, Recreation Program Manager, Fire Management Officer and District Ranger in Forest Service Region's 2, 4, 8 and 9. Steve has participated on, or led, unintended outcome learning reviews across the country including seven fatality investigations/ FLA/CRPs and over thirty non-fatality FLAs.

Steve authored the first "Peer Review" Guide in 2007, then later the Accident Prevention Analysis "APA" Guide and then every edition of the Facilitated Learning Analysis "FLA" Guide from 2008 through 2014. Steve has taught or lectured on Just Culture, High Reliability Organizing, Storytelling and Accident Investigations across the country for the past twelve years.

40. Australian volunteer rural fire brigades: the value of historical perspective

Presenter(s): Sandra Lauer, PhD scholar, Department of Sociology , Australian National University

Wildfire has shaped much of Australia's ecological landscape and is a fundamental part of those ecological processes. However, fire has not only changed the ecological landscape in Australia. It has also shaped how Australians think of themselves as a people. Every local community has its own memories of fire; stories of survival, disaster and heroism. Some of these events, such as the 1939 Black Friday fires, the 2009 Black Saturday fires in Victoria and the 2003 Canberra Firestorm, are etched in the story of the nation. Other smaller, localised bushfire events also have long lasting impacts on local communities, even if they are relatively unknown elsewhere.

Understanding historical events as trigger points and analysing supporting historical documents, personal stories, narratives and photos provides an opportunity to unpack "wicked problems" that are often seen as being unsolvable. The professionalisation of fire management is one such "wicked problem" that has emerged as being a catalyst for disharmony.

Volunteer rural fire brigades are an essential part of these local and national historical narratives about fire and their histories are a valuable means of understanding how fire regimes and responses to fire have changes over time.

This paper will present preliminary research findings on the changing functions of such volunteer rural fire brigades in the Monaro region, New South Wales. The paper will explore how such an in-depth historical analysis enriches the development and understanding of some of the key research questions being asked. In this way, the paper argues that historical analysis is an important method for providing context for fire-related research but also sheds new light on current "wicked problems", such as the professionalisation of fire management, that have evolved in response to complex local, national and international pressures.

The paper also suggests that historical analysis can then help inform future fire management strategies within New South Wales and Australia, within the broader context of national policy changes.

Keywords: volunteer rural fire brigades, Australia, New South Wales, Monaro, history, narrative, bushfire, wildfire, case study, sociology, fire management

Bio: Sandra is a PhD scholar in the Department of Sociology at the Australian National University. She completed her Masters degree in Geographical Sciences in 2010. Sandra is also an active volunteer firefighter in the NSW Rural Fire Service.

41. Making Every Word Count: Teaching Wildland Fire in the Brazilian Amazon

Presenter(s): Matthew Carroll, Smokejumper/Spotter at the McCall Smokejumper base

Additional Author(s):
Robert Morrow
Forrest Behm
Jayleen Vera
Jason Lawhon

In 2009 the US Forest Service International Programs (IP) was asked to supply subject matter experts (SME) in wildland firefighting to train a group of ranch workers, settlers and indigenous peoples in Mato Grosso State, Brazil. The groups requesting training were already engaged in fire suppression on complex, rapidly moving, grass and forest fires and were asking for help in improving their efforts. The SMEs who filled the request faced a sizable, but probably not unique, challenge: Design a training that can be accomplished in 4 to 5 days through a translator (and sometimes double translators) to a group with a broad range of social, educational, cultural backgrounds and there is no expectation that any of the participants will ever take another training in wildlland firefighting.

The group of SMEs working in Brazil framed the training around becoming more effective and safe, where everything taught throughout the course could be tied back to one or both of these foundational elements. They developed training tools such as the concept of moving from being lucky to being good, which introduced ideas of risk and error tollerant systems. A "mental toolbox" where concepts like situational awareness, LCES and the 10&18 could be figuratively placed, allowing the SMEs to link the physical firefighting tools with the mental ones and emphasizing the importance of a mental toolset. These few examples illustrate the attempt to distill multiple NWCG classes into a single training that would have the best chance at making the participants more effective and safe.

This session begins with a brief overview of the evolution of the training courses from 2009 through November 2014, highlighting the trade-offs, lessons learned, epiphanies and failures throughout that time. The session hopes to conclude with a discussion on how we can begin to capitalize on the collective lessons learned so that the next group tasked with such a challenge can build off the knowledge of others.

Keywords: Safety, Effectiveness, Teaching, Brazil, Organizational Learning

Bio: Matt Carroll is currently a Smokejumper/Spotter at the McCall Smokejumper base and has been a wildland firefighter since 2000. He has been detailed into the Human Factors Specialist position at the US Forest Service Office of Learning (OOL) since January of 2014. Matt's work with the OOL began with the creation of the Margin video to bring the concept to the field. He has also been working on accident/incident reporting systems, risk assessment and management, Individual and organizational learning and resilience.

42. Optimal Forest Management: A Dynamic Analysis to Promote Healthy Forests and Economic Development

Presenter(s): Kara, Walter, PhD Candidate, University of New Mexico

The frequency, size, and impact of wildfires grows more every year and with droughts in many parts of the country, the risk of wildfires is also increasing. Following policy changes that made forest treatments easier, the number of treatments has increased especially in the Wildland-Urban Interface (WUI). With this change in procedure, researchers began to develop models to analyze the relationship of forest management and wildfire risk. This research develops a dynamic optimal control model to analyze the relationship between forest health and treatments. This research contributes to the existing literature by considering two different treatments that have yet to be examined together: prescribed burning and mechanical thinning. In addition, it will include both ecological and environmental variables; this will allow forest managers to consider both the ecological health and economic health of people living in the area. Finally, the model will consider a different objective function, which will maximize the net benefits of forest change with forest health subject to the economic, ecological, and financial constraints. Results will show the optimal time path and trade-offs for different treatments and their effects.

Bio: Kara Walter is a 4th year Ph.D. Candidate studying economics at the University of New Mexico. She is an applied microeconomist particularly interested in natural resource economics and ecological economics. Her research focuses around wildfires and how they interact with the economy and human populations. She earned her MA in economics from UNM in 2013 and a BA in economics and finance from University of Southern Indiana in 2011.

MODELS AND METHODS OF SAFETY

43. Suppression of forest fires by the drop water flows interspaced in time and space

Presenter(s): Pavel A. Strizhak, National Research Tomsk Polytechnic University

Additional Author(s):
Zhdanova Alena Olegovna, postgraduate, professor
Kuznetsov Geniy Vladimirovich, doctor of physical and mathematical sciences
Strizhak Pavel Aleksandrovich, doctor of physical and mathematical sciences, professor

Experimental results of drop water flows evaporation when moving through the high-temperature gases (combustion products of typical liquid fuels) are presented in the paper. Experiments were made with application of the panoramic optical noncontact methods of "tracer" visualization (PIV, IPI, PTV, PLIF). Characteristics of evaporation and influence of the dimensions, moving velocities and concentration of droplets in a flow on its were found. Regularities with braking of droplets in the flame area, change of characteristic forms, collisions, coagulation and crushing were revealed. Physical and mathematical models of the movement of droplets through the flames were developed on the basis of experimental data. The numerical values of droplets existence times in the flames of different height when moving of droplets with different velocity and distances between its were found. The model allowing defining the demanded concentration of droplets, its sizes and motion velocities, at which predetermined temperature decrease in the flame zone and concentration of combustion products and an oxidizing agent are possible, was developed. The simulation of flaming combustion suppression and thermal decomposition of typical forest combustible materials (birch leaves, pine and fir-tree needles) vapor-droplet water flows was performed. The model allowing describing the processes of heat transfer under the full evaporation of water droplets in a flame and generation of only water vapors at the surface of FFM is developed. The demanded temperatures of vapor-gas mix and thickness of FFM corresponding to conditions of FFM decomposition reaction suppression were found. The system describing the heat transfer conditions under the liquid film evaporation on the boundary with thermally decaying FFM was also considered. The minimal thickness of a liquid film, at which temperature in FFM is lower than temperature of thermal decomposition, was found. Results of numerical system simulation (in which the processes of heat transfer when forming of heterogeneous system (water with solid inclusions) between the layer of forest combustible material and the trace of water massif are considered) were presented. It was found that the possible increase of "buffer layer" concerning 0,005 m doesn't practically influence on FFM cooling conditions. The system model which describes the processes of heat transfer under the definite distance between extinguishing liquid droplets on the surface of intensively pyrolyzing FFM was developed. It was found that heat of phase transformation under the evaporation of two "neighboring" water droplets is sufficient for the energy absorption accumulated in a heated-up layer of FFM. The model which allows considering the process of heat transfer during the passing of all water in the pores of a near-surface layer of FFM and also the formation of a water film over FFM layer filled with water was developed. It was found that the velocities of chemical reaction in this area are inertially

decreased owing to the cooling of adjoining, filled with water FFM layers.
The reported study was supported by the Russian Science Foundation
(Project No. 14-39-00003).

Keywords: flames, suppression, drop water flows, simulation, experiment, panoramic optical method

Bio: Doctor of physical and mathematical sciences, professor, National Research Tomsk Polytechnic University

44. A Proposed Experimental Methodology for Assessing the Effects of Water and Dry Matter Content on Live Fuel Flammability

Presenter(s): Oleg Melnik, Graduate student, Department of Renewable Resources, University of Alberta

Additional Author(s):
Stephen Paskaluk, Research Engineer, Department of Human Ecology, University of Alberta
Mike Flannigan, Professor, Department of Renewable Resources, University of Alberta
Mark Ackerman, Adjunct Professor, Department of Mechanical Engineering, University of Alberta

Fire management effectiveness and safety of firefighters strongly depend on accurate predictions of fire behavior. To ensure the reliability of predictions, a fire modeling system needs a valid numerical input for flammability not only of dead fuel, but also of live fuel. The objective of this study is to evaluate the effects of water and dry matter content on energy release rates, aiming to develop an approach for quantifying live fuel flammability.

In this study we defined and measured flammability of live fuel as a response of live fuel to the conditions of frontal fire. These conditions were experimentally simulated using flame of a 100×100-mm calibrated open methane burner placed underneath a 100×100-mm sample of new, 1-year, and 2+ years old shoots of white spruce (Picea glauca). Heat release rate and effective heat of combustion during the first 60 seconds of combustion (average frontal fire residence time) were measured using oxygen-consumption calorimetry. Flammability of the sample was evaluated as its contribution to the incoming methane flame and calculated as effective heat of combustion of the methane flame with the burning sample within the flame minus effective heat of combustion of the methane flame alone.

Water content of 1-year and 2+ years old shoots caused notable decrease in shoot flammability. For new shoots with water content over 180% calculated net energy release was negative, meaning a reduction in the energy release rate for the methane flame. High water content and substantial losses of energy for water evaporation caused increased time-to-ignition and reduction in the reaction temperature of both the methane flame and the flame of the sample. According to these results, new shoots actually suppress incoming flame of the approaching forest fire. The effects of dry matter content and density on shoot combustion characteristics are currently under investigation and will also be reported. The conditions of frontal fire are much better represented in the proposed experimental method than in the existing techniques, thus providing more realistic estimation of live fuel energy contribution to the frontal fire intensity. Further development of the proposed experimental methodology will allow quantification and prediction of the flammability of live fuels and eventually inclusion of this important variable in the fire modeling process.

Keywords: firefighters safety, fire behavior prediction, live fuel flammability, water content, dry matter content, oxygen consumption calorimetry, heat release rate, effective heat of combustion

Bio: Oleg Melnik graduated from the Ukrainian State University of Forestry and Wood Technology with BSc in Forestry in 1984. He acquired 15-years of experience in operational forest firefighting while working for the Ministry of Forestry of Belarus holding a position of a Divisional State Forest Protection Officer. Currently he is a Master Student in Forest Biology and Management with the University of Alberta conducting research on flammability of live fuel. He is a participant of the Western Partnership for Wildland Fire Science and a member of the Canadian Remote Sensing Society, Canadian Aeronautics and Space Institute, and International Association of Wildland Fire.

45. Interacting with Wildfire Simulations and Historical Wildfire Analysis

Presenter(s): James R. Gattiker

Additional Author(s):
Stephen Guerin, CEO simTable.com

Public outreach, planning, and training benefit from the innovative use of historical wildfire behavior datasets and real-time interaction with wildfire models. The presentation of relevant wildfire historical datasets helps to guide discussions about wildfire characteristics in the context of chosen scenarios. The real-time interaction with wildfire models facilitates discussions of mitigation of wildfire threats, firefighter responses, and emergency management including evacuations and smoke impacts. This talk will discuss experiences using Simtable in these contexts, and how the quantitative use of historical datasets as well as real-time wildfire models adds value to the interactions.

Historical wildfire records are used to derive empirical characteristics that help to understand the nature of future fires, with analysis methods including machine learning, spatial modeling, clustering, and agent-based modeling approaches. The analysis of historical wildfires leads to improved understanding of wildfire behavior, better models of wildfire spread, and can suggest refined indicators of potential fire hazard and mitigation strategies. Training simulations use the historical data to ensure that the relevant breadth of wildfire behavior is incorporated. Similar previous fire events can be recalled during fire situation assessment, in both training and operational modes, to provide qualitative guidance on possible fire behavior.

Simple fire progression spatial models are use to provide a continuous fire progression exactly consistent with historical perimeters. Semi-empirical models of fire progression allow simulations that can be operated interactively in real time, facilitating the exploration of wildfire behavior for training and outreach. These models can be tuned on the discovered historical properties to assess likely fire progression. There is an inherent high uncertainty in many aspects of wildfire assessment and projection due to inherent limitations in dataset detail (e.g., relevant meteorology at tens of meters) and in the limitations phenomenological models suitable for fast user interaction. When using wildfire models, the historical data are a potential resource for tuning model parameters and analyzing the limits of model predictions.

Keywords: wildfire data analysis, wildfire modeling, public outreach and education, wildfire management training

Bio: Dr. Gattiker has been a staff member at Los Alamos National Laboratory for over 20 years, working on data analysis and statistical modeling in a variety of application areas related to scientific advancement and national security, including applications in climate and environment. He has recently been working on applied data analysis with simTable, developing enabling views of historical wildfire data for wildfire understanding, supporting modeling and situation awareness.

46. Wildland Firefighter Safety and Fire Behavior Prediction in the Field

Presenter(s): Marty Alexander

Additional Author(s):
Wesley G. Page, Fuels Tech, USDA Forest Service

A whole host of firefighter safety guidelines have gradually emerged over the years starting with the Ten Standard Fire Fighting Orders in 1957. Similarly, many advances in fire behavior research and fire behavior training have taken place. The Yarnell Hill Fire tragedy of June 30, 2013 involving the Granite Mountain Interagency Hotshot Crew (GMIHC) represents the latest in a long list of wildland firefighter fatalities on a global basis as a result of a burn-over or entrapment. While the issue is multi-faceted, it does beg the general question: Have we in wildland fire administration, training and research somehow failed firefighters?

According to the Serious Accident Investigation Report on the Yarnell Hill Fire, the flame front in the vicinity of the GMIHC entrapment area/deployment site advanced at a rate of ~16-19 km/h with flame lengths of ~18-24 m. This in turn raises a number of specific questions:

- Was this level of fire behavior predictable given the fire weather forecast products available at the time and the current set of fire behavior guides recommended for fireline personnel?
- How often, if at all, are current fire behavior guides utilized by field going personnel, and if they are not used, why?
- Did the GMIHC attempt to make a prediction of potential fire behavior (i.e., rate of fire spread and flame length) before leaving the safety of the "black" sometime after 1604 hours?
- If the GMIHC did in fact attempt to make predictions of potential fire behavior, did they also calculate their "margin of safety" as per Mark Beighley (1995. Fire Management Notes 55(4): 21-24.) based on their assumed rate of travel and the fire's expected rate of advance?

We will never know the answers to the latter two questions raised above but perhaps it is time that we find out what is actually going on in the field. This paper examines directly the first two questions and also surveys, on a global basis, the current status of field guides and aids to predicting fire behavior at the individual crew level. Recommendations for further study are offered.

Keywords: fire behavior, margin of safety, fatal firefighter entrapments and burnovers

Bio: Marty Alexander began his career in wildland fire in 1972, serving on the Bighorn inter-regional hotshot crew for two seasons. He retired in November 2010 as a Senior Fire Behavior Research Officer with the Canadian Forest Service in Edmonton, Alberta, after nearly 35 years service. He is presently an Adjunct Professor of wildland fire science and management at the University of Alberta. His research/technology transfer efforts have focused on applications of fire behavior knowledge and is considered an authority on the Canadian Forest Fire Danger Rating System. In 2003, Marty received the IAWF International Wildland Fire Safety Award.

DECISION MAKING AND FIRE

47. The Protective Action Decison Model: It's Application in an Australian Bushfire Context

Presenter(s): Ken Strahan, Managing Director, Strahan Research

Lindell and Perry's Protective Action Decision Model (PADM) is a judgement and decision making model which has been extensively used to analyse the behaviour and decision making of people subject to potential and actual threat from a wide range of natural hazards, especially in the USA.
Although the PADM has been used in a limited way in a small number of wildfire studies in North America this has not been the case for studies of bushfire in Australia. This presentation addresses two questions. (1) Does the PADM require adjustment or refining for use in studies on individual and household decision making in a wildfire/bushfire context? (2) How might the Australian policy of "Prepare Act Survive" (PAS) which emphasises the dangers of staying and defending during extreme fire weather conditions and promoting leaving early as the safer option, influence the application of the PADM?

The presentation will discuss differences between wildfire/bushfire and other natural hazards and how these differences may affect the application and interpretation of the PADM. The greater complexity of decision-making that can result from the PAS policy impacts some of the core aspects of the PADM.
Specifically the presentation will discuss three key issues for the model in the context of bushfire in Australia:

(1) Reduced importance of threat perceptions and (2) the increased importance of stakeholder perceptions in the decision -making process. (3) Greater complexity of the protective action decision-making process especially in identifying, comparing selecting and timing the implementation of the protective action.

These three issues are extremely significant to the PADM. First, threat and stakeholder perceptions are two of the three elements which Lindell, the co-creator of the PADM has identified as its "core". Second, the protective action decision making process, which is served by the information search process, is the decision-making engine of the PADM which produces an appropriate protective response. Better understanding these issues in the context of Australian bushfire will help to refine and perhaps extend the PADM.

Keywords: PADM, wildfire, bushfire, choice, decison making

Bio: Ken Strahan is the Managing Director of Strahan Research and has been involved in emergency management research, primarily in relation to bushfire in Australia, for 22 years. He has provided social research services to a number of agencies including the Country Fire Authority (Victoria), Country Fire Service (South Australia), Office of Emergency Services Commissioner (Victoria) and the Department of Premier and Cabinet (New South Wales).
Ken is also a PhD candidate at the RMIT University researching self-evacuation decision-making in a bushfire event in Australia.

48. Connecting Science and Decision-Making in Wildland Fire Management

Presenter(s): Melanie Colavito, School of Geography and Development at the University of Arizona

Climate change has already had significant impacts on fire regimes in the United States and these impacts are expected to intensity throughout the coming century. Decision-making, management action, and scientific research that focus on ways to increase both ecological and social resilience to changing disturbance regimes are therefore becoming increasingly important. At the same time, there are ongoing calls for more useful scientific information to inform decision-making and management action, especially within the context of climate change. Nonetheless, effectively connecting science, decision-making, and management action remains a challenge for numerous reasons. This study seeks to address this challenge by investigating the most effective ways to develop and apply scientific information about resilience for decision-making and on-the-ground management. This presentation will describe the results of interviews that were conducted with scientists, managers, and other stakeholders immediately following a workshop that focused on ways to better understand and foster ecosystem resilience under rapidly changing conditions in the Southwest U.S. This study found that scientific information is being used in a variety of ways in land management, from formally in planning documents to informally in the field. Nonetheless, there are still many obstacles to using scientific information effectively or developing studies to directly address management questions due to institutional requirements and limitations for managers and scientists alike. Two distinct types of scientific information needs are identified, including the need for new research and the need for more effective communication of existing information and research, each with its own pathway for informing decision-making and management action. Additionally, both verbal and written approaches for communicating scientific information are compared and assessed. The presentation will conclude with a list recommendations for effectively developing and applying scientific information about resilience for on-the-ground management. The results of this research can be used to improve our understanding of the human dimensions of fire management, specifically with respect to disseminating and applying science for decision-making under rapidly changing environmental conditions.

Keywords: decision-making, usable science, fire management, resilience, climate change

Bio: Melanie Colavito is a PhD candidate in the School of Geography and Development at the University of Arizona. Melanie's research focuses on the roles of science and collaboration in decision-making for forest restoration and fire management in the Western U.S. Her main objective is to design her research to answer pertinent scientific and management questions, as well as to share her results in a range of formats to appeal to different audiences. Melanie also has a minor in Remote Sensing and Spatial Analysis, as well as graduate certificates in Geographic Information Systems and College Teaching. She will graduate in 2015.

49. Power and Decision Making: A Foucaultian Analysis of Wildland Decision Making

Presenter(s): Van V. Miller, professor , Central Michigan University

If the conference theme "Managing Fire, Understanding Ourselves: Human Dimensions in Safety and Wildland Fire" truly aims at understanding ourselves, then we participants must engage intellectually with the concept of power, i.e. broadly defined as the ability to influence decision making (Dahl, 1957 and Foucault, 1982). To undertake an analysis of WF decision making, a method better known in the social sciences than in the physical sciences will be utilized. Foucaultian analysis seems highly appropriate for this task because of its detailed interest in the 'problem itself' and of an established methodology for investigating the designated problem.

The nexus between WF decision making and outcomes (operationalized as decisions, actions, and results) represents the central concern of this proposed paper and can be readily examined with the Foucaultian method at three levels of analysis—policy, IC, and crew. In line with the method, the problem will be specified through this question: With over a century of professionalized wildland firefighting in the United States, why do we still observe major conflicts about WF practices and outcomes? To address this problem using Foucaultian analysis, the question will be explored via the archaeology-genealogy-discourse framework that it espouses (Kendall and Wickham, 1999).

Finally, suggested refinements to WF decision making will be offered for each of the analytical levels studied. In keeping with the Foucaultian method and its mandated skepticism, the problem facing WF decision making should be viewed as a series of contingencies where a particular choice resulted in a path of actions with results that would not have been realized had another contingency choice been selected. To clarify contingency choices and paths of actions in greater detail, the current and conflicted notion of the WUI (wildland urban interface) as a negative WF risk factor will be discussed in considerable detail.

Keywords: Power Risk Decision Making

Bio: Van V. Miller is a professor at Central Michigan University and does research on wildland fire and sustainable development. He holds a Type 2 wildland firefighter certificate and is an active member in the Brazos Canyon Volunteer Fire Department.

50. Nudging Wildfire Managers – Taking Advantage of Behavioral Economics in Decision Support and Performance Management

Presenter(s): Dave Calkin, PhD, Research Forester, USDA Forest Service, Rocky Mountain Research Station

Additional Author(s):
Michael Hand, Research Economist, USDA Forest Service Rocky Mountain Research Station
Matthew Thompson, Research Forester, USDA Forest Service Rocky Mountain Research Station

Decision making in wildfire management is characterized by high levels of uncertainty, both in terms of environmental conditions and human factors. Behavioral economics and decision science research has established several decision making errors and biases when humans are confronted with high levels of uncertainty that result in sub-optimal outcomes as compared to economically efficient solutions. Wildfire specific research has demonstrated that wildfire managers are subject to many of these well-established biases and errors (see for example Wilson et al., 2011, Calkin et al. 2013, and Hand et al. forthcoming). Thaler and Sunstein in their book, Nudge, suggest that government programs use choice architecture to alter people's decisions and behaviors in predictable ways to improve outcomes associated with uncertain decisions. Although wildfire decision support systems have made advances in presenting managers with risk information, the potential use of choice architecture in wildfire management scenarios has not yet been explored. In this presentation we will discuss the nature of identified decision biases within wildfire management, their expected impact on efficient wildfire management, and identify the potential for the application of choice architecture to improve wildfire management outcomes.

Keywords: Decision biases, choice architecture, decision support

Bio: Dave Calkin is a Research Forester in Human Dimensions Program at the US Forest Service Rocky Mountain Research Station in Missoula, Montana, USA. Dave is the team lead of the Fire Economics group of National Fire Decision Support Center, a joint agreement between Fire and Aviation Management and Research intended to improve risk based fire management decision making through improved science application and delivery. Dave's research incorporates economics with risk and decision sciences to explore ways to evaluate and improve the efficiency and effectiveness of wildfire management programs.

EVACUATION AND SHELTERING

51. Do I stay or do I go? The role of risk tolerance in evacuation decisions during a wildfire event

Presenter(s): Sarah McCaffrey, Research Forester, USDA Forest Service Northern Research Station

Additional Author(s):
Avishek Konar, PhD Candidate, Ohio State
Robyn, Wilson, PhD, Associate Professor, Ohio State

Most socio-psychological wildfire research focuses on risk mitigation actions taken before a fire event occurs with less attention paid to homeowner actions during a fire. However, increasing incidences of homeowners refusing to evacuate or leaving at the last minute during wildfires and other natural disasters had led to a growing interest in research into evacuation decision making. We randomly selected homeowners from three counties in the states of Washington, Texas and South Carolina, and conducted a mailed survey to assess their evacuation decision making process in the spring of 2013. These three counties were specifically chosen because of their high wildfire risk, but they each varied in terms of past experience with wildfire and mandatory evacuation orders. Drawing on Protection Motivation Theory and the Extended Parallel Process Model, we assessed individual homeowner's threat and coping appraisal related to wildfire, as well as individual risk attitudes. We found that individuals are less likely to stay and defend when the perceived benefits of evacuation are high, and perceived efficacy for staying is low. We also found that those who evacuate pay more attention to official decision cues (e.g., being asked to evacuate by a safety official) as opposed to social or physical cues. In general, those who stay and defend are more risk tolerant and perceive greater control over wildfire. To ensure maximum public safety, crisis communication efforts should focus on the benefits of evacuating early. In addition, efforts should be made to ensure that those who are likely to stay and defend are justified in their personal belief that they can do so safely.

Keywords: risk tolerance, evacuation decision, risk communication, risk perception

Bio: Sarah M. McCaffrey, Ph.D. is a Research Social Scientist for the USDA Forest Service, Northern Research Station. Her research focuses on the social aspects of fire management. This has included National Fire Plan and Joint Fire Science sponsored projects examining the characteristics of effective communication programs and the social acceptability of prescribed fire, thinning, and defensible space. More recently she has begun work on the social issues that occur during fires including alternatives to evacuation and community-agency interactions during fires.

52. Sheltering practices during bushfires: lessons from the 2009 Black Saturday fires

Presenter(s): Joshua Whittaker, PhD, Research Fellow, RMIT University and Bushfire & Natural Hazards CRC

Additional Author(s):
Raphaele Blanchi, PhD, CSIRO Land & Water
Justin Leonard, CSIRO Land & Water
Kimberley Opie, CSIRO Land & Water
Katharine Haynes, PhD, RIsk Frontiers, Macquarie University

On Saturday 7 February 2009, 173 people lost their lives and more than 2000 houses were destroyed in bushfires (or wildfires) in the Australian State of Victoria. Residents had been advised to prepare to stay and defend their homes and properties against bushfire, or to prepare and leave well before a fire arrived in their area. This advice, known as the 'Prepare, stay and defend or leave early' policy, was based on evidence that well-prepared residents can protect houses from bushfires, and that a large number of deaths have occurred during late evacuations. However, on Black Saturday, 118 people died inside houses or other structures. A Royal Commission into the fires found that the binary approach of 'stay and defend or leave early' did not reflect the reality of what people do during bushfires. It recommended the development of a comprehensive bushfire policy that provides for 'more options and different advice'. In particular, it was suggested that community refuges and personal bushfire shelters be considered as a backup in the event that residents were unable to safely leave or defend their property. In response, most fire services have begun to establish local community refuges, and the Australian Building Codes Board (2010) has developed the 'Performance standard for private bushfire shelters'. Public interest in sheltering is growing.

This paper presents key findings from a study of sheltering practices during the 2009 Black Saturday fires. Based on an analysis of interviews with survivors and life and house loss data, it examines the circumstances and challenges experienced by residents when sheltering. Key factors that influence sheltering outcomes include: the knowledge, preparedness and actions of residents; exposure to heat, fire and smoke; and the type and vulnerability of the shelter. The paper concludes by considering the implications of the research for bushfire safety policy and community education.

Keywords: Bushfire; wildfire; community safety; sheltering; preparedness

Bio: Josh is a Research Fellow in the Centre for Risk & Community Safety at RMIT University and is affiliated with the Bushfire & Natural Hazards Cooperative Research Centre. He has undertaken a range of research projects on the human dimensions of wildland fire and was a member of the Bushfire CRC's Black Saturday research taskforce.

53. Establishing wildfire evacuation zones—a coupled human-environment system approach

Presenter(s): Dapeng Li, Department of Geography, University of Utah

Additional Author(s):
Thomas J. Cova, Professor of Geography, the Department of Geography, University of Utah
Philip E. Dennison, Professor of Geography, the Department of Geography, University of Utah

Wildfires are a common hazard in the western U.S. due to fuel accumulation and seasonal drought and cause significant losses of life and property every year. With the rapid population growth in the wildland urban interface (WUI), public safety in fire-prone WUI areas has attracted significant research interests in the past few years. Wildfire evacuation zones are used by incident commanders (ICs) to divide the risk area into several zones so as to facilitate staged evacuation. The ICs need to take into account both fire progression and threatened population before they can delineate evacuation zones using prominent geographic features based on their experience. Wildfire evacuation triggers are prominent geographic features (eg., ridges, roads, and rivers) utilized in wildfire evacuation and suppression practices, and when the fire crosses these features, an evacuation will be recommended for the communities or firefighters in the path of the fire. Recent studies of triggers have used Geographic Information Systems (GIS) and wildfire spread modeling to calculate evacuation trigger buffers around a location (P) with a given time (T) as the input. Trigger modeling has been formulated into a Wildland Urban Interface Evacuation (WUIVAC) model. From the system modeling perspective, wildfire spread is an environment system, while the evacuation of threatened population is a human system. This work examines how to couple wildfire simulation and trigger modeling to establish evacuation zones by using a coupled human-environment system approach. The proposed coupling approach takes into account the coupling of fire simulation and evacuation modeling at the data, model, and knowledge level. The proposed evacuation zone establishment method consists of three steps: 1) trigger modeling is used to calculate trigger buffers for each household; 2) fire spread simulations are performed to trigger the evacuation of all households and derive the recommended evacuation departure times (REDTs); 3) the households are aggregated and grouped into evacuation zones based on their REDTs and their spatial locations, which will enable the ICs to develop a staged evacuation plan. This method uses GIS to model the process in which a spreading fire triggers the evacuation of a set of households based on their trigger buffers. In the end, a case study of Julian, California is used to test the effectiveness of the proposed method, and the results reveal that the proposed method is effective and can be used for household-level staged evacuation planning.

Keywords: wildfire evacuation zones, triggers, wildfire simulation, coupled human-environment system

Bio: Dapeng Li is a PhD student in the Department of Geography at the University of Utah. He earned his Bachelor's degree in Geographic Information Systems (GIS) from China University of Geosciences and his Master's degree in Cartography and GIS from Peking University. His research interests include wildfire evacuation modeling and GIS. His dissertation focuses on modeling wildfire evacuation as a coupled human-environment system.

PEOPLE, CLIMATE AND LANDSCAPES
54. Spatial allocation of landscape values

Presenter(s): José J. Sánchez, PhD, Research Statistician, Forest Service PSW Research Station

Additional Author(s):
Ken Baerenklau, PhD, Associate Professor, University of California, Riverside
Armando González-Cabán, PhD, Research Economist, Forest Service, PSW Research Station

We used a stated-choice experiment method to estimate landscape values of the San Jacinto Wilderness in southern California. The analysis utilizes survey data from backcountry visitors who responded to questions about recreation behavior (i.e., number of trips taken in the past 12 months to each trailhead, distance traveled, etc.). We developed a GIS data layer containing non-market values derived from a Kuhn-Tucker demand model. Each pixel in the data layer contains an estimate of the recreation values at that location. The spatial elements in the regression allow us to estimate how the aggregate trailhead values and welfare effects are derived from the different parcels that comprise a trail's viewshed. Together, these two steps enable estimation of the value of recreation benefits derived from experiencing different parts of the landscape.

Using GIS viewshed tool and the estimated recreation values, maps were developed containing values for a 30x30 meters parcel. On a per hectare basis, aggregate annual values range from .01 cents to $4,224.25/ha throughout the wilderness, with a mean of $123.86/ha. The highest values are located in the highest elevations at San Jacinto and Tahquitz Peaks and the most frequently visited sites: Devil's Slide and Long Valley trailheads. Because our spatial allocation method is based on visibility, these parcels received higher visibility weights and thus contribute more to the value of a trip. Therefore, parcels that are both highly visible and frequently viewed receive the highest values. In contrast, parcels located in relatively remote areas and away from trails in our study have lower and sometimes no recreation value because of their limited visibility and/or low visitation rates (or having no data on the particular trailhead). However, this does not mean that those areas do not have economic values; rather we did not have any information to calculate these other values.

Keywords: GIS; Kuhn-Tucker demand system model;Nonmarket valuation; Recreation

Bio: Dr. José Sánchez recently graduated (June 2014) from University of California, Riverside with a PhD in Environmental Sciences. Dr. Sánchez is currently working with USDA Forest Service Pacific Southwest Research Station as a Research Statistician. His research focuses on nonmarket valuation of ecosystem services and evaluating the economic impact of wildfires on natural resources.
He has a master's degree in Statistics from Washington State University and a bachelor's degree in Economics from the University of California, Irvine.

55. People's Perceptions of Post-Wildfire Landscape Recovery

Presenter(s): Chad Kooistra

Additional Author(s):
Dr. Troy E. Hall, Professor and Department Head, Forest Ecosystems and Society Department, Oregon State University
Dr. Travis Paveglio, Assistant Professor, Conservation Social Sciences Department, University of Idaho

Considering the increasing potential for widespread forest disturbances, it is important to understand the implications of landscape changes, and perceptions of changes, on people's responses to forest disturbances. Understanding how people perceive landscape change over time following forest disturbances helps researchers, land managers, and community leaders identify important biophysical and social characteristics that influence their responses to those disturbances. This presentation describes people's perceptions of landscape recovery following a significant wildfire. The lightning-ignited Dahl fire burned 12 miles southeast of Roundup, MT in June 2012. The fire burned approximately 22,000 acres and destroyed 73 residences. We conducted interviews in the summers of 2013 and 2014 with more than 50 residents, land managers, emergency personnel, and other stakeholders. While interviews covered several topics, this presentation focuses on responses to questions regarding perceptions of post-fire landscape recovery. Interviews revealed that people's understanding of the role of wildfires as a natural ecosystem process (i.e., their mental models), as well as their connections with the landscape, were important factors that influenced their perceptions of post-fire landscape recovery. Many respondents referenced previous wildfires in the area by explaining how parts of the landscape affected by the Dahl fire might compare to certain areas of the previous fires. Participants with a stronger understanding of the ecological role of fire seemed less concerned about the long-term negative impacts of the fire on the ecological and aesthetic aspects of the changed landscape. Also, participants who identified with a more utilitarian connection to the landscape (e.g., ranchers) tended to have more positive outlooks on wildfires, and landscape recovery, than those participants who expressed connections to the landscape based on other reasons, like aesthetics and privacy. We will discuss people's perceptions of landscape recovery, including the roles of people's mental models and their connections to the landscape in influencing those perceptions, in more detail. We will also offer insights about the implications of our findings for incorporating people's attitudes in management decisions, communicating about wildfire issues with the public, and encouraging more resilient and adaptive communities in the Wildland Urban Interface.

Keywords: social science, landscape recovery, resilience, adaptive capacity, perceptions, mental models, attitudes

Bio: Chad earned his B.S. in Natural Resource Recreation and Tourism at Colorado State University in 2005. After working a few years for federal and NGO land management agencies in Colorado and Nevada, he earned his M.S. from the University of Idaho (CSS Department) in December 2011 studying Colorado residents' attitudes towards forest management after a widespread pine beetle outbreak. His PhD research at Oregon State University, supported by a NASA grant, seeks to understand social aspects of extreme wildfires. He intends to pursue a professional career teaching and conducting research about human dimensions of natural disturbances.

56. Lessons from a Legacy of Wilderness Fire: Benefits, Challenges, and Tools for Success

Presenter(s): Vita Wright, USFS Human Performance RD&A and the NPS Branch of Wildland Fire

Additional Author(s):
Carol Miller, Research Ecologist, Aldo Leopold Wilderness Research Institute
Stephen Kimball, Regional Wilderness Specialist, USDA Forest Service Northern Region
Stu Hoyt, Regional Fuels Specialist, USDA Forest Service Northern Region

The decision to allow a wildfire to burn on its own terms, and for long duration, is one of the most challenging yet important decisions a manager can make. It can involve high risks, uncertain outcomes, and the decision is often faced in an unsupportive, even contentious, social and political environment. For the past 40 years, setting aside the 10 A.M. policy, land managers in the Northern Rockies have faced these challenges and taken advantage of the vast wilderness in the region to learn how to use natural ignitions to accomplish ecological benefits. Fires in the United States' Selway – Frank Church – Gospel Wilderness Complex, Bob Marshall Wilderness Complex, and Glacier and Yellowstone National Parks have shown managers and the public alike conditions under which fires can burn successfully. Many of the champions for wilderness and long duration fire have lived and worked in the Northern Rockies, making the region

a hub of knowledge and experience on the topic. To capture this knowledge, we have interviewed more than thirty past and present fire managers, fire scientists, and decisions makers about the evolution of wilderness fire management in the Northern Rockies, the decision making process, and tools available to support the management of fire for resource benefit. Including interview clips, this presentation draws from the wisdom and insights of those who have a reputable history of managing wilderness fires to convey conditions that allow for successful management of long duration fires, challenges associated with fire management decisions in and near wilderness, and the consequences of both suppression and management for multiple objectives. This information will be captured in a series of videos to provide a valuable resource for managers and line officers currently faced with these decisions, as well as members of the public who struggle to understand agency fire management decisions.

Keywords: wilderness fire, fire use

Bio: A fire social science analyst, Vita Wright works in a shared position between the USFS Human Performance RD&A and the NPS Branch of Wildland Fire. Vita has worked at the interface of science and management for the past seventeen years. Currently, she leads the Northern Rockies Fire Science Network. Previously, she developed and led the Aldo Leopold Wilderness Research Institute's Research Application Program. In addition to disseminating science, she studies organizational culture and organizational learning in support of fire communication and decision making, safety, and the integration of science with management.

57. How effective is wildfire communication to New Zealand communities and how can it be improved?

Presenter(s): E. R. (Lisa) Langer, Senior scientist and research leader, Scion

Additional Author(s):
Mary Hart, Social researcher, Validatus Research Ltd.

Worldwide, most wildfires are caused by human activity (Ellis et al., 2004). Likewise in New Zealand, human activity is responsible for the vast majority of wildfires, which arguably can be largely prevented. Between 1992 and 2007, approximately 3,000 wildfires per annum occurred in New Zealand (Doherty, et al., 2008) and they have been predicted to increase with global climate change, an expanding rural-urban interface and changing fuel loads (Jakes & Langer, 2012).

As a result of the relatively low fire occurrence, evidence suggests that the majority of New Zealand communities have low awareness of the rural fire risk. Consequently communities have low levels of preparedness for wildfire events that could impact on them (Jakes & Langer, 2012). Matched against this, the use of rural fire for land management, recreation and cultural purposes (e.g. cooking food by traditional methods) is relatively high.

Effective communication is the key to raising awareness, minimising human-caused rural fires, and hence the impact wildfires hold for communities. However, how effective is current wildfire communication to New Zealand communities and how can this be improved?

Scion's Rural Fire Research Group analysed communication strategies within three New Zealand rural and rural-urban interface communities and with national fire and land managers as part of an Australasian Bushfire Cooperative Research Centre project. The research has shown that fire agencies should carefully consider their methods of communication, which range from one-way communication using traditional approaches and no face-to-face contact to two-way dialogue with one-on-one personal communication with individuals and communities. The research has concluded that the universal approach used in the past is not effective in communicating rural fire messages. Instead communication needs to target the relevant audiences (rural and semi-rural, recreational users/visitors and cultural fire users and non-fire users). The message must be tailored to fit each audience's needs to optimise the use of limited resources. Information to increase levels of awareness of fire risk is needed by everyone and preparedness information is required for all at-risk property owners. However, information on fire restrictions and appropriate mitigation strategies to ensure safe fire use is not required by non-fire users.

Keywords: communication strategies; rural communities; rural fire users; risk awareness; preparedness.

Bio: Lisa Langer has led Scion's social fire research since 2003. Her qualitative research has focused on community resilience and recovery following wildfires, fire danger warning communication, fire insurance, and mitigating the risk of human-caused fires. Recently she completed a contract for the Bushfire CRC leading the New Zealand component of the Effective Communication fire warnings and preparedness project. She has presented her research at international fire conferences in the US and Europe, as well as to Australian and New Zealand audiences.

FIRE ADAPTED COMMUNITIES

58. Developing fire adapted communities: The importance of interactions among elements of place-dependent local context

Presenter(s): Travis Paveglio, Department of Conservation Social Sciences, University of Idaho

Additional Author(s):
Jesse Abrams, research associate, Ecosystem Workforce Program, University of Oregon
Autumn Ellison, research assitant, Ecosystem Workforce Program, University of Oregon

Resident perceptions and actions related to wildfire management are influenced by a complex set of factors that are often tied to a place-specific context. Existing efforts to predict or understand resident response to the risk and reality of wildfire often focus on the contribution of one or a few influences affecting individual or collective actions for fire mitigations. Fewer efforts take a more holistic view and attempt to understand how various factors collectively influence local response to wildfire across cases. This study responds to that lack by utilizing a recently created framework for understanding adaptive capacity to wildfire in a comparison of preparation and response to wildfire impact across two socially diverse locations. More specifically, we chose to conduct case studies in two different "WUI archetype" communities. Recent research indicates that these different "WUI archetype" communities approach wildfire planning and mitigation in consistently different ways based on local social context. A total of 77 interviews were conducted in 2014 across the two cases. A nearly identical semi-structured protocol was used in both cases. The intent of the research was to better illustrate how elements of local social context collectively influence wildfire perspectives and behaviors in a given locality. Our results suggest that the influence of commonly cited predictors for wildfire mitigation actions, including homeowner's associations, place attachment and previous experience with wildfire can vary based on their interaction with other elements of local context such as residents' desire for privacy, preferences for wildland or ornamental vegetation, identification as "suburbanites" or "country residents," and willingness to collectively organize. We compare our results to a recently developed typology of "WUI archetypes" to assess its usefulness in helping to understand local wildfire mitigation context. We also compare our results to existing wildfire social science findings and argue for a more holistic view of local social context as a way to design tailored strategies for increasing resident responsibility for wildfire.

Keywords: adaptive capacity; Wildland Urban Interface; WUI archetypes; responsibility; mitigation

Bio: Paveglio is an assistant professor in the Department of Conservation Social Sciences at the University of Idaho. He has been conducting research on the human dimensions of wildfire for 10 years. Paveglio has published research on adaptive capacity for wildfire, evacuation and alternatives to evacuation during fire events, simulation of wildfire risk, wildfire mitigation planning and interactions between firefighters and the public. He has an interdisciplinary background in sociology, natural resource sciences and communication.

59. Reducing Structural Losses from Wildfire: Are Regulations the Answer?

Presenter(s): Cheryl Renner, President, Renner Associates, LLC

When wildfires occur adjacent to communities resulting in the loss of homes, businesses, and community structures, people ask how we might have used knowledge or technology to mitigate such a disaster. An understanding of the home ignition zone and how structures ignite leads us inevitably to consider ways to motivate homeowners to reduce fuels around their homes and build with ignition-resistant materials. Many call for regulations, such as wildfire zoning ordinances and building codes, to make development in high fire risk areas safer.

This presentation will review examples of existing regulations, some adopted by states and some adopted by municipalities or counties, which have been effective in motivating homeowners to create and maintain defensible space around homes. Examples of places where ordinances have failed will also be discussed. The National Fire Protection Association and the International Code Council offer model ordinances to reduce structural losses that can be modified to address local needs and conditions. Many questions remain, such as: should ordinances be national, state, or local in applicability? How can we convince people to adopt wildfire mitigation ordinances? What does it take to enforce such ordinances? How can the ordinances address future vegetative fire hazards that will grow after a subdivision is built? Should ordinances address only new construction, or apply to existing structures? Do neighborhood covenants, codes, and restrictions work?

Keywords: defensible space, wildfire mitigation, ordinances, wildfire zoning, zoning, reducing structural ignitability

Bio: Cheryl has over 20 years experience in land use and forestry planning. She researched wildfire mitigation ordinances for the database, www.wildfireprograms.usda.gov and co-authored a review of state and local regulation for wildfire mitigation for The Economics of Forest Disturbances, by Holmes, Prestemon, and Abt, 2008. She also co-authored the Reducing Structural Ignitability and Strengthening Community Fire Preparedness section of the "Community Guide to Preparing and Implementing a Community Wildfire Protection Plan" (2008).
Cheryl is a former Planning Director and Zoning Administrator for a city in Louisiana, with experience in dealing with the public on land use regulation ordinances.

60. Wildfire policy after structure loss: how does regulation alter rebuilding and residential growth after wildfires?

Presenter(s): Miranda Mockrin, PhD, Research Scientist, USDA Forest Service

Additional Author(s):
Susan I. Stewart, Research Associate, University of Wisconsin
Hillary Fischler, Graduate Student, Oregon State University

The number of structures destroyed by wildfire in the United States has risen dramatically over the past decade, with approximately 1,300 residences lost annually to wildfire since 2000. In response, fire policy now emphasizes the need to create fire-adapted communities, where the community takes responsibility for its wildfire risk by protecting residents and homes through preparedness and risk mitigation. But is this imperative understood and accepted by communities in the wildland urban interface (WUI)? We do not yet have a solid body of evidence to answer this question, in part because of the delays between wildfire events, regulations, and outcomes on the landscape. Drawing from case studies around the country, we examine communities where wildfires caused significant loss of structures from 2009-2011, in order to determine when and where changes were made in regulations post-fire. We examine changes in zoning and lot sizes, codes that require fire-resistant construction materials and defensible space, and broader planning and open space preservation efforts. We then draw from research on WUI growth and rebuilding to look at where and when post-fire residential growth occurred. By combining information on residential development with our work on post-fire regulation, we will describe how changes in governance can contribute to fire adaptation.

Keywords: Fire-adapted, regulations, rebuilding, wildland urban interface

Bio: Miranda Mockrin is a research scientist with the Human Dimensions Program of the Rocky Mountain Research Station, USDA Forest Service, based in the Washington DC area. Research projects include quantifying mapping and tracking the wildland-urban interface over time, examining rebuilding in the wildland-urban interface after wildfires, studying ecological, economic, and social effects of alternative forms of housing development (conservation developments), and disseminating demographic information to natural resource managers. She received her PhD in Ecology from Columbia University in 2008 and started her Forest Service career in the Presidential Management Fellows Program.

61. Fire Adapted Communities in the Real World: Community Perspectives on What Actions and Processes Are Needed for Diverse Communities to Become More Resilient to Wildfire

Presenter(s): Sarah McCaffrey, PhD, Research Social Scientist, Northern Research Station

Additional Author(s):
Bruce Goldstein, Associate Professor, University of Colorado at Boulder
Alicia Davis, Research Associate, University of Colorado at Boulder

The National Cohesive Wildland Fire Management Strategy seeks to foster creation of fire-adapted communities. While policymakers and managers have developed a fire adapted community definition and a list of actions that are considered part of effective adaptation, there is little sense for how communities are interpreting and applying the notion. Understanding whether those on the ground are thinking of fire adapted communities in a similar way as policymakers and managers will be important in ensuring agencies identify how they can best support efforts of local communities to become "fire adapted" in a way that is both site-appropriate and likely to be implemented. The Fire Adapted Communities Learning Network has been established to accelerate adoption, innovation and diffusion of best practices associated with Fire Adapted Communities programs. The network has identified 18 pilot communities that have already begun to take steps to become fire adapted. This presentation will discuss preliminary results from interviews with key stakeholders in five pilot communities to understand their perspective on the topic, what actions they have taken and plan to take to become fire adapted, and how they think that will make them more resilient in the face of fire. How the overall fire adapted community idea is being interpreted, the range of elements being considered by different stakeholders, how the 'community' portion of 'fire adapted community' is being defined, and the perceived advantages and disadvantages of the concept will be discussed.

Keywords: Fire Adapted Communities, Preparedness, Mitigation, Communication, Collaboration

Bio: Sarah M. McCaffrey, Ph.D. is a Research Social Scientist for the USDA Forest Service, Northern Research Station. Her research focuses on the social aspects of fire management. This has included National Fire Plan and Joint Fire Science sponsored projects examining the characteristics of effective communication programs and the social acceptability of prescribed fire, thinning, and defensible space. More recently she has begun work on the social issues that occur during fires including alternatives to evacuation and community-agency interactions during fires.

HEALTH

62. Preliminary evaluation of factors affecting inhalation exposures among wildland firefighters

Presenter(s): Tim Reinhardt, CIH Associate Scientist, Amec Foster Wheeler PLC

Additional Author(s):
George Broyles, Fire & Fuels Project Leader, US Forest Service

Preliminary Evaluation of Factors Affecting Inhalation Exposures among Wildland Firefighters
In this paper, we present preliminary results of a statistical evaluation of various site, environmental and work activity factors on the shift- and fireline-average smoke exposures among wildland firefighters in the U.S. Inter and intra-crew variability to exposure and exposure metrics for fireline overhead personnel will be presented.

Wildland firefighters work in a dynamic environment and are exposed to a variety of hazards, including inhalation hazards from fire smoke, soil dust and powered equipment exhaust. Potential health effects include short-term conditions such as headaches, fatigue, nausea, and respiratory distress while long-term health effects may include an increased risk of cardiovascular disease.

The USFS under took a four year project to quantify exposure for wildland firefighters across the United States. Data was collected on wildland and prescribed fires in 17 states representing 11 of the 13 NFDRS fuel models. Exposure to carbon monoxide, respirable particulate matter (PM4) and crystalline silica (SiO2) were measured in the breathing zone of firefighters. Direct observation of firefighters was done in order to determine which variables are related to high exposure so that firefighters and fire managers can be better prepared to reduce these exposures. Measurements were also taken at incident base camps. During the four-year study, 7,517 hours of CO measurements on firefighters and 1,554 hours of CO measurements at ICPs and spike camps were taken.

Based on the findings there has been no appreciable reduction in firefighter smoke and dust exposure from levels that previous research had found. Exposure to wildland smoke has direct consequences on the ability of firefighters to remain safe by compromising their ability to think clearly and function at their highest mental and physical level. Exposure to the harmful constituents in wildland smoke must be addressed effectively in order to assure risk management decisions are sound.

Partial funding for this project is comes from JFSP Project Announcement No. FA-FON0013-0001, task statement 2; Health impairment from exposure to fire smoke: Relationships among the National Ambient Air Quality Standards (NAAQS) and industrial health guidelines.

Keywords: Inhalation irritants, carbon monoxide, silica, particulate matter, risk management, firefighter health and safety

Bio: Tim Reinhardt holds a BS in Environmental Science (Washington State University) and MS in Forest Resources (University of Washington) and has over 30 years' experience in air quality, human health risk assessment, and health, safety and environmental compliance. He worked as a wildland firefighter in 1978-79 with the USDA Forest Service, assisted emissions measurement research in the 1980s with the USDA-FS Pacific Northwest Research Station, lead research performing occupational exposure measurements among firefighters in the 1980s and 90s, and has been a Certified Industrial Hygienist since 1992.

63. Adaptation of physical training and task performance to wildland firefighting in Spain. Improving firefighters wellness, capabilities and safety

Presenter(s): Elena Hernandez Paredes

Additional Author(s):
López Satué, Jorge. Wildland firefighters professional trainer Coordinator. Empresa de Transformación Agraria, TRAGSA. Spain.

Understanding the need to adapt the physical training and task performance to the singular characteristics related to the environmental conditions and the type of work in wildland firefighting makes a great difference in firefighters wellness, capability and safety. Since 2007, the Spanish Forest Fire Service has launched and implemented a specific program focused on these relevant aspects. The analysis of several indicators, such as heart rate, level of dehydration, core temperature, carbon monoxide inhalation, heat flux exposition, and environmental temperatures during real wildland fire operations plus the direct observation of the different suppression performances and the amount of injuries suffered by the firefighters have made us develop specific fitness programs for our wildland firefighters. These programs, after almost 8 years of existence, have shown us great results in terms of damage rates reduction, efficiency rates improvement and safety and performance enhancement.

Keywords: Wildland firefighters, physical training, safety, fitness program, environmental conditions, suppression.

Bio: Forestry engineer with a Master of Science (M.Sc.) in Forestry by Technical University of Madrid and a Master in Occupational Safety & Health, specialized in Risk Prevention.
Service Manager at the Forest Fire Service, Ministry of Agriculture, Food and Environment in Spain since 2009. Previous experience in wildland firefighting as helitack crew boss for 4 years.
Manager of the National Helitack Crews (BRIF), over 500 people. Coordinator at national level of wildland firefighting safety issues and training. Technician on duty at the Wildland Fire National Coordination Center.
Participation at international level in several working groups on wildfires (FAO-Silvamediterranea; European Commission; UNISDR).

64. A Review of Wildland Fire Smoke Exposure and Its Health Effects on Wildland Firefighters and the Public

Presenter(s): Olorunfemi Adetona, PhD

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Luke Naeher PhD
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Each year, the general public and wildland firefighters in the United States and globally are exposed to smoke from wildland fires. As part of an effort to characterize health risks of breathing this smoke, a review of the literature was conducted using six major databases, including PubMed and MEDLINE Web of Knowledge, to identify smoke components that present the highest risks, the mechanisms of toxicity, the health effects that have been identified in epidemiology studies, and the current gap in knowledge on the health impacts of wildland fire smoke exposure.

Components for which detectable measurements have been reported include particulate matter (PM), major gases, hydrocarbons, alcohols, aldehydes/ketones, organic acids, esters and exotic compounds such as polychlorinated biphenyls and dioxins. Of these, PM, carbon monoxide and formaldehyde are the components of most concern based on hazard indices calculated from the maximum reported or estimated average exposures from the studies.

Respiratory and cardiovascular events measured in time series studies as incidences of disease-caused mortality, hospital admissions, emergency room visits and symptoms in asthma and chronic obstructive pulmonary disease patients are the health effects that are most commonly associated with community level exposure to wildland fire smoke. These effects were mostly observed in association with ambient air concentrations of fine particulate matter (PM2.5). Wildland firefighters, although healthier than the general public, are exposed to toxic mixtures containing high concentrations of carbon monoxide and formaldehyde in addition to elevated levels of PM. Research into the health effects of this toxic mixture is currently limited.

There is a need for research on acute and longer term effects of wildland fire smoke exposure. The health effects of acute exposures beyond susceptible population and the effects of chronic exposures experienced by the wildland firefighter are largely unknown. Longitudinal studies of wildland firefighters during and/or after the firefighting career could help elucidate some of the unknown health impacts of cumulative exposure to wildland fire smoke and the workplace protection that could be required for the occupation.

Bio: Currently, I am working as a postdoctoral research associate at the University of Georgia. My training is in toxicology, and is focused on human exposure to environmental agents and the assessment of associated health effects. My doctoral degree research was on occupational wood smoke exposure and its acute health effects on lung function and oxidative stress among wildland firefighters.

65. Assessment of the Barriers to Wildland Firefighters' Fitness Training

Presenter(s): Aria,Mangan, M.S. Candidate, Research Assistant, University of Montana

Additional Author(s):
Aria Mangan, Research Assistant, University of Montana
K. Ann Sondag, PhD. Project Director, University of Montana
Joseph Domitrovich, PhD. Exercise Physiologist, University of Montana and MTDC

Introduction: Working on a wildland fire can be physically and mentally taxing. Given the physical demands of the job, fitness is a key component in keeping wildland firefighters (WLFFs) healthy and safe from injury. Unfortunately little is known about physical training (PT) regimens of WLFFs.

Purpose: The purpose of this study was to examine motivators and barriers to PT in WLFFs. Personal, interpersonal, organizational and environmental factors that influence PT were identified. Strategies for overcoming barriers were recommended.

Methods: This study utilized a descriptive research design. Information about PT practices was collected through interviews with key informants (i.e. individuals in leadership positions who work directly with crew members). Interview data was analyzed qualitatively. Additionally, a questionnaire was developed, reviewed by experts, pilot tested and distributed electronically to WLFFs. Questionnaire data was entered in the SPSS statistical program. Barriers and motivators to engaging in PT among distinct categories such as agency type and crew type were examined for differences among the categories.

Results: Fourteen interviews were conducted with key informants from multiple state, federal and volunteer agencies. Two over-arching concepts emerged from interviews as major influences on PT. The first concept, firefighter culture, encompassed several themes. Themes included the powerful influence of leadership and the desire to be seen as a strong, capable and dependable crew member. The second concept, environment, included the influence of factors such as training facilities and equipment and the need for more holistic education about PT and health. Preliminary questionnaire results from nearly 1000 firefighters reveal the most frequently identified barrier to PT to be projects and work related trainings taking precedence over PT. Multiple motivating factors were identified including having a supervisor that participates in PT and wanting to be seen as a strong crew member.

Conclusions: This project was an attempt to gain an understanding of the current physical training practices of wildland firefighters. More importantly, results from this study identify, from the perspective of the firefighters themselves, the major motivators and barriers to engaging in quality, consistent physical training.

Keywords: Physical Training, Barriers, Motivators,Wildland Firefighters

Bio: Aria Mangan has a B.A. in Biology with a minor in Health and Human Performance. Aria is currently a Master of Science Candidate at the University of Montana studying Health and Human Performance with an emphasis in Community Health. Aria has six seasons of wildland fire experience working for the Forest Service in Region 4 and Region 1. Aria is currently working as a Research Assistant at the University of Montana.

66. An Alternative Way to Estimate Wildfire Smoke Health Costs? A Case Study of a Southwestern US "Mega-Fire" using the Benefits Mapping and Analysis Program – Community Edition (BenMAP-CE)

Presenter(s): Benjamin A. Jones, MA, PhD Candidate, University of New Mexico

Additional Author(s):
Jennifer A. Thacher, PhD, Associate Professor, Economics, University of New Mexico
Janie M. Chermak, PhD, Professor and Chair, Economics, University of New Mexico
Robert P. Berrens, PhD, Professor, Economics, University of New Mexico

Exposure to wildfire smoke can increase morbidity in urban areas. Research calls for monetizing human health impacts in wildfire damage assessments. However, if original health outcome data are collected, valuing wildfire-related health impacts is costly and time-consuming. Benefits transfer is a more accessible alternative that is often employed. Yet several methodological issues remain unexplored regarding transfers of air quality concentration-response functions and economic values. These issues are largely ignored in wildfire smoke damage assessments. This research provides a case study illustration of a new tool for estimating wildfire smoke damages, the US EPA benefits mapping and analysis program – community edition (BenMAP-CE), which is used to investigate methodological issues surrounding the analyst's choice between transferring results from "wildfire-specific" or "urban air" (unrelated to wildfire) studies. The case study is of a southwestern US "mega-fire" event. Results indicate that the economic costs of a wildfire smoke event are substantial. Additionally, transfer of wildfire-specific study results produces substantially higher morbidity incidence estimates and costs compared to use of results from urban air studies. These findings demonstrate: (1) that BenMAP-CE can be applied to wildfire events and (2) the importance of transferred study appropriateness when conducting a smoke damage assessment using benefits transfer.

Keywords: wildfire, benefit transfer, health effects, smoke, BenMAP-CE, willingness to pay

Bio: Benjamin is a 4th year PhD candidate in the Department of Economics at the University of New Mexico and a Doctoral Fellow of the Robert Wood Johnson Foundation Center for Health Policy. His research focuses on the environment-health nexus where economics can be used explore the human health and labor dimensions of changes to the natural environment. Ongoing work explores the interactions between environmental policy and health within the context of invasive species such as the emerald ash borer, wildfire smoke exposure in urban areas, and use of artificial light at night.

67. Impact of a Flame Resistant Synthetic Material Base Layer on Heat Stress Factors

Presenter(s): Matthew Dorton, Masters Student, University of Montana

Additional Author(s):
Joseph Domitrovich PhD, Exercise Physiologist, Forest Service
Brent Ruby PhD, Professor, University of Montana
Charles Dumke PhD, Professor, University of Montana

Protective clothing worn by wildland firefighters (WLFF) may increase physiological strain and heat stress factors due to increased insulation and decreased ventilation. The effect of a flame resistant synthetic material base layer on heat stress factors

Bio: Matt Dorton is a graduating masters student at the University of Montana. His research interests include the physiological responses to exercise and the environment.

SPECIAL SESSION TWO: WILDFIRE MANAGEMENT IN COUPLED HUMAN AND NATURAL SYSTEMS: INTEGRATING BIOPHYSICAL AND SOCIOECONOMIC INFORMATION

Current wildfire risk management efforts focus on assessing and managing the biophysical sources of wildfire risk, such as fuel loading reduction, and these efforts have often successfully allowed for the allocation of scarce resources to areas where they are most effective in reducing wildfire risk. However, the need for more integrative approaches to managing wildfire risk is rapidly growing, as wildfires in the western US and elsewhere occur with increasing frequency and size, often exceeding institutional capacities for their control and suppression. It is increasingly recognized that wildfire-related problems are not solely biophysical, but actually exist within a social-ecological context. Landowners' wildfire risk perceptions, economic dependence, governance, and other socio-economic values contribute to defining landscape management objectives and the capacity of landowners and land managers to mitigate wildfire risk potentials. In this context, coupled natural and human systems (CHANS) research, which explicitly recognize links between humans and their environments, can provide insights into the sustainability of fire-prone landscapes. Moreover, an integrated biophysical-socioeconomic approach enhances the ability of stakeholders, decision-makers, and scientists to jointly identify and assess landscape-level scenarios of risk mitigation effort on both public and private lands.
In this session, we will explore the characterization of CHANS for the management of risk in fire-prone forest landscapes, with an emphasis on the integration of biophysical and socioeconomic information to improve the efficacy of investments to reduce wildfire risk.

68. A conceptual framework for coupling the biophysical and social dimensions of wildfire to improve fireshed planning and risk mitigation

Presenter: Jeffrey D. Kline

Additional Author(s):
Alan A. Ager, Operations Research Analyst, USDA Forest Service, Pacific Northwest Research Station
A. Paige Fischer, Assistant Professor, University of Michigan

The need for more sophisticated approaches to managing wildfire risk is becoming more recognized as uncharacteristically large wildfires in the western US and elsewhere overwhelm government capacities for their control and suppression. Natural hazards research suggests that to be effective, the process of evaluating and mitigating hazards must address the influence of both biophysical and social factors of risk. Wildfire risk is influenced both by biophysical factors that determine the likelihood and intensity of wildfire in particular locations, and social factors that determine how landscape managers, local officials, and individual landowners perceive and address risk. We propose a coupled biophysical-social framework to managing wildfire risk that relies on wildfire simulation to identify spatial patterns of wildfire risk and transmission within "firesheds" surrounding communities, and social science to understand wildfire risk perceptions and the degree of collaboration and mitigation behavior landscape managers, local officials, and individual landowners.

A coupled biophysical-social approach to managing wildfire could provide an improved method for defining the spatial extent of wildfire risk to communities compared to current planning processes. It creates an explicit role for social science to improve understanding of community-wide risk perceptions and predict landowners' capacities and willingness to mitigate risk by treating hazardous fuels and conducting Firewise activities. The approach would enable identifying potential comparative advantages in the location of risk mitigation effort, whether on public or private lands, according to the degree to which specific locations contribute to the transmission of wildfire risk and how likely landowners are to mitigate risk. We will demonstrate a potential application of the framework and approach to managing wildfire risk in communities located in fire-prone landscapes, by combining recent advances in wildfire simulation modeling with social science, including social network analysis, examining the likelihood of risk mitigation effort. Such coupled systems approaches potentially can contribute to a more effective implementation of the new Federal Cohesive Strategy, and provides a more robust framework for prioritizing federal fuel management investments.

Keywords: wildfire risk transmission, wildfire risk mitigation, firesheds.

Bio: Jeff Kline is a research forester with the USDA Forest Service's Pacific Northwest Research Station in Corvallis, Oregon. He has worked with forestry and land use issues for 30 years with nonprofit, state, and federal agencies and organizations. He has a MS degree in Resource Administration and Management from the University of New Hampshire, and a PhD in Environmental and Natural Resource Economics from the University of Rhode Island. His current research examines the effects of population growth and land use change on forests and their management, and related changes in how the public uses and values forests.

69. The dynamics of fire-prone coupled human and natural systems (CHANS) and the emergence of wicked problems

Presenter: Patrick Bourgeron, INSTAAR, University of Colorado

Additional Author(s)
Jelena Vukomanovic
Hope Humphries

Environmental issues in coupled human and natural systems (CHANS) often bear the characteristics of wicked problems. These are complex problems where there is no single definition of the issues, no definitive and optimal solution exists, and proposed solutions create unintended secondary problems at different spatio-temporal scales and in different domains. Wicked problems in fire-prone CHANS are the consequences of multi-scale and multi-domain organization, which can display non-linear responses to drivers of change and can cause cascading thresholds. Because wicked problems always occur in a social context, they are often overlooked by natural scientists. In the Colorado Front Range (COFR) CHANS, a fire-prone system, we investigated the specific circumstances under which crossing a single threshold between alternative regimes can lead to a "cascading effect", in which multiple thresholds across scales of space, time, and social organization, and across ecological, social, and economic domains may be breached. We explored the conditions under which such cascading thresholds result in a wicked problem. We then applied the wicked-problem framework to the effects of interactions between climate and human-mediated changes on COFR CHANS and analyzed the trade-offs in ecosystem services occurring across space and time with different degrees of reversibility.

70. Impacts, trade-offs, and cross-scale connections between wildfire and ecosystem services in the Colorado Front Range

Presenter: Jelena Vukomanovic

Additional Author(s):
Patrick S. Bourgeron, Senior Research Associate, Institute of Arctic & Alpine Research, CU-Boulder

The wildland-urban interface (WUI) occupies 9% of the conterminous land surface of the US and contains 39% of all housing units. The increased presence of people in the Colorado Front Range due to residential development (exurbanization) and recreation, along with increasing disturbances such as fires and insect outbreaks, can lead to decreases in key ecosystem services (ES). In fire-prone landscapes, understanding the changes to ES from fire is critical to characterizing the sustainability of social-ecological systems. We review the connections between ES and fire and assess the cumulative impacts and trade-offs that may result from these connections in the context of residential development. We present a conceptual and methodological approach to characterize and evaluate these connections, with the goal of improving the assessment of impacts resulting from changes in ES by identifying knowledge gaps, research priorities, and challenges. Exurban development and recreation result in trade-offs between ES, highlighting the challenge of predicting and managing changes to ecosystem function under changing land-use patterns; improved assessment of impacts and connections can help guide decision-making and planning.

Keywords: ecosystem services; exurbanization; land-use change; social-ecological systems; trade-offs; Colorado

Bio: Jelena Vukomanovic holds a PhD in Arid Lands Resource Sciences from the University of Arizona and is a Research Associate at the Institute of Arctic and Alpine Research, University of Colorado – Boulder. A landscape ecologist whose expertise lies in coupled human-natural systems and the human dimensions of natural resources, she uses mixed methods to model the spatial and temporal dynamics of landscape change in the wildland-urban interface. Jelena studies the drivers and impacts of land-use changes and demographic shifts in exurban areas by examining trade-offs in ecosystem services and characterizing thresholds across scales and domains that lead to alternative regimes.

71. Linking Forest Management and Fire Hazard Conditions in the Eastern Cascades Ecoregion

Presenter: Susan Charnley, PhD, Research Social Scientist, US Forest Service

Additional Author(s):
Thomas A. Spies, Landscape Ecologist, US Forest Service

This paper aims to increase understanding of human adaptation to fire-prone landscapes in Oregon's Eastern Cascades Ecoregion by examining feedbacks between the fire management actions of large forest landowners, and fire hazard conditions on their ownerships. The questions addressed are: 1) how do landscape conditions combined with external social drivers influence the forest and fire management actions of large landowners; 2) how do the forest and fire management actions of large landowners influence fire hazard conditions on their ownerships; 3) how adaptive are the fire management behaviors of different large landowners; and 4) what can we learn from this assessment for improving human adaptation to fire-prone ecosystems? The large landowners of interest are the U.S. Forest Service, private corporate forest owners, and the Oregon Department of Forestry; we compare and contrast forest and fire management practices, and fire hazard conditions, both within and between these ownerships. The geographic area of focus is south-central Oregon.

Our analysis combines both social and environmental data. Environmental data characterizing fire hazard conditions on different land ownerships are derived from fuels models and vegetation structure data. Data characterizing landowner management approaches and their social and ecological drivers are derived from in-person interviews and agency databases. An agent-based model called Envision is used to project future fire hazard conditions on the different ownerships under current management scenarios, helping to assess how adaptive the management actions of different landowners are. By combining social and environmental data to better understand the fire management decisions of landowners, this analysis improves understanding of coupled human and natural systems on large forest ownerships in the Eastern Cascades Ecoregion, and points to policy and practices to improve human adaptation to fire-prone landscapes.

Keywords: human adaptation to fire-prone landscapes; Forest Service; private corporate forestry

Bio: Susan Charnley is a research social scientist with the USDA Forest Service's Pacific Northwest Research Station in Portland, Oregon. As an environmental anthropologist, her research focuses on natural resource use and management among rural producers, and the institutions needed to help support sustainable livelihoods and healthy ecosystems on public, private, and communal lands. She works mainly in the western United States and Africa.

72. Predicting WUI homeowners' fire risk mitigation behavior under different landscape management and climate scenarios

Presenter: Christine Olsen

Additional Author(s):
Keith Olsen, Senior Faculty Research Assistant, Oregon State University
Emily Platt, Planning and Monitoring Specialist, USDA Forest Service Region 6
Jeff Kline, Research Forester, USDA Forest Service Pacific Northwest Research Station
Eric White, Senior Research Assisstant Professor, Oregon State University
Tom Spies, Research Forester, USDA Forest Service Pacific Northwest Research Station

As wildfires have grown in size and number in recent years, the size of the wildland-urban interface (WUI), where wildland vegetation meets urban development, has also increased through amenity migration and a growing suburban population. This has led to greater numbers of human lives, properties, and values at risk of wildfire. Conceivably, WUI homeowners can reduce their level of wildfire risk by using non-flammable construction materials, pruning nearby branches, and reducing tree density, among other wildfire risk mitigation measures. Commonly known as defensible space, it is generally agreed that these actions improve the survivability of homes during wildfires. However, many homeowners still do not act. In this study we use an agent-based modeling framework that was programmed using survey data to predict WUI homeowners' fire risk mitigation behavior under different landscape management climate scenarios over a 50-year period.

We will present a conceptual model describing WUI homeowners' propensity to conduct mitigation activities for reducing wildfire risk, as well as a coupled human and natural systems (CHANS) agent-based modeling framework for examining fire-prone landscapes. Data for the conceptual model came from a 2012 mail survey in central Oregon that asked homeowners about their mitigation activities, in conjunction with wildfire modeling and spatial landscape variables. Analysis from this model, which showed that landscape conditions influence mitigation behavior, was then used to inform homeowner decision-making rules in the CHANS agent-based modeling framework. Other actors in this landscape included federal managers, industrial owners, tribes, and non-industrial private landowners. This framework was run for 50-year projections under different management and climate scenarios, including: current management policy for federal land, no management on federal land, current policy without WUI treatment preference, and a restoration approach, as well as the current and restoration scenarios with increased climate change. Output from the framework predicts homeowners' propensity to mitigate on their properties under the different scenarios. Results from this analysis will improve our understanding of possible homeowner responses to landscape management and climate changes in the future.

Keywords: firewise, defensible space, communities

Bio: Christine Shaw Olsen, PhD, is a Research Social Scientist in the Department of Forest Ecosystems & Society at Oregon State University in Corvallis, Oregon. Dr. Olsen is co-investigator of the Northwest Fire Science Consortium and researches citizen-agency interactions, public opinions about fire and fuel reduction activities, fire mitigation behavior on private land, and communication and education about forestry and fire. Her most recent projects examine public perceptions of smoke, citizen-agency trust, and homeowner perceptions of fire risk and mitigation behavior. Dr. Olsen teaches classes about managing for multiple resource values, sustainable natural resource management, and social science research methods.

73. SPECIAL SESSION THREE:
Rethinking Awareness, between firefighter safety and safety strategy

Presenter: Marc Castellnou, Fire Manager, Catalan Fire Service,
Al Beaver

Additional Author(s):
Marta Miralles, GRAF Fire Analyst, Catalan Fire Service
Josep Pallàs, GRAF Firefighter, Catalan Fire Service

Entrapments during wildfires continue to happen in spite of the increase in safety protocols use, awareness implementation and lessons learnt put into practice inside firefighting organizations worldwide. In fact, a closer look to entrapments history tell us lessons to be learnt keep piling up in our lists for every new accident.

Almost after any accident review a LACES failure is signaled as explanation, specially a failure in awareness. So we find ourselves piling up again lessons to be learnt inside the A of Awareness. The A in the protocol is getting big and big again. All we pretended to simplify is getting complex again and bottleneck on decision making is forming due the quantity of factors to think about, inside the fire and outside it. As a consequence we feel the pressure to be aware of everything since we cannot differentiate what is important and what is not. Under this scenario, uncertainty is gaining ground in our mind when it comes to decide.

In recent accidents, we have been working in crew member's decision making analysis using mind maps methodology. We use those to understand instead of judging the information firefighters manage when deciding under pressure when they realize an entrapment is possible. We are looking to identify exactly what information and noise they had in their situational awareness. This approach adds light to the ongoing discussion about if failure on decision making in entrapment situations can be seen as consequence of protocol awareness at crew level or as organization information management failure. If what happens is because we failed, there are things to learn, protocol implementation to improve, and especially lessons learnt to remember. But if what happen is not a mistake and the decision was right according the information available, then we have to look at the organization itself and its way to manage information. We have to look our organization and try to figure out how to manage external uncertainty in order to avoid collapse. We cannot in any case charge external factors awareness into crews that manage only internal fire factors information. This of course is adding uncertainty into our fire services, making them more defensive, less aware of the fast-changing-realities they are working in.

If we organize our fires making sure that different levels of command take care of different levels of awareness then uncertainty can be reduced into a manageable amount of information. We can bring back more simple analysis this way distributing awareness, and serving as organization our crews needs instead of adding pressure on them.

Critics to this approach are based in the fact that not all uncertainty can be reduced, especially that one coming from unpredictable situations. To reduce it we propose an uncertainty management based on scenario building using the knowledge we have about external influencing factors and internal influencing ones. Corrections have to be made in those uncertain scenarios before sending crews in. In fact what this does is to assume part of the awareness (the one based on external factors) goes into strategic planning and leave only internal factors and tactics for crews in those already certain situations.

Packing uncertainty reduces awareness weight and situation can be managed with more simplicity, speeding up the decision making again.

Keywords: uncertainty awareness safety LACES
Bio: Marc Castellnou is a fireman with over 25 fire seasons and over 60 large fires in Spain, France, Greece, Scotland and USA. He has extended experience in incident strategy, operation commandment and forest fire management. He introduced the concept of fire analysis in Europe, and has developed it extensively. Marc is the Forest Area Chief inside the Catalan Fire Service, where he introduced the Prescribed Burning Program. He promoted a lessons learned culture, and a shift towards fire management and strategical decision-making in forest fires. Marc has been working in fire management projects all over Europe. Marc is founder and Chairman of Pau Costa Foundation, a platform on forest fire management, as well as an instrument to divulgate and investigate in fire ecology..

Al Beaver - During a forty year career in wildland fire management Al worked in most aspects of the business in Canada, Alaska, Sweden and Australia. Al is a nationally qualified Fire Behaviour Analyst and was a member of the instructor cadre for the Canadian Advanced Fire Behaviour and Fire Behaviour Specialist Courses where he instructed on fire behaviour relating to firefighter safety. He presented at the first Fire Wildland Fire Safety Summit in Rossland, British Columbia and in 2000 was the recipient of the Wildland Fire Safety Award.
Al moved his career to Victoria, Australia in 2009 where he worked in Strategic Risk Management Planning, Risk Modelling and Decision Support Systems and Fire Behaviour Based Readiness and Response.

LEADERSHIP
74. Resonant Relational Leadership

Presenter(s): David Christenson

Have many leaders brought out the best in you or not? What did they typically say or do? How did they make you and others feel? We know what good leadership is like when we experience it. We also know what poor or dysfunctional leadership feels like.

The best leaders build or rebuild resonant relationships. These are relationships in which the leader is in tune with or in sync with the people around him or her. Leadership is about the relationship between the leader and the people around him or her.

What can we learn from recent developments in science that can help us understand what resonant relational leadership can do for us?

A growing body of research on the human brain proves that, for better or worse, leaders' moods affect the emotions of the people around them. The reason for that lies in what scientists call the open-loop nature of the brain's limbic system, our emotional center. A closed-loop system is self-regulating, whereas an open-loop system depends on external sources to manage itself. In other words, we rely on connections with other people to determine our moods. A leader's mood has the greatest impact on performance when it is upbeat. But it must also be in tune with those around him. We call this dynamic resonance.

1. Emotional intelligence competencies are the competencies that enable you to be aware of your own emotions and manage them.

2. Social intelligence competencies are the competencies that enable you to be sensitive to others' emotions and manage your relationships with them.

An emotionally and socially intelligent leader can monitor his or her moods through self-awareness, change them for the better through self-management, understand their impact through empathy, and act in ways that boost others' moods through relationship management.

Take 20 minutes to learn a few ways you might improve your ability to lead yourself and others.

Keywords: Relational Leadership, Emotional and Social Intelligence

Bio: David is the CEO of Christenson & Associates, LLC, a consultancy group primarily serving safety-critical, high-risk industries and now doing business with other groups as O4R: Organizing For Resilience. This organization serves others with education, training, coaching and mentoring in professional leadership development, advanced emergency management, and principles-based thinking. David completed the Masters of Science degree program in Human Factors and Systems Safety at Lund University, Sweden in 2012. He is currently exploring PhD opportunities with the Taos Institute.

(2002 – 2014) Assistant Center Manager of the U.S. Wildland Fire Lessons Learned Center, National Advanced Fire & Resources Institute

75. Transfer of Knowledge, Skills, and Abilities from Leadership Development Training

Presenter(s): Michael T. DeGrosky, Chief Executive , Guidance Group, Inc

Leadership development training represents a form of human resource intervention, the fundamental purpose of which is to improve organizational performance. However, leadership development training represents a useful intervention only when participants transfer what they learn into enduring workplace practices. Both researchers and training practitioners use the term training transfer to describe the process by which training participants extend learned knowledge, skills and abilities into the workplace beyond the training environment and sustain those learned knowledge skills and abilities over time. The researcher's qualitative investigation examined lived training transfer experience by interviewing 17 participants in the National Wildfire Coordinating Group's L-380 leadership development training intervention. The author identified eight factors that motivated the study's participants to transfer the knowledge, skills and abilities (KSAs) they had learned in their leadership development training. In this paper, the author explored the importance of two of those factors, (a) self-understanding and self-improvement and (b) resonance. The author also discussed findings that the degree to which the study's participants perceived meaning from their training influenced both the participants' desire to learn the proffered KSAs and their desire to turn those KSAs into routine workplace practice. Both training practitioners and academics interested in the efficacy of leadership development training can use the findings of this study to understand how participants in a leadership development training intervention experienced their own motivation to transfer learned KSAs from leadership development training into professional practice and how those experiences influenced participants' later transfer of what they learned into professional practice. Understanding these motivations will prepare, both training practitioners and academics to improve the aptitude of organizations for providing training participants with the capacity to transfer their training into the workplace as a significant driver of training effectiveness.

Keywords: Leadership, Training Transfer, Leadership Development, Self-understanding, self-improvement, resonance, motivation to transfer, training effectiveness

Bio: Michael DeGrosky is Chief Executive of Guidance Group, Inc. a consulting firm specializing in the human and organizational aspects of the fire and emergency services. He is an experienced wildland and municipal fire professional with an emergency service background spanning 37 years. Mike is an alumnus of the University of Montana, School of Forestry and Fort Hays State University, College of Business and Leadership, where he earned a master's degree in organizational leadership. He earned a PhD in Business Administration with a specialization in Organizational Leadership from Northcentral University.

76. The relationship of mindfulness and self-compassion to desired wildland fire leadership

Presenter(s): Alexis Lewis Waldron, PhD, Post Doctoral Scholar, Oregon State University

Additional Author(s):

Vicki Ebbeck, Assistant Professor, Oregon State University

Advances in training and strategies have been made in wildland fire human factors with the inception of the "L-Courses" or leadership courses developed in 2004 with the publication of the internal agency document Leading in the Wildland Fire Service (National Wildland Coordinating Group [NWCG], 2007). While this document has served as a foundational piece for moving leadership and human development forward in wildland fire, more empirical support from the wildland firefighting environment has been needed. Through previous research that Lewis (2008) conducted using a qualitative approach to investigate how fire personnel describe good, safe, and effective leadership in wildland fire in the U.S., a scale was developed which was used in this research to assess wildland fire leadership qualities, behaviors, and actions that firefighters have described as important. The current research has sought to increase the empirical work of leadership in wildland fire while building on previously established foundations.

A quantitative approach was adopted to explore facets of mindfulness and self-compassion in relation to their ability to predict crewmembers' perceptions of their supervisors' leadership capabilities. The sample was comprised of 43 wildland fire crews consisting of their primary supervisors (N= 43) and crewmembers (N=246) in the Western United States. A partial least squares path modeling approach was employed to test hypotheses of how supervisor' scores on aspects of mindfulness and self-compassion predicted crewmembers' perceptions of their supervisors' leadership. Findings revealed that supervisors who scored higher on certain aspects of mindfulness and self-compassion predicted higher leadership scores rated by their crewmembers. These results suggest that leaders who are more mindful and self-compassionate (in certain aspects) are perceived by their crewmembers as being better leaders in terms of competent decision-making, integrity, and personal genuineness. These results also indicate the potential that developing mindfulness and self-compassion in wildland fire leaders could have on the ultimate performance and safety in the wildland fire environment.

Keywords: Mindfulness, Self-Compassion, Leadership, Wildland firefighters, Supervisors

Bio: Dr. Waldron has been a wildland firefighter for 10 seasons on hand crews, engine crews, helitack crews, and heli-rappel crews, and has served as a human factors specialist for fatality incidents. Based on hers and others near misses/accidents and leadership experiences in fire she has developed a drive to build and enhance fire trainings and tools based on what firefighters have expressed is important. Dr. Waldron has used the tools developed with firefighters not only to develop firefighters personally and professionally, but also various athletes, challenge course facilitators, and other outdoor professionals.

77. Stockholm vs Woodstock: Risks Associated with Leadership

Presenter(s): Bill Arsenault, Operations Lead, Gem County Fire-EMS

Additional Author(s):
Curtis Sandy, MD, Board-certified ER Physician and EMS Medical Director

As wildfire professionals begin to understand the generational gap, firefighters are having a differing sense of opinions related to risk in the wildland fire environment. Understanding those gaps is critical to operational success. Organizational changes, sense-making, and self-preservation are successful keys to managing people and risks on a daily basis for wildland fire professionals. The one primary component to a successful operation is: communication. Highly successful military operations, fortune 500 companies, and emergency services organizations have adapted to the technical, global, and un-stoppable newer generation of professionals.

A secondary supportive component is "change management". By impliamenting that mental change, wildland fire professionals can expect a higher level of personal, crew, and agency intergrity and professionalism.

This discussion will provide insight on how to help the forward progression that we sometime get lost in. It will also provide the participant an understanding of how the human mind wraps it self around leadership nuances.

Keywords: Risk management, self-preservation, leadership, followership, communication, organizational changes, behavior

Bio: Bill Arsenault is a 25 year veteran of emergency services. He has operated in wildland/structural fire, EMS, military, and law enforcement environments. In addition, presented at the 2011 IAWF Safety Summit. He is known throughout the wildland fire community as a medical response SME for all-risk incidents.

78. Leadership, Accountability, Courage and Knowledge

Presenter(s): Victor Stagnaro, National Fallen Firefighters Foundation

This compelling presentation by the National Fallen Firefighter Foundations examines the root causes of LODD's and the role of Leadership, Accountability, Culture and Knowledge as it influences the end result. Many fire departments and agencies across the United States "LACK the Right Stuff" to prevent them from being on a path to a line of duty death, with Leadership, Accountability, Culture and Knowledge being the elements that need to be addressed and managed in those environments. Through education and training, those departments can improve their survivability by understanding the root causes of firefighter fatalities and tackling these four elements with special emphasis on understanding the culture of safety.

Keywords: Leadership, Accountability, Culture, Knowledge

Bio: Victor Stagnaro joined the staff of the National Fallen Firefighters Foundation in early 2010. He serves as the Director of Fire Service Programs, which includes the Everyone Goes Home®, the Local Assistance State Teams and the Taking Care of Our Own programs and courses. Victor's involvement with the NFFF dates back to 1998, when he served as the Incident Commander for the Memorial Weekend, a post he held for several years. He also assisted with the Foundations New York Response Team on 9/11. Prior to be hired by the NFFF, he worked for the Prince George's County Fire/Emergency Medical Services Department. In addition to having served as a firefighter and station officer, he has been a fire instructor, Public Information Officer, Battalion Chief, Executive Officer to the Fire Chief, Fire Marshal, and Operations Shift Chief, Victor served as the Deputy Chief of Emergency Operations prior to his departure from the department in 2010. He authored a chapter in Fire Engineering's Handbook for Firefighter I and II on EMS in the Fire Service.

79. Practicing as a Student of Fire: Local actions to support global issues

Presenter(s): Kelsy Gibos MSc., Wildfire Management Specialist, Edson Wildfire Management Area, Forest & Emergency Response Division, Alberta Environment & Sustainable Resource Development

Additional Author(s):
Roger Strickland, Senior Instructor, Country Fire Authority
Rod Stebbing, Principle Consultant, Emtrain Fire & Community Safety Pty Ltd

Paul Gleason left a legacy of thinking firefighters whose safety was linked to their application of fire science principles at the fireline. His vision fostered experiential learning where knowledge was passed from those bearing battle wounds of near-misses to those just beginning their inherently risky wildland fire career.

Australian wildfire educators Roger Strickland and Rob Stebbing have co-founded a unique community of practice called Students of Fire (SoF) under the auspices of IAWF. Driven by their personal experiences with a near-miss tanker burnover, SoF was developed as a platform for sharing. SoF is about activity and continual improvement; it is about local action to learn about a global issue. It builds connections across the wildfire community and a dialogue between firefighters, researchers, local government authorities, educators, and all those with responsibilities in wildfire.

SoF recognizes the value in informal sharing of personal experiences; it is born from those in-camp-after-dinner reflections between strangers on what was supposed to happen, what really did happen and attempts to explain discrepancies. It arises from a need to fuzz out jurisdictional borders and a desire to challenge the science of fire behaviour prediction. SoF is for thinkers; it is about inquiry and a search for understanding. It is a safe place to ask questions, to step outside of the boundary of the 'norm' and to challenge the use of terms like 'unprecendented', 'unexpected', 'extreme' and 'unforseen'.

This presentation outlines the mission of the Student of Fire project and provides details on how to participate at the workplace level. It is delivered by a practicing SoF who will provide tips to help ignite mindfulness about the relationship between science and safety and encourage calibration based on personal experience.

SoF highlights that the language of fire amongst those who observe it is universal. Comradery is widespread amongst personnel whether it is national or international boundaries that are breached by a spreading fire. Emergency management environments change over time and space, but the mathematics of fire spread and the feeling of heat on skin will remain the same.

Keywords: Students of Fire, Paul Gleason, experience-based learning, global fire community, lessons learned

Bio: Kelsy Gibos is a fire behaviour specialist who has observed and studied fire behaviour in Canada, New Zealand and Australia. Her experiences abroad have ignited an interest in sharing lessons learned especially with regards to the application of science at the fireground. Her focus is in finding a way to translate complex, peer-reviewed scientific information into practical, on-the-ground feet-in-the-ash applications. She currently resides in Edson, Alberta, Canada with her partner Travis and their two Australian cattle dogs.

RESILIENT RESPONSES

80. Building agency and community capacity for successful engagement – lessons learned from agency programs in Victoria, Australia

Presenter(s): Tamara Beckett, Manager Engagement, Fire and Emergency Management, Department of Environment and Primary Industries
Owen Gooding, Team Leader - Vegetation Management, Fire and Emergency Management, CFA

In Victoria, Australia, two agencies have responsibility for management and prevention of bushfires – one on public land and one on private land. The Department of Environment and Primary Industries and the Country Fire Authority have different legislation, different structures, different cultures and different relationships with communities, but they have one common objective: to minimise the impact of bushfires to the Victorian community.

Fire management agencies around the world recognise the need to engage authentically with the communities they serve in order to gain support for agency fuel reduction programs and to motivate communities to undertake wildfire risk mitigation works on land for which they are responsible.
In this paper, we will examine the effect of the Victorian community's support for and understanding of bushfire management and risk mitigation techniques, focusing on the fuel reduction burning program across both private and public land. Victorian agencies have each implemented a number of different approaches informed by various research. These approaches include knowledge transfer and knowledge building processes, traditional information-based engagement or education and application of community development principles to build community capacity for meaningful engagement. We will discuss the traditional and novel approaches undertaken by each agency individually to engage at the peak body and local community level, and contrast this with examples of where the agencies have worked together to deliver mutually beneficial outcomes.

Despite the differences in the agency legislative context, jurisdiction, and the sectors of the community engaged, program evaluations show there are common mechanisms which characterise success.
This paper examines the Victorian agency programs in the light of the evidence from the evaluations and social research. We conclude that there is a compelling need for fire agencies to adopt a knowledge-built approach to achieve a broad and sustained reach of fuel reduction programs.

Keywords: community engagement, risk, impact, bushfire management, knowledge building

Bio: Tamara has been with the Department of Environment and Primary Industries for five years, undertaking a variety of roles with complex stakeholder and community interaction, as well as having an emergency response role. Tamara has spent the last two years leading a team tasked with designing and driving cultural change within DEPI and the Victorian Emergency Management Sector to work more effectively with communities, and build capacity in communities with high fire risk to enable their meaningful input to planning and mitigating major bushfires.

Owen Gooding heads up the Vegetation Management program for the Country Fire Authority (CFA) in Victoria, Australia. The program provides technical expertise, planning and legislative compliance support for CFA volunteer fire brigades that undertake fuel reduction works. Prior to this role Owen worked in the regulatory setting for new developments in high wildfire risk locations. Owen has been involved in CFA's post incident analysis of house losses in major wildfires and was a member of the national task force that researched the Black Saturday losses in 2009. Owen's special interest is the social aspects of fuel reduction treatments.

81. Climate Wise Communities: enhancing traditional wildfire risk management using a community multi-hazard resilience program in Sydney, Australia

Presenter(s): Jennie Cramp, Technical Officer – Bushfire, Ku-ring-gai Council

Additional Author(s):
Dr Jenny Scott, Sustainability Program Leader, Ku-ring-gai Council

A trend of increasing wildfire frequency and severity poses serious risks to people, their built environment, the economy and biodiversity. Recent experience suggests the effectiveness of traditional wildfire hazard management is inadequate especially given more intense and catastrophic fire weather. Policy developments in Australia have yet to acknowledge the limitations of traditional wildfire hazard reduction measures. An appreciation of the social dynamics involved in wildfire preparedness, is essential in understanding why traditional hazard reduction measures are failing to manage the risks.
The Ku-ring-gai area is one of the most wildfire vulnerable communities in NSW, Australia due to local climate, extensive wildland-urban interface and population density. To enhance traditional wildfire risk management, Ku-ring-gai Council adopted a shared responsibility approach and implemented the Climate Wise Communities (CWC) program. Through facilitated interactive activities and scenarios, the CWC program enables residents to assess their vulnerability to wildfire and other extreme weather events at a personal, property and neighbourhood level to plan for improving resilience.
In collaboration with key emergency management agencies, Government, and not-for-profit organisations, a series of workshops were delivered to high risk groups and services in Ku-ring-gai. Over 220 participated including wildland-urban interface neighbourhoods, residents involved in local fireguard, resident action groups, volunteer groups including Bushcare and social support services. A focus has been seniors and early childhood services in which a multi-hazard approach was trialled. Future workshops planned include business continuity planning, landscaping and retrofitting, focus groups for women and non-English speaking residents, writing a survival plan and follow-up action plans with aged-care services.

In terms of wildfire, Council believes the CWC program assists in improving household preparedness and decision-making capacity before and during a wildfire. Participation in this program can influence an individual's decision regarding triggers for timely evacuation, property resilience and their capacity to stay and defend. The program also seeks to strengthen communication networks before, during and after a wildfire event to keep the community better informed, improve responses and aid recovery.
The authors propose that utilising social dynamics in wildfire safety adds some latitude and depth to current wildfire and other extreme weather risk management.

Keywords: wildfire preparedness, shared responsibility, resilience, interactive, networks

Bio: Ms Jennie Cramp has a background in the biological sciences and is a volunteer fire fighter with the New South Wales Rural Fire Service. She has number of years experience in organisational strategic planning. Her current employment as the scientific officer for bush fire at Ku-ring-gai Council focusses on collaborating with fire agencies, land managers and the community to develop and implement strategic bush fire risk management programs including contributions to Council's ongoing work implementing the Climate Wise Communities program. In 2014, Jennie completed post graduate studies in bush fire management at the University of Melbourne to further her career in bush fire behaviour analysis.

82. Wildfire Resilience: The Development and Validation of the Bushfire Psychological Preparedness Scale (BPPS)

Presenter(s): Jessica Boylan, PhD Candidate, University of Western Australia

Additional Author(s):
Carmen Lawrence, Winthrop Professor, University of Western Australia

Wildfires can be stressful events requiring individuals to demonstrate a level of psychological resilience to make fast and accurate safety-based decisions to reduce risk to themselves and others, to their property and surrounding

environment. For this reason, psychological preparedness is an integral part of preparing for a wildfire. Despite this, psychological preparedness continues to be an under-researched area in the wildfire context, partly because of the difficulty in conceptualizing what it means to be psychologically prepared and therefore develop a tool to quantitatively operationalize it.

Without such a tool, there are no clear criteria by which to judge whether and how well individuals are psychologically prepared. As a result, there is little evidence about the predictors and outcomes of psychological preparedness, which could lead to the development of effective interventions to improve overall preparedness and reduce the risks posed by wildfires. Therefore, the primary objective of this research is to fill this gap and develop a reliable and valid measure of wildfire psychological preparedness which can be used in the research setting to develop and evaluate theories that are dedicated to shaping and promoting wildfire safe behaviors.

In this presentation, the results from a series of studies performed to develop and validate the Bushfire Psychological Preparedness Scale (BPPS) will be shown. The conceptual model, which is based on the protective factors of psychological resilience, and developed to guide the generation of measurement items will be discussed. The review of items by subject matter experts will be shown and the results from a pilot study will demonstrate promising and preliminary evidence that the Bushfire Psychological Preparedness Scale is a reliable and valid measure of wildfire psychological preparedness.

Keywords: wildfire, psychological preparedness, resilience, measure development, BPPS

Bio: Jessica completed her Bachelor of Psychology with honours at Curtin University in 2007. She commenced her Master of Psychology (Industrial & Organizational) at the University of Western Australia in 2009, completing the coursework component in 2013. Following two years of full-time work and part-time study, Jessica returned to the university on a full time basis to commence her PhD in 2011. Jessica formed part of the Bushfire CRC PhD student cohort in the School of Psychology at the University of Western Australia. Broadly, Jessica's PhD focuses on conceptualizing and operationalizing bushfire psychological preparedness.

83. Increasing Community Resiliency by Promoting the Use of Prescribed Fire in the Southeastern United States: The Fire in Southern Ecosystems Program

Presenter(s): Adam Kent, Ecologist, Normandeau Associates, Inc.

Additional Author(s):
Christine Denny, Principal Scientist, Normandeau Associates, Inc.
Jim Brenner, Fire Management Administrator, Florida Forest Service

An important obstacle to prescribed burning has been the lack of effective, coordinated, targeted fire education programs. Because financial support often results from public support, it is important to have a constituency that supports prescribed fire. In general, residents of the southeastern United States do not have a good understanding of prescribed fire or of the natural role of fire. Understanding these two concepts is important for the public, especially in Wildland Urban Interface areas where wildfire risk is high.

Many Florida fire managers believe Florida's severe wildfires of the late 1990s resulted from fuel buildup due to public resistance to prescribed fire. At that time in Florida, very few public school teachers and a smaller number (than might be expected) of park and nature center staff were regularly teaching about fire. The Fire in Southern Ecosystems (FISE) curriculum was started in Florida as a Florida-specific program to provide educators with the background, knowledge, and skills they need to teach about fire. FISE is a free workshop and curriculum package for educators of all types. The goal of the FISE program is to engender a citizenry that supports prescribed fires. The program is expanding from Florida to other states in the Southeast and can be used as a model for fire education programs in other regions as well. Evaluation is key to improving the FISE program over time. A needs assessment was conducted and received input from more than 1,200 educators. Participants show statistically significant changes in knowledge and attitudes about fire immediately after, and even years after, attending a workshop. During more than 150 workshops in the past 15 years, this program has reached 95% of the school districts in Florida and more than 3,000 educators, with a potential impact of more than 1 million people. Workshops are coordinated and taught by Normandeau Associates, Inc., for the Florida Forest Service. The FISE curriculum and teaching resources are available to download for free from www.fireinsouthernecosystems.com.

Keywords: Fire, Southeast, Southern, Ecosystem, Education, Program, Community, Resiliency, Teach, Educator
Bio: Adam Kent is an Ecologist with Normandeau Associates with more than 20 years of professional experience as a wildlife biologist. His background includes securing funding for fire teams across the Southeast and instructing on fire ecology. Adam has written management guidelines, management plans, and educational materials that incorporate fire.

84. INSIGHT + ACTION = RESILIENCE Proven Results from Wollombi Australia

Presenter(s): Glenn, O'Rourke, BSc(Hons) MBA, Deputy Captain Wollombi Brigade, New South Wales Rural Fire Service

A strategic and targeted approach to building resilience in the high bushfire (wildfire) risk community of Wollombi has generated remarkable results beyond that of research findings reported by the Australian Bushfire and Natural Hazards Cooperative Research Centre [BNHCRC] between 2009 and 2014.
Nestled in a rugged valley north west of Sydney, the small rural village of Wollombi is bordered on all sides by extensive eucalypt forest. The risk of bushfire is high, with major fires occurring in 1994, 2001, 2002 and 2004.

INSIGHT - community resilience insights arising from research.
A review of findings of BNHCRC research conducted to investigate community responses to bushfire threat over seven studies between 2009-2014 reveals generally low levels of risk perception, planning and preparation to survive bushfire. Findings provide a clear focus for 'engagement action', and recognition of shared responsibility required to improve bushfire survival.

ACTION - responding to what we have learned from the research.
In 2005, the volunteer Wollombi Rural Fire Brigade established the Wollombi Valley Bushfire Safety Program. Driven by constant measurement and community feedback the program has continued to innovate, developing a series of integrated risk based initiatives specifically targeted at closing the survival planning, preparation, decision-making gaps highlighted in the BNHCRC research.

RESILIENCE - building stronger community resilience and a better prepared community.
The Wollombi model of integrated risk based community engagement has not only achieved significant increases in community bushfire risk awareness [from 0% to 73%], preparation skills [from 34% to 94%], decision making [from 7% to 90%] and planning [from 9% to 95%], but has most significantly achieved measured tangible behavioural change in both the 'preparation for' [91% prepared/well prepared/very well prepared] and 'response to' bushfire [79% plan implementation] as evidenced by the findings of locally conducted research. Most significantly, 51% declare they have a written Bushfire Survival Plan compared 5.4% of people surveyed by the BNHCRC.

CONCLUSION
The Wollombi experience presents strong proof that a strategic and targeted approach to community bushfire safety works…. achieving tangible behavioural change and significantly improved community resilience. The Wollombi Rural Fire Brigade program is a leading example of a highly effective localised research based program driven by volunteers.

Keywords: Wildfire; Community Safety; Volunteer Program; Resilience; Survival Planning and Decision Making

Bio: Glenn is Deputy Captain and Community Safety Officer of the volunteer Wollombi Rural Fire Brigade, of the New South Wales Rural Fire Service, Australia. He holds the NSW RFS Commissioner's Commendation for Service. Glenn commenced service as a volunteer over 30 years ago and is passionate about community bushfire safety. Over the past 10 years he has driven the development and implementation of what is regarded as cutting edge, best practice community engagement.
Professionally, Glenn is a strategist with an international construction company, and has a background in business strategy, change management and stakeholder communications. Glenn holds a Bachelor of Science (Honours) and Master of Business Administration.

85. Listening for Resilience: Expert Fire Managers Share Crucial Experience

Presenter(s): Rebekah Fox, PhD, Assistant Professor, Texas State University

Additional Author(s):

Shanna Shultz, Graudate Student, Texas State University

Firefighting fatalities and property damaged by wildfire prompt reviews aimed at preventing similar events from occurring. The principles of high reliability organizing (HRO) have been used to view such unexpected events with the goal of trying to make sense of what happened (Keller, Weick, Sutcliffe, Saveland, Lahey, Thomas, & Nasiatka, 2004). An HRO perspective suggests that organizing occurs in environments where both the stakes and ambiguity are high, and the environment itself is constantly changing. Organizations that are adept at recognizing and dealing with small but potentially disruptive discrepancies in work practice are able to do so by practicing five principles: 1) preoccupation with failure: 2) wariness with simplification; 3) sensitivity to operations; 4) deference to expertise; and 5) commitment to resilience.

However, practitioners who agree to the value of an HRO framework often have difficulty applying it and teaching others how to cultivate it. Part of this difficulty, we argue, is due to the fact that there are few studies that explicitly identify language associated with the HRO concepts.

As a part of a larger knowledge management project, seventy-four interviews were conducted from 2006-2010 with fire managers knowledgeable in wildland fire management operations (Thomas, Leonard, Miller, &Carol. 2012). Each interviewee was asked to select "a significant fire management challenge that they had successfully worked through" in their careers. We will present the findings of a content analysis of these interview data including the topics, strategies, and personal experiences interviewees recall when asked about difficult times in their careers or times when they practiced resilience.

The second part of this presentation will discuss how interviewees communicatively constructed resilience by asking "In what ways does communication play a role in the construction of resilience?" (adapted from Buzzanell, et al., 2009). These data draw attention to the type of language used by individuals when they recall troubling events and how they "bounced back" from those events. The qualitative content analysis along combined with the rhetorical analysis allow us to examine not only what is discussed, but also how the topics are communicated, thus aiding in the praxiological development of HRO theorizing.

Keywords: Resilience, HRO, Deep Smarts Interviews

Bio: Dr. Fox's research falls into three categories 1) organizational rhetoric, with a focus on power in organizations, 2) health communication with a focus on the U.S. nursing shortage, and 3) the rhetoric of social movements. She has been published in communication journals and journals in related fields, such Environmental Communication: A Journal of Nature and Culture, American Journal of Nursing, and Society and Natural Resources (in-press). Dr. Fox has edited IAWF conference proceedings for the Human Dimensions, Safety Summit, and Fire Behavior and Fuels conferences. She is currently working on a Joint Fire Science Project grant studying radio communication.

86. Special Session Four: Comprehensive Wellbeing and Resiliency

Presenter(s):
Bequi, Livingston PTC, IHC, Regional Fire Operations Health and Safety Specialist, US Forest Service
Michelle Reugebrink, Regional Occupational Health and Safety Manager, US Forest Service

Never in all the decades of wildland fire has personal health and wellbeing been so critical to the success of the profession and personal lives of our fire personnel. With so many traumatic events ocurring on a regular basis, compiled with ongoing stress in the workplace and personal lives, many of our fire personnel find it hard to cope and move forward after a traumatic event. Comprehensive Wellbeing and Resiliency takes each participant on on a personal and introspecitve journey, focusing on the whole person to include physical, mental, emotional and spiritual wellbeing through an interactive and hands-on approach to life.

Keywords: Resilience, Wellness, Health, Fitness

Bio: Bequi Livingston was one of the pioneer women in wildland firefighting who started her career in 1979 on the Smokey Bear Ranger District for the US Forest Service. Her career has spanned over 25 years including, hotshot, engine crew, helitack, hand crew, assistant fire management officer, prescribed fire operations specialist and currently serving as the Regional Fire Operations Health and Safety Specialist in the Southwestern Region of the US Forest Service. Bequi

recently attended Duke University becoming a Certified Professional Integrative Health Coach and is also a Certified Personal Fitness Trainer.
Bequi Livingston is currently assigned to Human Performance, RD&A working as a Comprehensive Wellbeing & Resiliency Training Manager. Bequi started her 25+ year career in wildland firefighting in 1979 working in a variety of wildland fire crews including hotshot, helitack, engine, fire prevention and a variety of fire leadership positions including her recent job as Regional Fire Operations Health and Safety Specialist.
Bequi's passion and expertise is in the fields of fitness and wellness and currently certified as a Personal Fitness Trainer, Group Fitness Instructor, Duke University trained Integrative Health Coach and Human Performance Institute, Corporate Athlete Trainer and instrumental in the development of the Interagency FireFit program.

Michelle Reugebrink works for RD&A, Human Performance Health, Wellness, & Resiliency Manager. This is Michelle's 29th year with the USFS. Michelle is a Duke Professional Integrative Health Coach, member of International Coaching Federation & a Professional Executive Coach. Michelle is working on certification Teacher in Mindfulness-Based Stress Reduction. Michelle is a train to trainer Corporate Athlete.
2008 Baskin-Robbins & the National Fallen Firefighter Foundation named Michelle Reugebrink one of America's 31 Firefighting Heroes. This recognizes her for outstanding acts of valor, commitment to the ideals of community service, protection of life as a Forest Safety Officer and wildland firefighter. 2007 Michelle received Chief's award, for "Her Passion and Caring for Employee Safety & Well Being."

87. Special Session Five: Competency in Crisis

This special session is designed to move participants to a higher level of competency in crisis management by the use of case study, facilitated dialogues and interactive exercises. Learners will virtually visit the Southern France Crisis Center and experience a 2014 day of Corsican multiple crises (simultaneous wildfires, evacuations, village fires, main roads blocked and a fire engine rollover accident) through interactive media with some of the French operations leaders. You will see firsthand how they consciously use High Reliability Organizing processes to support competency during this multi-crisis day and learn how to bring the salient parts together to "up your game."

Competency in this context is an amalgamation of critical thinking, time pressure decision making, and of course leadership. You will have the opportunity to learn and practice new skills in a safe environment with expert guidance. A library of case studies, in addition to the Corsican crisis, will be available after the special session to demonstrate key learning concepts with Saddleback and Yarnell Hill fatality fires as well as other international incidents.

Keywords: HRO Implementation, Action Learning

Bio: Since 2012 C. FRERSON works as Civil Protection Advisor in the Ministry of Interior, General Directorate of Civil Protection and Crisis Management, at the Southern Inter-ministry Headquarters. He is responsible for planning and is head of the Zonal Emergency Operation Center. In this position, he covers all kind of risks in 16 counties with 22,000 firefighters and a population of about 9 million citizens. C. FRERSON has presented at several international conferences and has published some papers about crisis management.

Christophe FRERSON holds a Master's degree in "RISK and Crisis Management."
Since 1998, he has worked as an officer in several Fire Departments in various positions, such as, Battalion Chief, Head of Fire Station, Incident Commander, Air Attack Supervisor, designer and head of Research & Technology for operations. During his posting as head of R&T service, he was maintaining international and university partnerships to focus on, share or disseminate lessons learned.

SPECIAL SESSION SIX: KEEPING FIRE ON THE MOUNTAIN

Moderators:

Henry Bastian, US Department of the Interior, Office of Wildland Fire, Fire Ecologist,
Laurie Kurth, US Forest Service, Fire and Aviation Management – Fuels and Fire Ecology, Applied Fire Ecologist
Frankie Romero, US Forest Service, Fire and Aviation Management – Fuels and Fire Ecology, Fire Use and Fuels Management Specialist

Federal wildland fire policy identifies human safety as the first priority for fire managers. But beyond this, the priority-setting becomes more obscure. There are protection objectives and resource objectives, and given the scenario, these do not always align. For decades, we presumed that fire only had the capacity to destroy and should be eliminated, thus swift and decisive suppression of all fires was viewed as the solution. Experience has proven that simplistic ideal wrong.

Today we know that in many of our fire adapted ecosystems, fire is an important and even vital process that is needed to maintain the structure and function of these landscapes. It is also increasingly recognized that the practice of continued suppression of all fires in fire adapted ecosystems is a short sighted solution with long-term consequences including predisposing these areas to higher intensity fire in the future thus, transferring the risk of harm to future generations. The tension between the benefits and the impacts from fire creates a challenging decision environment for land managers. This special session will explore some of the realities of managing fire on landscapes where not everything needs protection from fire and where decision makers at all levels are faced with the complexities of balancing short and long-term risks to people, communities, and natural resources. The goal will be to highlight real-world situations and explore the complexity of this resource management challenge.

We'll set the stage with a brief look at the history of beneficial wildfire on the landscape; amounts, trends, ecological effects, and the evolution of policies and practices. We will then take a look at research related to the influences of external and internal pressures on wildland fire management decision making followed by a series of practitioners presenting case studies where these dilemmas were encountered at the local, geographic area, and national levels. The session will conclude with a moderated Question and Answer session allowing audience members an opportunity to ask their own questions of the invited presenters.

88. How We Decide: Research on fire management decision making and risk
Presenter: Sarah McCaffrey

89. Defining the Risks and Opportunities: An Agency Administrator's Perspective
Presenter: Chuck Mark, Salmon-Challis NF, Forest Supervisor

90. Making the Tough, but Right Decision: Review of the 2014 Fire Season on the Kaibab National Forest
Presenter: Art Gonzales, Kaibab NF

91. Decision Making for Multiple Fires, with Multiple Objectives, Across Multiple Units: A Geographic Area Fire Managers Perspective
Presenter: Patti Koppenol

92. Using wildland fire to protect, maintain, and enhance resources: A National Perspective
Presenter: Dick Bahr

ASSESSING AND MITIGATING FIREFIGHTER RISK
93. Efficient calculations of optimum paths and travel time for firefighters

Presenter(s): Joaquin Ramirez

Additional Author(s):
Santiago Monedero, Main Researcher, Technosylva
Alicia Ruiz Acero, Wildfire Analyst at UNAP, GEACAM

There is a urgent need to better know the crews mobility on the ground. Main studies by Butler et al (2000) Dakin (2002) and Baxter et al (2004) point out the need for a wider analysis of data to start creating a wide use model.

A tentative list of variables that influence include crew (type, number of personnel and condition, differences during fire season, accumulated hours), terrain (vegetation, transitability, slope: grade and length, aspect) and weather conditions among others.

This work presents an implementation of existing travel rates values by Butler integrating the concept of evacuation time area, as presented by Frier et al (2013). The system allows the data assimilation of real time travel rates, and is going to be implemented during 2015 fire season by Castilla La Mancha Wildfire Agency (GEACAM). The extremely fast calculations allow the use in the field through portable devices, providing a better understanding of the crews' performance and an initial framework to capture GPS based tracks to support next generation of travelling modelling.

Keywords: travel rates, safety zone, crews mobility, GPS tracking

Bio: PhD on Forestry and Geomatics from the University of Leon.Co-Director of the first European MsC program on Wildfires (www.masterfuegoforestal.es) where he teaches "Geotechnologies on Wildfires". His applied research is focused on wildfire modelling and geo-tools.
He is the principal of Technosylva, (San Diego), where he develops tools for operational support, as Wildfire Analyst, first wildfire simulator oriented to support real time operations, and fiResponse, a complete wildfire management system used in European agencies since 1997 (www.wildfireanalyst.com www.firesponse.com).
He has also leaded Risk Assessments of different Spanish regions and in the US, as the Wildfire Risk Assessment for MC Camp Pendleton.

94. A comprehensive survey of the long-term health of current federal wildland firefighters

Presenter(s): Erin Semmens, PhD, Postdoctoral Fellow, University of Montana

Additional Author(s):
Joseph Domitrovich, PhD, Physiologist, USFS Missoula Technology and Development Center
Kathrene Conway, Computer Systems Analyst, University of Montana
Curtis W. Noonan, PhD, Associate Professor, University of Montana

Background: Over 15,000 men and women participate in wildland fire suppression activities every year, working long shifts over many days under extreme conditions. Wildland firefighters (WLFFs) are exposed to air pollutants, noise, heat, intense exertion, stress, and disrupted sleep, all of which have established long-term health effects. Although the body of literature describing the health consequences of structural firefighting is growing, the impact of sustained, repeated occupational wildland firefighting exposures over multiple years on the long-term health of WLFFs is unknown. Methods: Over 500 current WLFFs completed a mail survey of wildland firefighting occupational experience, chronic health conditions, behaviors, and demographic characteristics between March and November, 2014. Our primary objective was to evaluate cross-sectionally the relationship between wildland firefighting experience and the prevalence of several specific, self-reported health outcomes. Results: Seventeen percent of respondents were female, eight percent were Hispanic, and the vast majority (91%) was Caucasian. Respondents were, on average, 41 (standard deviation, sd:14) years of age and had seventeen years (sd: 12) experience in wildland fire. In logistic regression analyses adjusted for age, gender, and race, we observed that each additional year of occupational experience in wildland fire was associated with 4.7% (95% CI: 1.5%, 8.0%), 16.8% (95% CI: 1.9%, 33.8%), and 3.2% (95% CI: 0.1%, 6.3%) greater odds of prevalent hypertension, heart arrhythmia, and hearing loss, respectively. No increased risk of myocardial infarction or asthma in relation to wildland firefighting experience was observed in survey respondents. Conclusions: Although it is not known if these findings can be generalized to all WLFFs, in this sample of WLFFs who responded to a survey of their long-term health, we observed significant relationships between a longer duration of wildland firefighting experience and self-report of two established risk factors for cardiovascular events. In addition, a higher prevalence of self-reported hearing loss was linked to a greater number of years in wildland fire. The influence of behavioral factors on these associations as well as more studies examining objective measures of cardiovascular health in a larger population of WLFFs are warranted.

Keywords: long-term health, epidemiology, wildland firefighter survey

Bio: Erin Semmens is a Postdoctoral Research Fellow in epidemiology in the University of Montana's Center for Environmental Health Sciences in Missoula, Montana. She graduated from Duke University with a degree in Biology and Political Science, and earned both an MPH in Environmental and Occupational Health Sciences and a PhD in Epidemiology from the University of Washington's School of Public Health. Investigating the long-term health impacts of wildland firefighting and evaluating interventions designed to improve respiratory health in older adults and in children living in homes with wood stoves has been the focus of her research.

95. Quantifying Aviation Accident Risk in Wildland Fire Suppression

Presenter(s): Crystal S. Stonesifer, Biological Scientist, USFS Rocky Mtn. Research Station

Additional Author(s):
David E. Calkin, Research Forester, USFS Rocky Mtn. Research Station

Matthew P. Thompson, Research Forester, USFS Rocky Mtn. Research Station

Wildland fire suppression is a high-risk enterprise. This is particularly true for those individuals engaged in aviation operations since aviation-related accidents comprise a large share of historical firefighter fatalities in the United States. Decision support and risk management tools can help fire managers weigh the complicated tradeoffs involved when additional personnel risk is accepted in order to meet wildfire management objectives. However, there is currently limited understanding of the operational factors that lead to aviation accidents in particular, and it is unclear how local fire managers can mitigate the risk of an aviation accident once resources are in the air. To work toward addressing this need for informed risk-based decision support, specifically with respect to aviation use in fire suppression, we developed the Aviation Exposure Index (AEI). The AEI is an incident-level metric that can inform fire managers of the aviation accident expectation based on historical accident rates (10-year average) and observed aviation resource use. We focus on large wildfires in the United States in 2012 to demonstrate the development and applicability of this index. Results of this test year are presented by individual incident, aircraft type (tanker, fixed wing, or helicopter), and incident jurisdiction. While we feel that this index likely has the most value in terms of a real-time decision support capacity, there is also value in post hoc analyses of wider scale spatial or temporal trends to identify particular conditions where high levels of aviation exposure may occur. Here, we present results of these regional and seasonal analyses and discuss the potential implications.

Keywords: aviation exposure, decision support, risk management

Bio: Crystal Stonesifer is a research analyst in the Human Dimensions program with the US Forest Service Rocky Mountain Research Station in Missoula. Her background is in hydrologic modeling and fire science. She's been with the station for nearly 4 years. Her research mainly involves investigating and analyzing resource use in fire suppression, with an emphasis on aviation.

96. Bald Sisters Fire

Presenter(s): Brian Bishop

Answer the right question. The Bald Sisters fire started on 8/1/2014. There were three confirmed smokes in the upper 1/3 of the same drainage, within a steep Inventoried Roadless area (USFS). Access was extremely difficult with lookout points and safety zones in short supply, if not non-existent.

One smoke began to grow and exceed Initial Attack capabilities, more due to terrain, multiple fires in one drainage, and access.

It was quickly recognized that, other than Air Resources, indirect action was the best choice.
The management of the fire progressed from IA, type III IMT, and to a Type II IMT (by 8/7) with a National Incident Management Organization (NIMO) assigned.

As an analysis was completed, during the first 12 days, it was determined that a low probability of the fire challenging or exceeding planned indirect lines existed. Great consideration was weighed between risk and exposure to Firefighter's verses physical resource values. The strategy to monitor the fire, within constructed indirect lines, was decided upon.

The fire was returned to Type III status on 8/24 and Type IV on 9/23 with the fire being deemed out on 11/24/2014.

Throughout the duration evaluating risk and exposure to firefighters remained the priority. Some direct actions were taken, however, the well being of firefighters remained priority. The main consideration, to not engage in direct attack, was steep timbered terrain that made establishment of escape routes and safety zones challenging and challenged the ability to extricate injured personnel.

Complexity revolved around a highly visible fire to local communities, steep difficult access, Wildland Urban Interface within 10 miles of the western perimeter, and educating firefighters with clear leader's intent. The constant of public perception or understanding the chosen course of action created a challenge for fire managers to stay connected to the public through the duration.

The question we tend to try to answer, in wildland fire suppression, is "Can or how can we fight the fire safely". Well the answer is yes we have and we can, that is proven every season, if we define the definition of safety on personal injury

rates.   The real question to ask is "What is the risk and exposure to firefighters verses the resources we are trying to save". That was ask and challenged with the Bald Sisters fire.
Keywords: Manageing Firefighter Risk

Bio: Brian Bishop, District Fire Management Officer (USFS) is currently employed in Region 6 on the Malheur NF, Prairie City Ranger District as the DFMO since 2010. My career began in 1981 on the Mt. Baker Snoqualmie NF and has spanned five NF's and two Regions (4 and 6), although fire suppression assignments have taken me across the US. The bulk of my career has been spent in Fire and Fuels Management, with the exception of four and a half years in Timber Management, doing Timber Sale Preparations. This has included duties in Fuels Operations, Fuels Planning, Fire Suppression, Prevention, and Detection. I have also served on Type 2 Incident Management Teams.

97. De Soto Aviation Incident

Presenter: Danny Bryant, Acting Staff Officer; Fire, Safety, Lands and Minerals, Forest Service, National Forests in Mississippi

In this discussion, the speaker will provide a brief overview of the Aviation Incident of March 30, 2015 that occurred during the Florida Road prescribed burn on the De Soto Ranger District. The discussion will begin with some background information on the organization structure and Prescribed Burning programs in R8 and on the National Forests in Mississippi. We will then describe the Rx program on the De Soto including the issues and complexities. The discussion will then describe the planning and implementation of the Florida Rd prescribed burn, the accident itself and the response that followed. We will then focus on the main points for this discussion, the lessons learned. Points will include; the successes that occurred before and during the incident, the response phase, lessons that we've identified so far and how we can share this information. Main topics:

A. During a Forest Leadership Team meeting last year, we conducted a sand table exercise where the scenario involved a helicopter going down during a prescribed fire on the Forest. The scenario and following AAR lasted only about 2 hours but it allowed the participants to be better able to adequately manage the situation when it actually occurred.
B. The burn boss briefing before each prescribed burn, that involved aerial ignition, included detailed instructions to respond to an aviation mishap. This provided leaders intent and ensured that responders were able to act quickly.
C. Having experienced, capable Dispatchers with local knowledge in place.
D. De Soto being registered as "First Responders" sped up the request for Life-flight.

This presentation will then close with the next steps for the National Forests in Mississippi.

Bio: Danny graduated from Mississippi State University in 1984 with a BS degree in Forestry. He went to work for the Mississippi Forestry Commission in 1985 and worked as County Forester in several different counties over the next 13 years. In 1998, he moved into the Forest Protection Division in the State Office and became Fire Training Officer in 2000. Bryant was assigned as the Director of the Southern Regional Fire Training Center upon it's opening in March of 2005. In 2006, Bryant joined the USDA Forest Service as Assistant Fire Management Officer for the National Forests in Mississippi where he was in charge of the fuels, training and qualifications programs. In 2008, he accepted the Regional Fire Prevention and Coop Fire Program Manager position located in the Regional Office in Atlanta, GA. In 2009, Bryant returned to the National Forests in Mississippi. Danny became involved in western fire details in 1989 and worked up through crew and operations single resource positions. He has worked as Division/Group Supervisor on the Southern Area Incident Management Team (Red Team) since 1999. Bryant became certified as a Type 1 Operations Section Chief in 2006 and now serves as primary OSC1 on the Blue Team. He is also qualified as an Incident Training Specialist, ICT3, RXB2, Type II IC (T) and Type II Safety Officer (T).
Danny currently lives in Madison, MS with his wife and two boys ages 18 and 20.

98. Human Dimensions in Wildland Fire Management - Perspectives on the Past, Thoughts on the Future

Presenter: Tom Harbour, Director of the Fire and Aviation Management Program, US Forest Service.

Bio: Tom Harbour's first experience with wildfire was firefighting in central California in 1970. Since then, Tom has been involved in wildland Fire and Aviation Management his entire career. Beginning as a firefighter, Tom has had opportunities to fight, prescribe, and manage fires across the United States and internationally. His emergency management experiences have included fires, hurricanes, earthquakes, riots, floods, and other types of disasters all across America. His prescribed fire experience includes opportunities across the United States. He has been a Burn Boss, an Incident Commander, and Area Commander at the highest levels of complexity. He has a Bachelor of

Science degree in civil engineering from the University of California Davis and a Bachelor of Science degree in forest management from Washington State University. He graduated summa cum laude from the University of California at Davis and with Presidential Honors for a 4.0 GPA from Washington State University. He has done post-graduate work at the JFK School of Government, Harvard University and the Kenan-Flagler School of Business at the University of North Carolina. He served with faculty and leaders at the Marine Corps University, Quantico, Virginia. The US Forest Service Fire and Aviation Management program employs over 10,000 firefighters and has a budget over $2 billion (US). He has been happily married for over 35 years, and is a proud Father and Grandfather.

RISK

99. Marrying Strategic and Tactical Risk

Presenter(s): Ivan Pupulidy

Additional Author(s):
Matt Carroll
Curtis Heaton

The espoused goal of Strategic risk management is to be objective in the quantification of risk based largely on probability and severity (or consequence). It utilizes statistical tools and processes, base rates, and values, which can be assigned to hazards and calculated to allow for the prioritization of risks. Strategic risk assessment ultimately delivers in a prioritization that results in a decision regarding continuation, change or abandonment of a plan – in other words in a go/no-go decision. The basis of this decision is based on estimated exposure(s) compared against value(s) at risk. The calculation of strategic risk can become subjective if large data sets are not available. In this case the valuation of risk must rely on the intuitive, or best, guess of those empowered to create the assessment. Risk assessment is an anticipation of the future and as such will always have some inaccuracy – or it would not be risk.

The subjective nature of risk is further increased when the mission is assigned to tactical operators, because of the complexity of tactical operations. The subjectivity is more prevalent at the tactical level – there is a greater reliance on individual experience and experiential bias. Experiential bias is a natural tendency of people to normalize risk, which results in lower than actual value being placed on probability and/or consequence. Tactical risk management, therefore requires a process less tied to probability and consequence.

Understanding the difference between strategic and tactical risk management allows for a dissection of the one-size-fits-all risk management process to address the vulnerabilities associated with each level. At the strategic level we must acknowledge the fragility of our predictions and capitalize on opportunities to build adaptive capacity and margin for tactical operators. At the tactical level we must acknowledge the impact of the myriad conditions influencing risk management decisions, like human performance, biases, group and organizational pressures, etc. in order to build and maintain margin as conditions change.

Keywords: Risk, change, margin

Bio: Ivan Pupulidy is the Director of the USFS Office of Learning. In 1995, Ivan became a USFS Lead Plane Pilot and later a Regional Aviation Safety Manager. Ivan completed several internationally recognized programs in safety program management and accident investigation and is currently completing a PhD program at Tilburg University in the Netherlands. Ivan also flew HU-25 Falcon Fan-Jets at Coast Guard Air Station Corpus Christi, Texas and subsequently HC-130 Hercules aircraft, at Air Station Sacramento. Following the US Coast Guard, Ivan flew for the US Air Force Reserves in Iraq and Afghanistan and humanitarian support missions throughout central Africa.

100. The Incident Risk Console (RisC) – A Risk Assessment Synopsis for Wildland Fires

Presenter(s): Lisa Elenz, Deputy Program Manager, Wildland Fire Management Research Development & Application program, Rocky Mountain Research Station, US Forest Service

Additional Author(s):
Thomas Zimmerman, Senior Wildland Fire Consultant, Tom Zimmerman Consulting
Sean Triplett, Geospatial Manager, US Forest Service Fire and Aviation Management
Morgan Pence, Fire Application Specialist, US Forest Service Wildland Fire Management RD&A

Mitch Burgard, Fire Technology Transfer Specialist, US Forest Service Wildland Fire Management RD&A
Jill Kuenzi, Geospatial Coordinator, US Forest Service Fire and Aviation Management
Wildland fire complexity is increasing dramatically and presenting difficult problems and concerns for wildland fire management agencies. To improve decision-making and management capability, managers need more and better information about changing fire dynamics. Numerous information management systems exist and others are under development to provide improved wildland fire information, but systems providing risk assessment information are currently lacking. As a result, the US Forest Service National Director of Fire and Aviation asked if a new system to access and display such information from a variety of sources could be designed. The Incident Risk Console (RisC), a data analytics dashboard and business intelligence tool for wildland fire decision makers, was developed to provide national fire program managers with relevant fire information for emerging and complex ongoing wildfires. RisC information goes beyond available fire statistics and includes specific calculated information and indices that afford a visual risk assessment synopsis for wildland fires, an early alert/risk assessment for potential problem areas, and an overview summary of national and regional incidents. RisC includes eight specific risk attributes that summarize a range of conditions and activities on a fire-by-fire basis. These are: values Inventory, jurisdictions, significant fire potential, relative risk, suppression capability, aviation exposure, modeled values at risk, and modeled suppression effectiveness. The initial Incident Risk Console represents the transformation of an idea into an actual system. The 2014 fire season allowed for a test and an evaluation of its applicability. It was found to have specific value in providing new information useful in: clarifying the overall fire situation, understanding individual fire dynamics, and improving understanding of the effects of management decisions.

Keywords: risk assessment, information technology, decision-making

Bio: The WFM RD&A provides the latest research to the field through the development of tools, training, and by providing decision and analysis support. Until fall 2009 she was the FMO at Grand Teton National Park, previously working as the AFMO. She worked seasonally on crews and engines at Grand Canyon and Yosemite National Parks until she was hired permanently 1994 working in suppression, prescribed fire, fuels management, structural fire and emergency operations. She graduated from college in with a General Chemistry Degree, minoring in Mathematics and Nutrition from Northern Arizona University.

101. Developing a strategic wildfire risk assessment tool for the UK rural-urban interface

Presenter(s): Julia McMorrow, Senior Lectuer in Remote Sensing and NERC Knowledge Exchange Fellow, University of Manchester, UK

Additional Author(s):
Aleksandra Kazmierczak, Lecturer in Human Geography and Planning, Cardiff University, UK
Jonathan Aylen, Senior Lecturer, Manchester Business School, University of Manchester, UK
Rob Gazzard, Adviser, Technical Guidance, Forestry Commission England
James Morison, Programme Group Manager, Forest Research, UK
Andy Moffat, Honorary Research Fellow, Forest Research, UK

Wildfire is now on the UK National Risk Register, creating a need for improved policy and operational approaches to manage wildfire threat to vulnerable communities in the urban-rural interface. Government departments require a strategic tool to quantify the risk, hazard and impacts. Operational managers need to be able to identify areas of high wildfire threat which are adjacent to vulnerable communities as priorities for fuel management and evacuation by the emergency services.
Wildfire Threat Analysis (WTA) is a GIS-based tool which sees threat as a combination of three modules: Risk of Ignition (RoI) of vegetation fires; Hazard of fire spread; and Values at Risk (VaR), or assets potentially affected. It has been applied at a national and regional scale in New Zealand. We present results from a 6-month scoping study carried out by the University of Manchester and Forestry Commission England to investigate the feasibility of applying the WTA approach at a local scale in the UK.

The study area was a 11x12 km forest-urban interface area in South East England, where a significant wildfire occurred in April-May 2011. VaR and RoI modules were successfully co-produced with local stakeholders, including foresters, fire fighters, emergency planners, property owners, infrastructure managers and environmental experts. We used a Delphi method and Analytic Hierarchic Process, combined with spatial analysis of recorded vegetation fires in relation to causal factors. The RoI module was based on: proximity to built-up areas, roads and footpaths; land accessibility status; and land cover as a proxy for fuel type. The VaR map was developed by combining values for three themes: human

vulnerability; property and infrastructure; and ecosystem services. Human vulnerability and ecosystem services were novel elements not included in New Zealand's WTA.
A hazard module could not be developed due to lack of suitable fire climate data, but the Prometheus fire spread model was used to simulate fire perimeters and estimate actual and avoided losses. We highlight where further research is needed for WTA to become a strategic planning and operational tool for the UK. We recommend a nested WTA approach: national scale to identify hotspots for subsequent landscape-scale analysis.

Keywords: rural-urban-interface, GIS, wildfire threat, Swinley Forest fire, UK

Bio: Julia is a physical geographer and Senior Lecturer in Remote Sensing at the University of Manchester (UK). She holds a nationally-funded Knowledge Exchange Fellowship, leading the Knowledge for Wildfire project. Previously, she led the FIRES seminar series – fire interdisciplinary research on ecosystem services. As a member of the England and Wales Wildfire Forum and other national fire-related groups, she works closely with the Fire Services, land managers and other stakeholder communities to help provide evidence-based recommendations on wildfire policy. Her action research includes using satellite and Fire Service data to analyse spatial and temporal patterns of UK vegetation fire risk.

102. Reducing the Risk of High Intensity Prescribed Fire

Presenter(s): Rick Arthur

The use of prescribed fire is one of the most valuable tools in the wildfire managers toolbox. It can be used as part of an overall strategy for fuel reduction, landscape or ecosystem renewal, creating fuel breaks for future suppression strategies, etc.

As valuable as prescribed fire is, it is a risk if something goes wrong, the results can be catastrophic. Failure is not an option. The loss of a prescribed fire even with minimal impacts can result in a loss of public confidence, the suspension of prescribed fire programs, etc.

Learning from escaped prescribed fires clearly has a role to play for any high reliability organization. Learning from previous programs and applying those lessons to future projects has aided in reducing the risks of prescribed fire. At the same time it is critical to look into the successful prescribed fires, understanding what has made them successful, and applying those concepts to the next prescribed fire is important as well.

We cannot stop there. Fire management agencies need to develop new approaches, new technology, and new systems to meet the challenges that the future brings to us. Prescribed fire offers the opportunity to develop a greater understanding of fire behaviour and fuels response at an applied level. It provides us with the time to develop and test new techniques and tools that can be refined and applied to wildfire operations as well.

This presentation briefly covers some new approaches to reduce the risk of prescribed fire developed as part of the prescribed fire program in Southern Alberta. One example is the use of a "fuel amendment" process to increase the flammability of fuels within the prescribed burn unit. Increasing the flammability of the fuels within the burn unit allowed burning to occur in lower indices with less severe weather conditions while still achieving high intensity fire. At the same time, fuels outside of the burn unit have limited fire response given the same weather and indices.

Bio: Rick started his career on a seasonal fire crew with the Alberta Forest Service in 1974. After graduating from NAIT as a Forest Technologist in 1975, he has worked in numerous positions across Alberta. He has worked on wildfire operations from British Columbia to Ontario, from Yellowstone to the Yukon. He is passionate about most everything he engages in, especially fire history and fire behaviour and uses these skills to reduce the threat of wildfire as well as to restore it to the landscape through the use of prescribed fire. Rick understands and appreciates that fire is the "Ecological Imperative".

103. Dutch Creek Mitigation Measures: Successes & Failures

Presenter(s): Bill Arsenault, Fire/Medic, Operations Lead, Gem County Fire-EMS

Additional Author(s):
Curtis Sandy, MD, Board-certified ER physician & EMS Medical Director

Mike Evers, Fire/Medic, MEDL, Colorado Springs Fire Department

Since the inception of the Dutch Creek Mitigation Measures, wildland fire personnel continue to mis-understand critical key concepts of full implimentation of the measures.

An overview of Facilitated Learning Analysis (FLA), Serious Accident Investigation (SAI), After Action Reviews (AAR) and Lessons Learned that have provided measured successful outcomes as well as failures will be presented. These will include cardiac/medical cases, motor vehicle accidents, aviation usage, and emergency response preparedness to the above related "incident within incident' planning.
Through discussion and reviews, the participant will gain further understanding of key elements needed to continue to decrease wildland fire fatalities.

Keywords: Dutch Creek, leadership, medical training, helicopters, short haul, EMS, EMT, Paramedic, medical guidelines, clinical leadership

Bio: Bill Arsenault is a 25 year veteran of emergency services. He has operated in wildland/structural fire, EMS, military, and law enforcement environments. In addition, presented at the 2011 IAWF Safety Summit. He is well-known throughout the wildland fire community as a medical response SME for all-risk incidents.

104. Rethinking the Fire Shelter

Presenter(s): Vincent H. Homer

Additional Author(s):
Carol Rice, Wildland resources, Consultant

A review of the statistics yields a questionable life safety record for shelter deployments in burn over and entrapment situations. USFS data indicates a wildland firefighter who deploys a fire shelter in true burnover conditions has a 4% chance of perishing, and a 50% chance of receiving 2nd degree or worse burns if s/he does survive. These statistics and concern over firefighter safety prompted an investigation into a new design from a perspective of thermodynamics and atmospheric survivability.
We present data and concepts surrounding the thermodynamics of protecting humans from untenable temperatures, heat flux exposures and hot, toxic gases. Current Fire Shelters rely heavily on reflecting radiant energy from fires but do not provide sufficient protection against convective energy transfer. It is common in burn-over situations for shelters to experience direct contact with flames and high velocity, hot gases. We conducted high heat flux (~80 kw/m2) tests involving flame impingement on original and new generation fire shelter materials as well as heat resistant fabrics used in protective garments. These show that at 80 kw/m2 the inside surface of original fire shelter material reaches 75˚ C in less than 10 seconds. The New Generation, two-layer shelter performs marginally better. The only way to delay the temperature rise within the shelter is to provide insulation and/or heat sink capability. We present the design and test data on ways to delay heat rise, such that inside surface temperature can be held below 50˚C for up to 5 minutes.

The second major problem for the firefighter is maintaining a survivable atmosphere inside the shelter and exposure during repositioning during a deployment. We propose possible solutions for these problems.

It is obvious that adding insulation to the existing shelter configuration will increase the weight and bulk of the unit. Lighter and less bulky alternative materials and methods of construction will be discussed to reduce this problem.

The talk is intended to inspire a fruitful discussion of the Fire Shelter program using test data and configuration suggestions to improve upon the current Fire Shelter design.

Keywords: Fire Shelter, Burnover survivability, breathable air, thermal burns

Bio: Vincent H. Homer, PE, CSP
My experience includes 40 years of fire related work in industry and government as a safety, fire protection and explosion mitigation engineer as well as a design engineer for an aerial fire fighting company. My most recent project was a fire fighting system to protect personnel in armored vehicle post IED fires. I have also been a wildland fire fighter as well as a volunteer fire fighter in both rural and industrial settings. My education includes a Associate degree in Mechanical

Technology, BS in Aerospace Engineering and an MS in Engineering Management. I hold a PE (Mechanical) in three states and am a Certified Safety Professional.

105. Special Session Seven: Wildland Firefighter Health and Safety at MTDC

Presenter: Joseph Domitrovich, PhD, Exercise Physiologist, Missoula Technology and Development Center
Tony Petrilli, Fire Equipment Specialist, Forest Service, Missoula Technology and Development Center
Joseph Sol, MS Exercise Physiology, Exercise Physiology Data Manager, Missoula Technology and Development Center

The Missoula Technology and Development Center (MTDC) have been engaged in the advancement of firefighter Health and Safety in the 1960's. MTDC has had a Memorandum of Understanding (MOU) with the University of Montana since 1963 and just established a MOU with NIOSH further advance our ability to help wildland firefighters. The work undertaken by MTDC has revolved around physiology and health. The projects include physiological job demands, heat related issues, acute and chronic health effects (rhabdomyolysis and compartment syndrome), smoke exposure, fitness requirements, physical training basic principles, and nutritional/hydration requirements. This special session will give an overview of the projects at MTDC and how they are all interconnected to improve wildland firefighter safety and health.

BIOS: Joe Domitrovich is an exercise physiologist at MTDC and a Pulaski motor when he can get away from his computer. However, he is slowly moving up into telling others where to dig. He completed his Ph.D. at the University of Montana, Missoula in Interdisciplinary Studies with an emphasis in exercise physiology.

Tony Petrilli is an equipment specialist for the Fire and Aviation Program at the USDA Forest Service's Missoula Technology and Development Center (MTDC). He holds a bachelor's degree in education from Western Montana College. Tony began working for the Forest Service in 1982 as a firefighter for the Lewis and Clark and the Beaverhead National Forests. He became a smokejumper in Missoula for the Northern Region in 1989. In 1992 he began working wintertime details at MTDC; he then joined the Center full time in 2000. He has been the fire shelter and firefighter clothing project leader since 2005. Tony maintains fire qualifications as a Division/Group Supervisor and Incident Commander Type III and has served on more than 25 fire entrapment safety review or investigation teams as a PPE specialist.

Joe Sol attended the University of Montana in Missoula, Montana, with a focus on exercise performance in adverse environmental conditions (heat/altitude). While attending school, employed by the US Forest Service as a wildland firefighter. Passionate about improving health and safety of wildland firefighters using practical application of research from both the laboratory setting as well as in the field.

MITIGATION

106. Too Late When The Wildfire Is At The Mines Gate

Presenter(s): Greg Bartlett, Brandon University, Rural Development Institute

In 2012, the Canadian Mining Industry contributed $52.6 billion to Canada's Gross Domestic Product (GDP). In that same year wildfire suppression costs reached almost 1 billion dollars. The risk of wildfires could impact the Canadian GDP and the communities that rely on the resource extraction industry.
Most raw mineral extraction takes place in rural and remote areas of Canada. In recent years the natural hazard of wildfire has come into conflict with the technical operations of mining. The interaction has become known as NATECH (Natural Hazard Triggering a Technological Disaster).

This presentation will give examples of global research into NATECH, while highlighting International & Canadian experiences in dealing with such conflict. The presentation will provide a deeper understanding on how comprehensive emergency management can assist rural and remote industries by using well established urban interface mitigation techniques that can reduce the impacts of NATECH on rural communities and land-use stakeholders.

Keywords: Natech, Mining, Community, Industry, Rural, Remote, Stakeholders, Mitigation, Industrial

Bio: Greg started pursuing his passion for Fire & Life Safety in 1998 when he joined the Canadian Forces, C.F.B. Petawawa, Base Fire Service. Since then Greg has held positions with Urban, Suburban and Rural fire services across Canada, always tackling conflicts with in the rural urban fringe. He then relocated to Western Canada in 2006, to become the Provincial Wildfire Prevention Officer with Saskatchewan Environment. Greg is now attending, Brandon University in Brandon, Manitoba to complete his Science Degree in Applied Disaster & Emergency Studies, where he also is a collaborating, Student Researcher with the Rural Development Institute.

107. We all play a part- Bushfire Ready Neighbourhoods

Presenter(s): Peter Middleton, Community Development Coordinator, Tasmania Fire Service. Member of the International Association for Public Participation.

Additional Author(s):
Mai Frandsen, Dr- Reseacher, University of Tasmania

From pilot to program, the Tasmania Fire Service community development approach - the Bushfire Ready Neighbourhoods program.

In 2009 the Tasmania Fire Service embarked on a community development pilot program with the aim of trialling a community development approach to bushfire preparedness in a number of targeted communities that have a higher level of bushfire risk.

Critical to the approach was to build a strong evidence base by collaborating with the University of Tasmania, Australian Fire and Emergency Services Council (AFAC) and the Bushfire Cooperative Research Centre. This included the publication of a PhD thesis by Dr Mai Frandsen in 2012 titled: 'Promoting community bushfire preparedness: Bridging the theory – practice divide'. This collaborative research approach is leading the nation in informing best practice in community bushfire preparedness and has created a sound evidence base in Australia.

Since undertaking this pilot program Tasmania Fire Service has embarked on the implementation of a strategic community development program - Bushfire Ready Neighbourhoods including the employment of dedicated Community Development Officers across Tasmania. This has a long-term goal of embedding community development and engagement in the organisation's culture and the way we work with communities to share the responsibility for bushfire.

Peter will share the key learnings from this research. He will discuss key themes, what has worked, what has not and practical ideas that people working and volunteering at all levels in community bushfire preparedness can take from the research.
Key topics Peter will discuss include:
- 'One size does not fit all' community development approach;
- Case studies from Tasmania;
- Research and human behaviour analysis;
- Best practice community engagement;
- Evaluation techniques;
- Tools, techniques and approaches to building resilience.

National Winner of the 2014 Resilient Australia Award- the award recognises excellence and innovation in disaster resilience.

Keywords: shared responsibility; capacity building; community development; resilience; prevention; preparedness; organisational change; community led approach; engagement; research; evidence base.

Bio: Peter Middleton is the Community Development Coordinator at Tasmania Fire Service in Hobart, Tasmania, Australia.
Peter's role develops community capacity to prevent, prepare for and respond to bushfires and fires in the home. Peter coordinates the Bushfire Ready Neighbourhoods program which aims to increase shared responsibility and has a vision that 'we all play a part- individuals, fire agencies and communities'.

A member of the International Association of Public Participation. Peter has hands on firefighting experience as a Volunteer and Remote Area Firefighter in Australia for 15 years.

Peter has a passion for evidence based community development in emergency management which is demonstrated in the success of the program.

108. Impact of federal fuels treatments on community firesheds in the Deschutes National Forest

Presenter(s): Cody Evers, MS, MCRP, PhD Student, Portland State University

Additional Author(s):
Max Nielsen-Pincus, PhD, Assistant Professor, Portland State University
Alan Ager, PhD, Operations Analyst, USFS

Wildfires that spread from federal land to the urban interface are a primary cause of human and financial losses and escalating federal fire suppression budget. These fires are frequently transmitted across landscapes fragmented by ownership, development, fuels, management, and ecological conditions. Firesheds represent a conceptually simple way of capturing the complexity of these interactions within a single spatial area. Firesheds are built from values prioritized by communities - whether those are economic, social, cultural, visual or ecological - and expanded to include lands surrounding the community that can transmit wildfire hazard to those values. Mapping firesheds is a relatively new technique that can be accomplished using geospatial simulations - maps are built by tracing the extent of wildfire ignitions that are likely to burn into areas of value. Strategic fuel reduction simulations can be used to estimate the reduction of wildfire risk to community values, and to stimulate discussion about tradeoffs among community values. This information can used to revise or evaluate Community Wildfire Protection Plans (CWPPs) as well as to coordinate risk management activities both within and outside of the wildland urban interface, including surrounding public lands. To illustrate, we generated fireshed boundaries for the values at risk identified by 7 CWPPs in Deschutes County, Oregon, and assess the sensitivity of those fireshed boundaries to potential fuels treatments on nearby public land. Random wildfires were simulated on both treated and untreated landscapes, and burn conditions were developed from historical wildfires in the region. In the treatment scenario, twenty percent of the study area is mechanically thinned, prioritized on wildfire hazard and fire regime group. We find that fuel treatment on federal lands is especially important for some communities, but for others, has little influence on that community's fireshed boundary. We discuss implications of these finding for the design and revision of CWPPs and the coordination of wildfire risk management activities in the region.

Keywords: community wildfire protection plans, fireshed, wildfire simulation, wildfire risk, forest fuel treatments

Bio: Cody Evers is a PhD student and IGERT fellow at Portland State University School of the Environment. His research focuses on ecosystem services, urbanization, and wildfire risk management. He has been involved in wildfire simulation and wildfire risk assessment in the Pacific Northwest for over 5 years as part of numerous grants funded under NSF, USDA, and JFS.

TRAGEDY, DEATH AND RECOVERY

109. Wildland Fire Fighter Deaths in the United States: A Comparison of Existing Surveillance Systems

Presenter(s): Corey Butler, MS, Occupational Safety and Health Specialist, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health

Additional Author(s):
Joe Domitrovich, PhD, United States Forest Service, Missoula Technology and Development Center, Missoula, MT

Background: Wildland fire fighting is a high-risk occupation requiring considerable physical and psychological demands. Multiple agencies publish annual fatality data and/or summary statistics for wildland fire fighters (WFFs); however, the number and types of deaths reported varies. These differences create challenges to accurately characterize these fatal events. There are at least five different surveillance systems that capture deaths each with varying case definitions and case inclusion/exclusion criteria. Four of these are population systems and one is a case-based system. Methods We examined the data within each of the five surveillance systems to better understand the types of WFF data collected, to assess each system's utility in characterizing wildland fire fighters fatalities, and to determine each system's potential to inform prevention strategies. To describe similarities and differences in how data were recorded and characterized, we also matched the wildland fire deaths for three of the population based systems* and compared individual fatalities across systems. Results: Between 2001 and 2012, 247 unique deaths were captured among the systems; 73% of these were captured in all three systems. The most common causes of death in all systems were traumatic injuries associated with aviation, vehicles and medical events (i.e., heart attacks), and entrapments/burnovers. Our data show that, although the three systems often report similar annual summary statistics, the actual events captured in each system vary by roughly 20% each year, depending on the types of events that the system is designed to track. Conclusions: The overarching and central goal of each system was to collect accurate and timely information to improve WFF safety and health. Each system is unique and has varying inclusion and exclusion criteria for capturing and tracking different subsets of WFF tasks/duties. Use of a common case definition and better descriptions/interpretations of the data and the results would help to more accurately characterize WFF traumatic injuries, lessen the likelihood for misinterpretation of WFF fatality data, and assist with defining the true occupational injury burden within this high-risk population.

Keywords: surveillance; fatalities; wildland fire fighter

Bio: Lieutenant Corey Butler is an Occupational Safety and Health Specialist at the NIOSH Western States Office (WSO) in Denver, CO. LT Butler began working at the NIOSH WSO in 2010. She has worked on a variety of NIOSH projects, including State-Based Surveillance, Health Hazard Evaluations (HHEs), Fire Fighter Fatality Investigations and Prevention Program (FFFIPP) investigations, and the Fatality Assessment and Control Evaluation Program (FACE). LT Butler is also Co-Program Coordinator of the NORA Public Safety Sector. Prior to coming to NIOSH, LT Butler was a Public Health Prevention Service (PHPS) Fellow with the Centers for Disease Control and Prevention. As a PHPS Fellow, she worked in Atlanta, GA, at NIOSH in the Office of the Director and at the Office of Public Health Preparedness and Response, Division of Strategic National Stockpile (OPHPR/DSNS); she also started the Colorado Department of Public Health and Environment's Occupational Health and Safety Surveillance Program. Corey received a Bachelor of Science degree in Occupational Safety and Health from Montana Tech in 2002, and a Master of Science in Health Promotion from the University of Montana in 2004. During college, LT Butler spent her summers fighting wildland fires with the United States Forest Service.

110. Common Denominators on Tragedy Fires - Updated For a New Fire Enviornment

Presenter(s): Matthew Holmstrom, Superintendent L&C IHC

In 1976 Carl Wilson put forth his 'Common Denominators on Tragedy or Near Miss Fires,' and since then they have become standard training tools in both classroom and field. In 2006 Dick Magnan updated the originals, adding an additional four based on recent statistics. In the wake of recent tragedies, this tool should again be updated, reflecting our knowledge of human behavior. This paper attempts to identify and list some of the human factor considerations of historical tragic and near miss fires. Based on individual readings, accident reports and lessons learned, the article compiles large data into a more manageable, teachable format to share the Human Factors Common to Tragedy Fires with the Fire Service.

Keywords: Lessons Learned, Common Denominators, Human Factors

Bio: Currently the Superintendent of the Lewis and Clark Hotshots, Matt Holmstrom has been involved in fire since 1996, starting with the USFS immediately following high school. Though originally planning to use fire with the USFS as a summer job to pay for advanced degrees in History to go on and teach, that plan was derailed by the excitement, passion and commitment common to the fire service. As the Superintendent on L&C Matt has made training, especially in human factors, a key component to producing quality leaders and hopes to fight fire as long as the knees hold out

111. Embracing Recovery: Establishing a Chaplaincy Service for the Wildland Fire Community

Presenter(s): Matthew Carroll

Resilience, as it is applied in an organizational safety context, is defined by three primary components, anticipation, adaptation and recovery. Much of our focus is on the first two, theoretically because it is better to avoid than recover from some tragedy, but in order to wholly embrace the resilience concept we must allocate time and resources to building the capacity to recover.

The military chaplaincy service is an exemplary model of this. At a basic level, military chaplains are there to support "the free exercise of religion for men and women of all faiths," but serve to support pastoral care (spiritual and emotional counseling) needs as well. Although the military chaplaincy service is the most well known, structure fire, police departments and professional athletic teams also have them. A chaplaincy service aligns well with the concept of resilience in that it treats wildland firefighters as whole people while they are engaged in physically and emotionally taxing duty. Without such a service we are expecting firefighters to set aside part of their lives for the time they are committed to the incident, to just be firefighters and not whole people; this is fragile.

Typically when tragedy does strike, religious figures are brought in to aid as needed in the process of recovery. These individuals lack context and understanding of the daily life of wildland firefighters and have little to no previous connection with the people they are brought into help. An established chaplain would be in a better position to understand the unique character of the wildland fire community and may have already established a relationship with those affected. Building this pool of capacity for recovery is tangible resilience. This session will focus on introducing the idea of a wildland fire chaplainry service, determining its feasibility, level of acceptance and potential next steps.

Keywords: Chaplaincy Programm, Resilience, Recovery

Bio: Matt Carroll is currently a Smokejumper/Spotter at the McCall Smokejumper base and has been a wildland firefighter since 2000. He has been detailed in to the Human Factors Specialist position at the US Forest Service Office of Learning (OOL) since January of 2014. Matt's work with the OOL began with the creation of the Margin video to bring the concept to the field. He has also been working on accident/incident reporting systems, risk assessment and management, Individual and organizational learning and resilience.

FIREFIGHTER SAFETY

112. Assessing Firefighter Safety Zone Characteristics

Presenter(s): Philip Dennison, University of Utah

Additional Author(s):
Greg Fryer, University of Utah
Michael Campbell, University of Utah

Firefighter safety zones create a buffer between firefighters and dangerous fuels, reducing heat exposure to safe levels and preventing firefighter injury or fatality. Current guidelines for creating a safe separation distance (SSD) from fuels rely on a multiple of four times flame height plus sufficient area for the number of personnel and for equipment. Future guidelines for SSD may use vegetation height rather than flame height and include a multiplier based on wind and slope conditions. In either case, these guidelines represent ideal safety zones and actual safety zones designations may substantially deviate from guidelines due to limits of practical implementation. This talk will reveal preliminary results from an analysis of 12 safety zones used by a hotshot firefighter crew during the 2014 fire season. Recent progress on a spatial model for safety zone mapping will be reviewed. Safety zone characteristics for the 12 safety zones described in 2014 will be examined. Plans for collecting additional safety zone survey data for the 2015 fire season and beyond will be discussed.

Keywords: safety zones, LCES, safe separation distance

Bio: Dr. Philip Dennison is a Professor of Geography at the University of Utah. He is the Director of the Utah Remote Sensing Applications Lab, and is an author on over 50 publications addressing wildfire and remote sensing topics.

113. Lidar mapping of firefighter safety zones: A comparison of flame height- and vegetation height-based guidelines

Presenter(s): Michael Campbell, PhD Student, University of Utah Department of Geography

Additional Author(s):
Dr. Philip Dennison, Professor, University of Utah Department of Geography
Bret Butler, Research Mechanical Engineer, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory, US Forest Service

The ability of wildland firefighters to efficiently determine the suitability of safety zones is essential for preventing injuries and fatalities in wildfire events. At present, this assessment is largely performed by firefighters in the field. For more than a decade, safety zones were defined by a safe separation distance (SSD) equal to or greater than four times expected flame height. New guidelines suggest that this SSD should instead be computed based on the height of the surrounding vegetation, the slope of the terrain, and the wind speed. Though wind speeds are variable, vegetation heights and slopes remain fairly stable, enabling the evaluation of safety zone suitability prior to a wildfire event. The objective of this study was to compare the size and number of safety zones mapped with lidar data using alternative flame height- and vegetation height-based SSD guidelines. A study area covering approximately 450km2 in the Boulder Creek watershed, outside of Boulder, Colorado was examined. Results from the analysis suggest that the new vegetation height-based guidelines allow for fewer safety zones that are smaller in size. The models developed in this study can be adapted for use in a variety of vegetation types, offering a tool for identification and inventorying of potential wildfire safety zones.

Keywords: Lidar, Remote Sensing, GIS, Firefighter Safety Zones, WIldfire, Boulder, Colorado

Bio: Michael Campbell is a first-year PhD student in the Geography Department at the University of Utah. His PhD research focuses on the use of GIS and remote sensing in assessing and modeling firefighter safety. Prior to beginning his PhD, Michael worked for two years at the USFS Remote Sensing Applications Center as a Vegetation Mapping Specialist. He received his M.S. in Natural Resources from the University of New Hampshire, where his research revolved around remote sensing approaches to detecting timber harvesting practices in northeastern Oregon. In his free time, Michael enjoys skiing, hiking, biking, playing soccer and hockey.

114. Evaluation of a Safety Zone Digital Calculator

Presenter(s): Joaquin Ramirez, Technosylva

Additional Author(s):
Bret Butler, Missoula Fire Sciences Laboratory. USFS
Dan Jimenez, Missoula Fire Sciences Laboratory, USFS

Wildland firefighting by its nature is inherently dangerous. One of the critical decisions made by fire fighters on any wildland fires is the identification of suitable safety zones: areas where firefighters can safely wait for the fire to burn around them. The United States Forest Service defines a safety zone as "a preplanned area of sufficient size and suitable location that is expected to protect fire personnel from known hazards without using fire shelters". It is the intent that safety zones should be available and accessible in the event that fire behavior or intensity increases suddenly making current suppression tactics unsafe. We propose that the primary variable of interest be safety zone radius or its operational equivalent safe separation distance (SSD). In this presentation we describe a simple digital app that computes the minimum size of a safety zone needed to prevent burn injury as a function of vegetation type, terrain slope and wind. We present results from the app for a range of vegetation, terrain and wind conditions and compare the results to past fire incidents.

Keywords: Firefighter Safety, safety zone, fire behavior

Bio: Joaquin Ramirez , PhD in Forestry and Geomatics from the University of Leon. Co-Director of the first European MsC program on Wildfires (www.masterfuegoforestal.es) where he teaches "Geotechnologies on Wildfires". His applied research is focused on wildfire modelling and geo-tools. He is the principal of Technosylva, (San Diego), where he develops tools for operational support, as Wildfire Analyst, first wildfire simulator oriented to support real time operations, and fiResponse, a complete wildfire management system used in European agencies since 1997 (www.wildfireanalyst.com www.firesponse.com).
He has also leaded Risk Assessments of different Spanish regions and in the US, as the Wildfire Risk Assessment for MC Camp Pendleton.

CLIMATE/WEATHER/FIRE EXTREMES

115. Adding to fire fighter safety through modeling of thunderstorm-induced windshifts: A case study with the 30 June 2013 Yarnell Hill Fire

Presenter(s): Gary L. Achtemeier, PhD, Retired

Additional Author(s): Scott L. Goodrick, PhD, Project Leader, USDA Forest Service Center for Fire Disturbance Science

One of the most serious threats to the safety of fire crews is wind shifts caused by thunderstorm downdrafts. Slow-spreading low-intensity flanking fires can be transformed, in the matter of a few seconds, into a raging high-intensity head fire destroying anything and killing anyone in its path. Unless thunderstorm outflows are deep enough or close enough to radars to be observed, they can travel for great distances undetected. Some outflows can travel 50-100 miles from source regions to strike fire sites without any signs of changing weather.

We describe a class of thunderstorm wind models that allow Incident Commanders and others to see the progress of nearby outflows, assess the risk of changes in wind speed and direction, and take action to move fire crews to safety up to 30-60 minutes before wind shifts arrive at a fire site. The models link real-time operational radar precipitation data with ambient temperature and relative humidity to map locations and fields of outflow wind velocities they evolve relative to local terrain during the course of the day.

We demonstrate the potential of thunderstorm wind models for fire fighter safety through a "proof-of-concept" study of weather conditions that contributed to the deaths of 19 fire fighters at Yarnell Hill on 30 June 2013. The model was set up for the terrain of Arizona surrounding the Yarnell region with a resolution of 900 m. Radar data for 30 June 2013 were supplied by the National Weather Service radar located south of Flagstaff, AZ. Temperature and surface winds were supplied from Peeples Vally (1209-1509 LST) and from Phoenix from 1509-1709 LST.

At 1500 LST, gust flows breeched a gap in the mountain range about 30 km (18 mi) north of Yarnell. This gust flow surged south to reach the northern perimeter of the fire by 1616 LST (arrival reported at 1618 LST). Meanwhile outflows breeched a second gap in the mountain range 12 km (7 mi) east-northeast of Yarnell, merged with the southward-moving outflow, and arrived at the fire from the northeast. The outflow passed the southern perimeter of the fire between 1630-1645 LST (arrival reported at 1630 LST).

The results show the potential for thunderstorm outflow wind models to inform Incident Commanders of dangers pending from sudden thunderstorm-induced wind shifts, giving them time to assess the risk of changes in weather, and take action to move fire crews to safety before wind shifts arrive at a fire site.

Keywords: wind shifts, fire behavior, thunderstorm out flows, fire fighter safety

Bio: Gary L. Achtemeier now retired was formerly a meteorological scientist at the USDA Forest Service Center for Fire Disturbance Science located at Athens, Georgia, with interests in smoke/superfog -induced highway accidents, fire modeling, and thunderstorm-related hazards to fire management.

116. Prototype Fire Weather Impact Based Performance Metric

Presenter(s): Robyn Heffernan

It is the interaction of weather with an ignition or ongoing fire, combined with a community's vulnerability, which produces an impact. The intent of an impact based fire weather verification methodology is to develop a quantitative measure of customer satisfaction using non-meteorological parameters and fire based impacts. A prototype impact based performance fire weather metric with a couple years of data for sample locations was developed to illustrate how to potentially meet this intent.

The NWS produces a next day National Fire Danger Rating System (NFDRS) forecast. These forecasts aid Land Managers in making fire management decisions on a daily basis. All fire management decisions in a Fire Danger Rating Area (an area of land management responsibility) are based on NFDRS outputs. Staffing Level and Adjective Rating are commonly used by fire managers to make fire management decisions including how land management resources are to be allocated. Staffing Level is used for internal Land Management Agency resource allocation, while Adjective Rating is used to communicate fire risk to the public and limit public impacts on fire risk. Staffing Level and Adjective Rating are computed using a combination of NFDRS outputs.

Categories of fire management decisions (i.e. Staffing Level and Adjective Rating) for both forecasted and actual weather variables are compared to see if forecast error would have resulted in a different decision for the customer. The numbers of “Categories of Departure” between forecast and observed decision categories provide the “Error Value." The lower the “Error Value” the more successful the fire weather forecast impact on fire operations. Depending on resource needs that are associated with different levels of fire management decisions, a monetary estimation can be assigned to the Error Value. This enables the verification metric to quantify the value of fire weather forecast based on customer impacts. There are plans for this fire weather prototype to be run in a real-time analysis during the 2015 summer fire season.

Keywords: metric, verification, fire weather

Bio: Robyn Heffernan is the National Weather Service Fire Weather Science and Dissemination Meteorologist located in Boise, ID. Since early 2011, Ms. Heffernan has been responsible for leading several technological and science based efforts for the NWS fire weather program, as well as integrating these efforts into fire weather operations. Previously, Ms. Heffernan had joined the Predictive Services program as the Assistant National Fire Weather Program Manager for the Bureau of Land Management. Ms. Heffernan is currently the chair of the National Wildfire Coordination Group, Fire Environment Committee. Ms. Heffernan has a B.S. degree in Geography from Arizona State University.

117. Understanding effects of heat dosage on soils from slash pile burning in a Piñon-Juniper system (Pinus edulis-Juniperous monosperma)

Presenter(s): Elyssa Duran

Additional Author(s):
Dr. Sara Brown, Assistant Professor of Forestry, NMHU

Historically the Pinon-Juniper (Pinus edulis-Juniperus monosperma) savannas of the Lincoln National Forest near Ruidoso, New Mexico were much less dense, with large open patches of native grasslands with interspersed shrubs. Encroachment of these species is not well understood, but thought to be related to fire suppression, grazing, climatic factors, and other management activities. One method used to restore Pinon-Juniper savannas is thinning the trees, and then using heavy machinery such as a bulldozer to create piles of slash that are later burned. The goal of this study is two-fold: 1) to evaluate the heat dosage (intensity and duration) during burning across a spatial gradient from the center of the pile to the edge, as well as at 5cm below ground, and 2) to relate heat dosage in the slash piles to post-fire effects on the soil. Ten large slash piles were selected with control sites of a similar size immediately adjacent. Fuel loads were calculated for each pile and thermocouples were placed on the soil surface in the center of the pile, between the center and the edge of the pile, at the edge of the pile, and at 5cm below ground between the center and edge. We examined soil moisture, soil infiltration, soil pH, soil carbon content, soil texture, and soil stability at the slash piles and control sites. These measurements along with the thermocouple data will help us understand fire effects on soils. Preliminary results suggest that there is a heat dosage gradient from the center of the pile to the edge, and that the fire effects on soils are correlated to the heat dosage. These findings will help inform resource decision for land managers grappling with restoration of the woodland-savannas.

Keywords: Prescribed Fire, Pile Burn, Soil Effects, Burn Temperature

Bio: Elyssa Duran is a student at New Mexico Highlands University in Las Vegas, NM. This New Mexico native is a Candidate for a Master's of Natural Sciences. Elyssa has been involved previously with other wildland fire research examining soil nutrient levels on the 2011 Las Conchas Fire in her undergraduate work. She is now dedicated to researching the effects of pile burns, specifically on soils, as her Master's Thesis work.
Mitigation

118. Cost-effective fuel treatment planning

Presenter(s): Jason Kreitler, PhD, Research Geographer, U.S. Geological Survey

Additional Author(s):
Matt Thompson, PhD, Research Forester, U.S. Forest Service
Nicole Vaillant, PhD, Fire Ecologist, U.S. Forest Service

The cost of fighting large wildland fires in the western United States has grown dramatically over the past decade. This trend will likely continue with growth of the WUI into fire prone ecosystems, dangerous fuel conditions from decades of fire suppression, and a potentially increasing effect from prolonged drought and climate change. Fuel treatments are often considered the primary pre-fire mechanism to reduce the exposure of values at risk to wildland fire, and a growing suite of fire models and tools are employed to prioritize where treatments could mitigate wildland fire damages. Assessments using the likelihood and consequence of fire are critical because funds are insufficient to reduce risk on all lands needing treatment, therefore prioritization is required to maximize the effectiveness of fuel treatment budgets. Cost-effectiveness, doing the most good per dollar, would seem to be an important fuel treatment metric, yet studies or plans that prioritize fuel treatments using costs or cost-effectiveness measures are absent from the literature. Therefore, to explore the effect of using costs in fuel treatment planning we test four prioritization algorithms designed to reduce risk in a case study examining fuel treatments on the Sisters Ranger District of central Oregon. For benefits we model sediment retention and standing biomass, and measure the effectiveness of each algorithm by comparing the differences among treatment and no treat alternative scenarios. Our objective is to maximize the averted loss of net benefits subject to a representative fuel treatment budget. We model costs across the study landscape using the My Fuel Treatment Planner software, tree list data, local mill prices, and GIS-measured site characteristics. We use fire simulations to generate burn probabilities, and estimate fire intensity as conditional flame length at each pixel. Two prioritization algorithms target treatments based on cost-effectiveness and show improvements over those that use only benefits. Variations across the heterogeneous surfaces of costs and benefits create opportunities for fuel treatments to maximize the expected averted loss of benefits. By targeting these opportunities we demonstrate how incorporating costs in fuel treatment prioritization can improve the outcome of fuel treatment planning.

Keywords: cost modeling, fuel treatment planning, ecosystem services, cost-effectiveness

Bio: Jason Kreitler is a research geographer for the USGS working in the fields of conservation and natural resource management, including wildland fire. His research uses multiple disciplines and quantitative methods to understand the pattern and process of climate and land use change in socio-ecological systems.

119. Left out from wildfires mitigation: Does university's population think different?

Presenter(s): Thomas, Wuerzer, Ph.D., Assistant Professor, Boise State University

This research presents a novel perspective on college students and their risk perception in a fire prone US State; Idaho. Idaho was "top #1" by acreage in 2012 with approximate 15% of all US burned lands; in 2013 "top #2". Past studies have conducted surveys on residents in high wildfire risk communities to learn what factors make homeowners more likely to engage in mitigation activities and therefore increase communities' resiliency. This research emphasis is on a population that deals with the threat of fire but is likely less invested through property ownership and other investment of risk; yet, equally threatened in quality of life.

Are college students the left-out population in the 'planning for wildfires' and its communication process?

Main hypothesis is that a college population will have a different perception and awareness (and therefore mitigation actions) than i.e. residents invested in the wild land urban interface (WUI). Dominant research methodologies in past studies are identified as surveys, focus groups, or interviews focusing on homeowners in fire prone areas that have witnessed wildfire or are exposed to increasing fire risk. Yet again, research on population that has no property ownership, investments at stake, and therefore no direct monetary values associated (but potentially non-monetary), is found little to none in these studies.

The university population based study and its findings offers a contrast to current literature related to these traditional residents surveys/interviews. The study's survey and interactive spatial assessment of risk perception with allocation of perceived hazards zones promotes understanding of where risk is apparent for participants. Results are used to inform agencies such as campus emergency management, regional wild fire mitigation efforts, and to enhance public communication. Lessons learned include the challenges of a comprehensive inclusion process when mitigating for hazards and building resiliency in a region with development pressures.

Keywords: Wildfire, college students, risk perception, wildland urban interface

Bio: Dr. Thomas Wuerzer is Assistant Professor in Boise State University's Department of Community and Regional Planning. His work and research are bridged by an in-depth background in Geographic Information Systems (GIS). He is actively researching regional planning issues of wildfires within the Wildland Urban Interface with focus on wildfire and related hazards' impacts on natural and built environment, wildlife and human habitat.

120. Boulder County Wildfire Partners - Home Ignition Zone, Education, Certificates, Case Studies and iPads

Presenter(s): Ryan Ludlow, Forestry Education and Outreach Coordinator, Boulder County Colorado

Wildfire Partners is a new and innovative way to help homeowners prepare for wildfires. We provide a comprehensive, 2-4 hour assessment of the home ignition zone; a customized report detailing actions homeowners should take; a rebate for mitigation work; and a follow-up certification to ensure that the homeowner is as prepared as possible. In 2014, we easily enrolled our target of 500 homes and conducted 450 assessments.

Meetings between Boulder County staff and some of the nation’s leading wildfire mitigation scientists—Jack Cohen and Steve Quarels—helped build our program design. We focus on the need to create effective d-space, retrofit homes and maintain the efforts over-time. The latest social science highlights the importance of education and the need to explain the real hazard homeowners’ face. This is why we require each homeowner to actively participate in their home assessment.

Our program is using an innovative home assessment tool, an iPad app, which can be easily replicated in other communities. The app is powerful and allows us to capture photos and annotate them directly in app. Wildfire Partners is rich in data. All data we collect via the iPads is tracked in salesforce, a powerful database. Data can be analyzed by home, fire district, and mitigation measure. We also track the total hard dollars and hours of labor each homeowner contributes. At this presentation we will share our data, case studies and stories from homeowners who are benefiting from the program.

After homeowners complete all required mitigation measures we re-visit their property. If they pass their inspection we issue a Wildfire Partner Certificate. Allstate Insurance has announced their support for the initiative by being the first insurance company to accept our certificate.

The program has proven very popular with participants. In a recent survey, 91% of respondents said they are very likely or likely to refer a friend or neighbor to the program.

Our presentation will provide an overview of our program design, our innovative approach, the iPad assessment tool and why we believe Wildfire Partners is designed for success.
To learn more about Wildfire Partners visit: http://www.wildfirepartners.org/

Keywords: Wildfire Mitigation; Home Ignition Zone; Defensible Space; Home Retrofits; Education and Outreach; Case Studies; Certificates; Technology; iPad Assessment Tools; Mitigating Fire Risk; Understanding Risk; Wildland Urban Interface; Building Resilient Commun

Bio: Ryan Ludlow coordinates the Forest Health Outreach Program for Boulder County in Colorado. Ryan passionately promotes the need for proactive wildfire mitigation and understands the importance of designing effective educational programs. In 2010, the Fourmile Fire ignited in the foothills of Boulder County destroying 169 homes. This fire motivated Ryan and Boulder County to do more to help residents prepare for future wildfires. Over the past few years he has built a wide-reaching educational network that is working. Homeowners are taking personal responsibility and when you visit the foothills of Boulder County you can see the impact.

FUELS MANAGEMENT

121. Description of Firebrand Generation in a Pine Stand Fire

Presenter(s): Albert Simeoni, BRE Centre for Fire Safety Engineering, University of Edinburgh, UK

Additional Author(s):
M. El Houssami - BRE Centre for Fire Safety Engineering, University of Edinburgh, UK
E. Mueller - BRE Centre for Fire Safety Engineering, University of Edinburgh, UK
A. Filkov - National Research Tomsk State University, Russia
J.C. Thomas - BRE Centre for Fire Safety Engineering, University of Edinburgh, UK
N. Skowronski - USDA Forest Service, Northern Research Station, USA
M. Gallagher - USDA Forest Service, Northern Research Station, USA

K. Clark - USDA Forest Service, Northern Research Station, USA
R. Kremens - Rochester Institute of Technology, USA
A study on the generation of firebrands was carried out during a high intensity prescribed fire in the New Jersey Pine Barrens in March 2013. New methodologies were tested to obtain insight on the firebrand activity, and to quantify firebrand showers close to a fire front. Firebrands were collected from different locations in the forest during the fire and were analyzed for mass, size distribution and number density. Most firebrands were bark slices with substantial amounts of pine and shrub twigs. Bark consumption was studied by measuring the circumference variation at several heights on each of three different pine trees. The variation was in the same order of magnitude as the bark thickness determined in the firebrand collection section (1 to 5 x10−3 m). Shrub branches were compared before and after the burn with subgroups for 1h fuels then were compared to the collected shrub originated firebrands. Fire behavior, and fuel consumption were estimated to supplement the firebrand generation study: vegetation was characterized with field and remotely sensed data before the fire, canopy fuel consumption and shrub layer consumption were evaluated; meteorological conditions were monitored before and during the burn; fire spread and fire intensity were characterized in the burn plot. This work represent first exploration of various methodologies that will facilitate the collection of compatible data in a wide range of ecosystems and fire environments, aiding in the development of solutions to prevent structural ignition at the Wildland Urban Interface.

Keywords: Firebrand, Bark, Generation

Bio: Albert Simeoni is a professor at the University of Edinburgh, UK. He is also the director of the BRE Centre of Fire Safety Engineering. Previously, he was an associate professor at Worcester Polytechnic Institute, USA and assistant professor at the University of Corsica, France, where he got his PhD in Mechanical Engineering. He is working on the fundamental aspects driving fire behavior by conducting experimental, modeling and simulation studies, in which he focuses on the combustion, thermal transfer and fluid mechanics aspects.

122. Fuel Treatment Research and Technology Transfer – How to Better Support Practitioners' Needs

Presenter(s): Thomas Zimmerman. Ph.D. Senior Wildland Fire Consultant, Tom Zimmerman Consulting.

Additional Author(s):
Richard Lasko. Natural Resource Consultant. US Forest Service retired
Merrill Kaufmann. Emeritus Scientist, Rocky Mountain Research Station

Significant changes occurring in the wildland fire environment of the United States are generating uncharacteristic shifts in the complexity, behavior, extent, and effects of wildfires. Treatment of wildland fuels to mitigate the risk of severe wildland fire impacts to human communities and valuable natural and cultural resources, and maintain and improve the health and resiliency of forest and rangeland ecosystems is emerging as a keystone land management process. With fuel treatment activities receiving greater attention and scrutiny, it is imperative to find ways to improve overall fuel treatment program effectiveness. The foundation for successfully meeting this challenge is research that addresses pertinent issues and provides actionable information to support management practices. Although much work has been done on this subject, there is a need to provide better guidance to research and development to address high priority knowledge and technology needs. Many questions remain at the center of both management and policy. We conducted a one-year study, supported by the Joint Fire Science Program (JFSP), that surveyed a large number of individuals across the United States from areas including, but not limited to fire and fuels management, research, education, technology transfer, program management, decision-making, and program leadership. From these individuals we gathered fuel treatment research needs; explored the progress of the scientific community in meeting these information needs; examined technology transfer venues that link practitioners to scientific information; and assessed program reference materials, management tools, and other supporting information. From this information, we identified potential areas of future fuel treatment research and possible venues for improving technology transfer.

Keywords: fuel treatment, science, fire management, wildfire, fire risk, technology transfer

Bio: Thomas Zimmerman is senior wildland fire management consultant. He served for 35 years in wildland fire management with the Bureau of Land Management, National Park Service, and US Forest Service in various capacities at all organizational levels. He has worked in areas of fire ecology, fire suppression, prescribed fire, wildland fire use, fire behavior, smoke management, incident management, emergency response, technology transfer, training, national fire policy development and implementation, fire reviews and accident assessments, decision making, risk assessment, and change management. He is a certified Senior Fire Ecologist and Senior Wildland Fire Manager by the Association of Fire Ecology.

123. Modeling Potential Fire Behavior Changes Due to Fuel Breaks in the Monterey Ranger District, Los Padres National Forest, California

Presenter(s): Stacy Drury, PhD, Senior Fire Ecologist, Sonoma Technology Inc.

The Monterey Ranger District (MRD) of the Los Padres National Forest and its partner, FireScape Monterey, are proposing to re-establish and maintain a set of fuel breaks around the Ventana Wilderness. The proposed fuel breaks are intended to 1) increase fire suppression efficiency, 2) reduce wildfire risk to life and property near the MRD and surrounding communities, 3) reduce wildfire suppression costs, and 4) reduce adverse fire suppression impacts. I used the fire behavior modeling tools in the Interagency Fuels Treatment Decision Support System (IFTDSS) to analyze whether the fuel breaks would increase wildland fire suppression efficiency and reduce wildfire risk to life and property. The project objectives were to a) identify if large fires would occur within the Ventana Wilderness and move into the surrounding wildland-urban interface (WUI), b) identify whether the fuel breaks are strategically located where they will be encountered by wildfire, and c) identify the potential for the fuel breaks to mitigate fire movement into the communities of Big Sur, Palo Colorado, and Cachugua.
I used a multi step process to bring historical fire occurrence, historical fire weather patterns, and fuel model assessments into a fire behavior modeling framework. I modeled potential fire behavior and fire growth across spatial landscapes with and without the proposed fuel breaks simulated in the landscape. Baseline conclusions support preparing and maintaining the fuel breaks. The modeling shows that fuel breaks are strategically placed in locations that have historically burned during wildfires and/or have provided opportunities for fire suppression activities, such as back burning. Alone, and in conjunction with fire suppression actions, the fuel breaks can lower flame lengths and mitigate fire movement, meeting the objectives of the MRD. The lowered flame lengths and decreased rates of spread can provide opportunities for firefighters to use alternative strategies for suppressing fire. Pre positioned fuel breaks can serve as anchor points for creating additional fuel breaks as needed or provide safe areas for igniting back burning operations.

Keywords: Fuels Treatment planning, Fuels Treatment evaluations, Fire Behavior Modeling

Bio: At STI, Stacy provides scientific oversight and technical guidance on fire and fuels research and software development. He conducts research on fuel loading, fire occurrence, fire behavior, fuel consumption, and fire effects. Much of Stacy's research is centered on modeling wildfire hazard and risk – in particular, how fuels treatments mitigate fire hazard and risk to natural resources and communities. He has assessed fuels treatment effectiveness using satellite imagery, modeled fuel loading changes due to fuels treatments, and modeled potential fire behavior and fire effects in the Wildland Urban Interface.

FIREFIGHTER SAFETY

124. Yarnell Hill Entrapment; Additional lessons that could be learned

Presenter(s): Rich McCrea, Wildland Fire Consultant, LarchFire LLC

Additional Author(s):
Al Studt, Lieutenant, Cape Canaveral Fire Rescue

On June 30, 2013 nineteen wildland firefighters from the Granite Mountain Hotshots lost their lives on the Yarnell Hill Fire. There are mapping techniques, technologies and protocols that could be used on future wildland fires that would enhance operations and be valuable during emergencies, when teams are in trouble. These include enhanced mapping techniques by use of the United States National Grid (USNG), the use of MAYDAY terminology & processes, and using web tools in combination with smart devices to quickly make interoperable maps or files for immediate use as the firefight is just beginning.
MAYDAY: In the United States, structural firefighters have for years used this term to designate serious trouble and personal danger. Departments all over the nation have protocols and have trained on how to react to MAYDAYs.
No such single word exists for wildland firefighters and there is no reason to create a new separate one. The strong recommendation is that forestry/wildland fire management adopt the standard term MAYDAY and train with it.

US National Grid USNG: U.S. National Grid (USNG) standard, FGDC-STD-011-2001, provides a nationally consistent language of location that has been optimized for local applications. The USNG expands the utility of topographic, street, and other large-scale maps by adding several powerful features: It provides an standard grid reference system that is seamless across jurisdictional boundaries; it provides the foundation for a universal map index; it enables quick, user-friendly position referencing on appropriately gridded paper and digital maps, global positioning systems (GPS) receivers, smart phones, tablets and desk computers. USNG is easy to learn and use and is interoperable with multiple agencies including the US Military. There are many potential applications of USNG in wildland fire operations including tracking firefighting resources, planning and implementation of daily fire operations, and tracking fire behavior across the landscape. Finally, truncated USNG shall be used by teams calling MAYDAY. The recommendation for this is 100 meter square grids of just six digits. For the Yarnell 19 it would have been: 362 880.

Keywords: Yarnell Hill Incident, US National Grid

Bio: Rich works as a wildland fire management consultant and freelance writer. During his career, he worked 32 years with the Department of Interior in fire management and forestry. Outfitted with a degree in Forestry, he started his career as a seasonal employee with the Forest Service as a forestry technician and member of the Helena Hotshot Crew, then moved on to permanent positions with the Bureau of Indian Affairs as a Forester and Fire Management Officer. Rich has considerable experience working with incident management teams including over 23 years' experience as a qualified fire behavior analyst

125. Distilling and disseminating new scientific understanding of wildland fire phenomena and unfolding of large wildfires to prevent wildland firefighter entrapment

Presenter(s): Janice Coen, PhD, Project Scientist, NCAR

Large wildland fires are dynamic phenomena that may encounter a wide range of fuels, terrain, and environments often during one event and can produce extreme phenomena not observable in laboratory or prescribed fires such as blow-ups, 100-m long bursts of flame shooting ahead of the fire line, fire winds 10 times stronger than ambient wind speeds, deep pyrocumulus, and firestorms in which the fire-generated winds overwhelm ambient winds – all resulting from the interactions between a fire and its atmospheric environment, notably the production of fire winds. Despite uniform training curricula, rigorous command and control structures, and succinct principles like the 10 Standard Fire Orders and 18 Watch Out Situations, even seasoned firefighters may be tragically unprepared for complex and explosive fire behavior that can lead to burnovers.

Both observational and modeling research have unearthed dynamic fire phenomena and confluences of atmospheric, fuel, and topographic conditions that have likely contributed to numerous firefighter fatality incidents. Infrared imagery has revealed bursts of flame that shoot ahead of the fire line along the ground; such imagery and phenomena has recently reached S290 training curricula. Coupled weather-wildland fire models tie numerical weather prediction models to wildland fire behavior models to simulate the impact of a fire on the atmosphere and the subsequent feedback of these fire-induced winds on fire behavior, i.e. how the fire creates its own weather. We apply the CAWFE coupled weather-fire modeling system to past fatality incidents including the Esperanza Fire and Yarnell Hill Fire events to understand past wildfire events and distill knowledge for dissemination with the wildland firefighting and scientific community. We show how CAWFE, currently being implemented as a forecasting tool as it transitions from research to operational use, can be used to anticipate fire growth and changes in fire behavior, filling a gap where current tools are weakest, in plume-driven fires and those affected by changing weather conditions.

Keywords: fire behavior, weather modeling, coupled atmosphere-fire models

Bio: Dr. Janice Coen is a Project Scientist at the National Center for Atmospheric Research in Boulder, Colorado. She studies fire behavior and its interaction with weather using coupled weather-fire computer simulation models and by analyzing infrared imagery of wildfires and prescribed fires. She received a B.S. in Engineering Physics from Grove City College and an M.S. and Ph.D. from the Department of Geophysical Sciences at the University of Chicago. She has been a member of the Board of Directors of the International Association of Wildland Fire and is currently an Associate Editor for the International Journal of Wildland Fire.

126. Listening Up, Down, and Around: Sound Studies and Wildland Firefighter Situational Awareness

Presenter(s): John Widman, PhD Student and Teaching Assistant, UCLA Department of Ethnomusicology

When listening is discussed in training curriculum and articles concerning wildland firefighting in the United States, the primary focus is on building positive interpersonal communication skills and providing a basis for good communication. However, formal discussions on the application of listening to sounds in the wildland fire environment to achieve greater situational awareness are rare. According to the NWCG L-180 "Human Factors on the Fireline" instructor's course book, situational awareness is a product of "observations" and "communication". However, there is no suggestion that "observation" should include anything beyond visual information other than receiving observations communicated by another party. In the S-133 "Look Up, Look Down, Look Around" course, firefighters examine seven key environmental factors to risk management that are also in the Incident Response Pocket Guide. While firefighters are encouraged to handle fuels to help evaluate moisture and temperature, other environmental cues are assessed visually. This is a logical and effective approach, but including other senses might help us add depth to our current practices. One way to achieve this would be encouraging purposeful listening in the fire environment, both to respond to aural cues and as a way of involving other senses in information gathering.

Evaluating sounds to achieve greater situational awareness is already a part of recent studies on the role of sound in the Iraqi conflict. Researcher Martin Daughtry catalogs several ways soldiers use sounds from different kinds of weapons and situations to enhance knowledge of the battlefield. Conversely, Suzanne Cusick and Jonathan Pieslak survey how music has been used at high volumes to overwhelm the senses of opposing forces and detainees. While we are not "at war" with fire, examining these existing studies of how sound can be used both to enhance and confuse understanding might help us better comprehend how to evaluate our own sound environments as firefighters. By placing the work of Cusick, Daughtry, and Pieslak in dialogue with existing informal commentary on wildland fire soundscapes found in written and video accounts as well as my own experience, I intend to show how sound studies can augment our existing conceptions of situational awareness.

Bio: John Widman is a PhD student in UCLA's Ethnomusicology Department focusing on ways that music and culture interact. Spending eight seasons (2006-2013) as a wildland firefighter based in Alaska, he is interested in the relevance of contemporary studies in sound to the firefighter.

CLIMATE/WEATHER/ FIRE EXTREMES

127. Fire Extremes and the Triangle of Climate, Fuels and People (Part 1)

Presenter(s): Tamara U. Wall

Additional Author(s):
Timothy Brown, Director, Western Regional Climate Center, DRI

Over the past decade or so, statements by fire personnel claiming unusual fire behaviour beyond training or experience levels seem to be increasing. Concurrently, climate and weather extreme events have been increasing, fuel loads have notably increased due to both natural occurrence and management practices, an human populations have been expanding into the wildland and rural interfaces. All of these factors appear to be intersecting causing an increase in "extreme" fire events based on another fire triangle of climate, fuels and people. Sometimes fire personnel are surprised at how large a fire becomes. In some cases, the extreme event is truly a surprise; in other cases, while seemingly a surprise at the time, upon further reflection perhaps it should not have been. In either event, personnel safety can easily be at higher risk during extreme events, as these situations tax critical thinking given they are outside the common fire experience.

For this project, we employed a novel methodology that used micro-stories gathered from firefighters about their experiences with unusual, impressive, or surprising wildfire behavior. In combination with a quantitative question framework, these individual observations form a dataset that focuses on identifying weak signals and patterns in the context surrounding these events. Concurrently, a quantitative assessment of the several extreme wildfires has examined the climate conditions surrounding these events. If, as there appears to be, a convergence of fire extremes and the triangle of climate, fuels and people—understanding the relationships between these elements, which are likely to be weak signals that can move into alignment, will be integral to gaining a better understanding public and firefighter safety under hotter, drier, conditions.

This presentation discusses project results that focus on understanding the situational factors and context behind firefighters' observations about unusual or surprising wildfire behavior to 1) determine if situational awareness factors

can be identified to lessen the surprise of these events; and 2) provide recommendations that incorporate knowledge of extreme events into fire management training.
Keywords: Fire extremes, large fires, human factors, climate, fuels, fire behavior, risk, safety

Bio: Dr. Tamara Wall is an assistant research professor at the Desert Research Institute and works with the Western Regional Climate Center, the Center for Climate, Ecosystems, and Fire Applications, and the California-Nevada Applications Program (part of the national NOAA-sponsored Regional Integrated Sciences and Assessments network). Current projects include (1) a co-PI on a USDA AFRI sponsored project using a participatory modeling approach in the Tahoe Basin, (2) Working with agencies and organizations in southern California to develop the Santa Ana Wind Threat Index and (3) as lead PI on the Fire Extremes project with the USFS Wildfire RD&A group.

128. Fire Extremes and the Triangle of Climate, Fuels and People (Part 2)

Presenter(s): Timothy J Brown

Additional Author(s):
Nick J. Nauslar, Graduate Research Assistant, Desert Research Institute
Tamara U. Wall, Assistant Research Professor, Desert Research Institute

Over the past decade or so, statements by fire personnel claiming unusual fire behavior beyond training or experience levels seem to be increasing. Concurrently, climate and weather extreme events have been increasing, fuel loads have notably increased due to both natural occurrence and management practices, and human populations have been expanding into the wildland and rural interfaces. All of these factors appear to be intersecting causing an increase in "extreme" fire events based on another fire triangle of climate, fuels and people. Sometimes fire personnel are surprised at how large a fire becomes. In some cases, the extreme event is truly a surprise; in other cases, while seemingly a surprise at the time, upon further reflection perhaps it should not have been. In either event, personnel safety can easily be at higher risk during extreme events, as these situations tax critical thinking given they are outside the common fire experience.

In Part 1 of this project presentation, the methodology of gathering micro-stories from firefighters about their experiences with unusual, impressive, or surprising wildfire behavior is described. These stories represent the firefighters perception of the event. Linking physical environmental aspects of fire to human perceptions of extreme fire and surprises is challenging. It requires a quantitative assessment of fuels, weather, climate and fire behavior that corresponds to the event. Part 2 of this project presentation describes utilizing case studies of environmental conditions that correspond to a set of firefighter narratives. Utilizing quantitative information based on factors such as fire danger, fire behavior and weather, these elements can be examined for their statistical representation of an extreme event. The degree of extremeness can then be assessed in the context of the firefighter perception.

The overall project goal is to examine a convergence of fire extremes and the triangle of climate, fuels and people—understanding the relationships between these elements, which are likely to be weak signals that can move into alignment. This is integral to gaining a better understanding public and firefighter safety under hotter, drier, conditions. This presentation, Part 2 of 2, describes the physical environment components of extreme fire and the relation to firefighter perceptions.

Keywords: Fire extremes, large fires, human factors, climate, fuels, fire behaviour, risk, safety

Bio: Dr. Tim Brown conducts applied research and applications development at the Desert Research Institute in Reno, Nevada. His primary academic interests include analysis of wildland fire-climate and fire-weather connections; the fire environment; applications development for wildland fire management planning, decision-making and policy; the interface between science and decision-making; and co-production of knowledge. Dr. Brown is Director of the Western Regional Climate Center, and established and directs the Program for Climate, Ecosystem and Fire Applications (CEFA) at the Desert Research Institute in Reno, Nevada. He is also graduate faculty in the Atmospheric Sciences Program at the University of Nevada, Reno.

POSTER PRESENTATIONS

P1. Forest Fire Safety Handbook: updating training literature for the Spanish spoken community

Presenter: Raul Quilez

Additional Author(s):
Enrique Mérida, Researcher, Universidad de Cordoba
Joaquin Ramirez, Principal, Technosylva

Statistics show that from 1910-2013 in US there is a record of 1075 deaths from wildfires. In Spain, many fighters were injured and 276 killed in Spain working on forest fires from 1979-2010 (Cardil & Molina, 2013).

Publications regarding safety in forest fires suppression are widely dispersed and mostly in English, which makes them quite inaccessible to the different Spanish spoken crews and staff.

This manual collects in a logical and updated way all the knowledge in fire safety issues. It starts with Fire behavior (Chapter 1), followed by extreme fire behavior and surprising phenomena (Chapter 2), followed by a deep analysis of existing safety standards (Chapter 3). It follows with best ways to apply safety procedures to most common workflows (Chapter 4). A summary of accidents and incidents, that can serve to any unit to review safety standards are addressed, with a special emphasis on what triggered these entrapments (Chapter 5). Finally, we conclude by proposing a training program, with a series of safety exercise that units can apply to improve the safety in their daily work (Chapter 6).

Keywords: fire safety, fire behavior, study cases, training materiasl

Bio: Raul holds a MsC Wildfires (MasterFuego program) and a BsC in Forestry. He works for the Valencia Firefighters agency as Foresty specialist and Incident Commander from 2003. He has a long experience in extreme behavior fires in Mediterrranean areas since 1992, being one of the most respected professionals in Spain, with collaboration in national training.

P2. Interactive 911 Program

Presenter: Sandra Inman-Carpenter

Additional Author(s):
Tiffanie Santi-Sachse Lead prevention Officer
Kevin Robinson Prevention Technician

The 911 presentation is an updated version of the 1980's 911 model created by the state. What we have done on the Stanislaus is improve this program and use available technology to make it even more appealing and realistic to kids, as well as covering the four learning styles (visual, kinesthetic, auditory, and reading) by creating an interactive version that consists of ten 3-4 minute video's depicting real life incidents as the incident/accident progresses. We teach the important things they need to know such as; their addresses, phone numbers, landmarks, cross streets - and of course when it's appropriate to use the 911 system and how to use it correctly.

A 'Student' is chosen from the classroom/audience to be the one to call our 'mock' 911 dispatcher (they are prompted to do so in the video). And while only one student does the actual "reporting" - we encourage the whole class to help out the reporter if they get stuck (as 3rd graders frequently do).

Statistics have shown that role playing is an especially good way to address various emergency scenarios and give your kids the confidence they'll need to handle them. (Kids Health,2010)

Bio: Started my fire career with the California Conservation Corps in 1987 on a hand crew and cook specialist at the Santa Clara CCC Fire Center. Started working as a fire fighter with CDF, Napa California in 1991 where I began my volunteer in prevention with CDF in 1993. In 2001 I started working with US Forest Service as a fire engine operator in Nevada and continued to volunteer in prevention activities. In 2007 I became the Lead Prevention Technician on the Calaveras Ranger District and received my BS in Criminal Justice and Investigations in 2010.

P3. The Role of Departments of Transportation in Wildfire Response

Presenter: Wesley Kumfer

Additional Author(s):
Micah-John Beierle, Independent Researcher
Sanjaya Senadheera, PHD, PE, Texas Tech University
Phi Nash, PE, Texas Tech University

The state of Texas suffered a devastatingly serious wildfire season in 2011. In order to better prepare for future fires and to more effectively use available resources, the state determined that additional training for emergency assets was necessary. As one of the supporting agencies responsible for wildfire management, the Texas Department of Transportation (TxDOT) determined that the maintenance division needed to be properly instructed as to how to most safely and effectively be deployed for wildfire response. The Texas Tech University Center for Multidisciplinary Research in Transportation (TechMRT) was contracted to develop and provide this training.

The TechMRT research team developed an in-depth training program through several steps. First, an in-depth literature review was conducted to determine how TxDOT fits into the hierarchical structure of the state Emergency Support Function (ESF) annexes and what its specific role was in the wider state emergency management framework. Second, six training modules were developed to address the following topics: wildfire response overview, organization and communication, equipment and resources, safety, data collection and management, and training materials. Last, these six modules were incorporated into an implementation project, and nine Wildland Fire Management Training Workshops were hosted.

The results of these workshops exceeded expectations. Course responses indicated a unanimous level of approval for the training, and oral communication revealed a dire need for improved training, particularly regarding safety and education, that was met by the implementation workshops. Attendants felt that after the workshops they better understood their role in wildfire response and management and could make better assessments of risk. Overall, this project revealed the critical functions and supportive roles for departments of transportation in wildfire management.

Keywords: Department of Transportation,Wildfire Management,Safety,Organization

Bio: Wesley J. Kumfer, M.S., is a research assistant and graduate course instructor at Texas Tech University. He has co-authored over 15 research reports, IAC reports, and research products on behalf of the Texas Department of Transportation (TxDOT) in the areas of traffic engineering, corridor analysis, bicycle policy, strategic research, and wildland fire response. Additionally, his doctoral research focuses on transportation and traffic safety. Mr. Kumfer is passionate about education, and began teaching courses and attending educational workshops in early 2013.

P4. Gender and Leadership in Wildfire Suppression: Women Leaders on the Fireline

Presenter: Rachel Reimer,MA Candidate, Royal Roads University

Introduction:
Recent research has characterized wildland firefighting as a "highly masculinized occupation" (Pacholok, 2013, p. 13) and as a "means through which traditional gender roles and power relations are maintained" (Eriksen, 2014, Intro para. 3). The "marginalisation of emotion[sic]" and a "masculine way of engaging with risk" in the ranks of wildfire suppression

agencies have necessitated that women engaging in fireline roles must comply with and model the masculine culture (Eriksen, 2014, p. 129). One case study describes a binary within wildfire, wherein "good firefighters are masculine, and bad firefighters are unmasculine or feminine" (2013, p. 55). The most recent research on gender and wildfire provides comprehensive insights from Australia, the United States, and Canada. Eriksen, in her comparative work based in New South Wales, Australia and California, U.S.A., concludes that "the gender issues...clearly cut across geography and employment status" (2012, p. 129). Both Pacholok and Eriksen question the individual agency of female wildland firefighters as being capable of affecting positive change in the realm of gender (Eriksen, 2012, p. 146; Pacholok, 2013, p. 102). And yet positive change is happening (Pacholok, 2013, p. 114). Women have entered the fireline and have progressed to earn positions of leadership within many wildfire suppression agencies.

Research Question

There are women in fireline positions of leadership who constitute "boots on the ground" - whose daily "micro-level, face-to-face interaction(s) can also spark change" (Pacholok, 2012,p. 113). This study seeks to understand if / how women in operational, fireline-based positions of leadership are creating and sustaining positive Prepared by Rachel Reimer for the International Association of Wildland Fire change in wildfire suppression. Are there commonalities between women successful in leadership within wildfire suppression - in personality, leadership style, interpersonal relationships with supervisors, peers, and subordinates, and in their level of task related fireline skills (e.g. chainsaw operation)? If there are commonalities, can these successful habits of women leaders on the fireline be taught, trained, or facilitated at a program-wide level? This study seeks to assess the currently existing successes that wildfire suppression agencies are experiencing among women leaders, and to build on these successes in a way that is relevant and directly meaningful to wildland firefighters at all levels.

Bio: Rachel Reimer earned a BA in International Development Studies from the University of Winnipeg in 2010. During her studies she conducted research with the U.N.W.R.A. Lebanon
Women's Program on capacity building for women leaders in refugee camps. She worked for the Institute for Community Peacebuilding in Winnipeg, MB facilitating nonviolent
communication. She is undertaking her MA in Leadership Studies at Roads University (Victoria) 2015-16. She is an Initial Attack Crewleader with the British Columbia Ministry of Forests, Lands, and Natural Resource Operations, Wildfire Management Branch. This is her fifth season on wildfire suppression crews.

P5. The Sounds of Wildland Firefighting in Action: Communication Research Study

Presenter: Elena Gabor

Additional Author(s):
Rebekah L. Fox, PhD, Assistant Professor, Texas State University
Dave Thomas, Renoveling, Ogden, Utah
Jennifer Ziegler, PhD, Associate Professor, Dean of Graduate School, Valparaiso University
Anne Black, PhD, Rocky Mountain Research Station

The goal of this poster presentation is to share what we have learned about the process of conducting research on radio communication practices in wildland fire. How people talk to each other using radios and other communication devices during an incident to maximize principles of high-reliability organizing mindfulness is not well understood. Furthermore, the current training in radio communication best practices tends to be mostly informal and inconsistent across fire organizations. By focusing attention on how interactions and sensemaking in the field are shaped by available technologies, this study, funded by the Joint Fire Science Program, seeks to benefit members of the inter-agency wildland fire community and the human factors research community.

Specifically, our research project seeks to accomplish the following goals: (a) to understand how people make sense of radio messages on an incident while distributed geographically; (b) to understand opportunities as well as practical and cultural constraints within current radio and other practices for communicating risk; and (c) to understand how interactions in the field are shaped by the available technologies.

Although our overall goal may seem straightforward, the process of researching radio communication in wildland fire is complex and presents several obstacles. Our study involves observing communication in multiple contexts (active fire incidents, training simulations, and dispatch centers) as well as conducting follow-up interviews, and analyzing actual radio transmissions. This poster will reveal the steps that have been taken to accomplish this type of research with the intent of producing research articles and conference presentations that contribute to both theory and practice and increase firefighter safety. We will discuss developing project goals, interviewing people in the field, navigating human subjects review processes, and the producing materials such as "Informed Consent Forms," "Interview Protocols" and "Observation Protocols", etc.). Additionally, we plan to engage IAWF conferences goers in a conversation about our project in order to learn from their experiences communicating on wildland fires. We hope that by introducing this study to the IAWF community during the combined Safety Summit and Human Dimensions Conferences, we will gain feedback on our methods and support for our study.

Keywords: radio; communication; sensemaking; research protocols

Bio: Elena Gabor received her B.A. in Journalism and her M.A. in Media Management from the University of Bucharest, Romania. Subsequently, she received a second M.A. in Communication from Virginia Polytechnic Institute and State University (Blacksburg, VA) and her Ph.D. in Organizational Communication from Purdue University (West Lafayette, IN). Elena Gabor has been at Bradley University since 2008, where she has taught courses in the Organizational Communication unit. Her research interests focus on radio communication in wildland fire, organizational resilience, and sensemaking.

P6. Social "Watch Out" Situations for Incident Management Teams

Presenter: Toddi Steelman

Additional Author(s):
Branda Nowell, Associate Professor, School of Public and International Affairs, North Carolina State University
Clare FitzGerald, School of Public and International Affairs, North Carolina State University
Mary Clare Hano, School of Public and International Affairs, North Carolina State University

In addition to managing the biophysical aspects of large wildfires, Incident Management Teams (IMTs) must also manage the social aspects of the fire. However, we have a much more sophisticated understanding of the biophysical risks related to wildfire than the social risks. Land cover type, topography, soil moisture, humidity, fuel loads, wind, and weather are common in the vocabulary of most fire managers. We are much less conversant in the language related to risks for problematic communication and coordination among responding agencies and how these risks can be assessed and managed. However, many experienced IMTs implicitly manage for these social or relationship risks during a wildfire. We harvested the experience of 24 highly experienced fire managers, which included US Forest Service and Bureau of Land Management Fire Staff, Fire Chiefs, State Forestry officials, Forest Supervisors, and Sheriffs, all of whom served on IMTs in different capacities from across the United States (10 states) so that we might more explicitly and systematically understand those risks and share that knowledge. We further worked with Area Commanders, Incident Commanders, and Deputy Incident Commanders to identify and confirm the top most challenging social watch out situations faced by IMTs and the social watch out situations most commonly faced by IMTs. Articulating this list and providing some discussion about these situations and what can be done to effectively manage them could lead to better safety outcomes for IMTs.

Keywords: Social Watch Out Situations, Risk Management, Communication, Incident Management Teams

Bio: Toddi Steelman is Executive Director and Professor, School of Environment and Sustainability (University of Saskatchewan). Her research focuses on improving the governance of environmental and natural resources, emphasizing science, policy, and decision-making interactions. She places special emphasis on the role of the public and community in decision-making. She is Co-director, with Dr. Branda Nowell, of the Fire Chasers project at North Carolina State University (research.cnr.ncsu.edu/blogs/firechasers/).

P7. Australian volunteer rural fire brigades: the value of historical perspective

Presenter: Sandra Lauer

Wildfire has shaped much of Australia's ecological landscape and is a fundamental part of those ecological processes. However, fire has not only changed the ecological landscape in Australia. It has also shaped how Australians think of themselves as a people. Every local community has its own memories of fire; stories of survival, disaster and heroism. Some of these events, such as the 1939 Black Friday fires, the 2009 Black Saturday fires in Victoria and the 2003 Canberra

Firestorm, are etched in the story of the nation. Other smaller, localised bushfire events also have long lasting impacts on local communities, even if they are relatively unknown elsewhere.
Understanding historical events as trigger points and analysing supporting historical documents, personal stories, narratives and photos provides an opportunity to unpack "wicked problems" that are often seen as being unsolvable. The professionalisation of fire management is one such "wicked problem" that has emerged as being a catalyst for disharmony.

Volunteer rural fire brigades are an essential part of these local and national historical narratives about fire and their histories are a valuable means of understanding how fire regimes and responses to fire have changes over time.

This paper will present preliminary research findings on the changing functions of such volunteer rural fire brigades in the Monaro region, New South Wales. The paper will explore how such an in-depth historical analysis enriches the development and understanding of some of the key research questions being asked. In this way, the paper argues that historical analysis is an important method for providing context for fire-related research but also sheds new light on current "wicked problems", such as the professionalisation of fire management, that have evolved in response to complex local, national and international pressures.

The paper also suggests that historical analysis can then help inform future fire management strategies within New South Wales and Australia, within the broader context of national policy changes.

Keywords: volunteer rural fire brigades, Australia, New South Wales, Monaro, history, narrative, bushfire, wildfire, case study, sociology, fire management

Bio: Sandra is a PhD scholar in the Department of Sociology at the Australian National University. She completed her Masters degree in Geographical Sciences in 2010. Sandra is also an active volunteer firefighter in the NSW Rural Fire Service.

P8. Fire Adapted Communities Learning Network

Presenter: Michelle Medley-Daniel, Fire Adapted Communities Network Program Manager, The Watershed Center

The Fire Adapted Communities Learning Network (FAC Network) is an innovative approach to accelerating wildfire adaptation efforts across the US. Modeled after the Fire Learning Network, which has been operated by The Nature Conservancy and their federal and community partners for nearly a decade, the FAC Network connects communities that are working to create more resilient landscapes, communities and institutions.

The multi-scalar, cross-sector approach to adaptation that is being demonstrated by FAC Network participants offers lessons about resilience, community relationships to fire, and varied organizational cultures and approaches. Brief case stories profiling several of the communities participating in the FAC Network will offer attendees insight into how these communities are learning, adapting and sharing innovations and best practices.

Bio: Michelle Medley-Daniel is the Watershed Research and Training Center's Fire Adapted Communities Learning Network Program Manager. In her role she both manages the network's operations for the organization, and also acts as a liaison in the network—directly working with communities throughout the west to improve their wildfire resilience. She holds bachelor's degrees in English and Studio Art from Humboldt State University. For the past ten years Michelle has been coordinating networks of environmental educators and rural communities, as well as providing communications and development services to non-profits.

P9. Knowledge for Wildfire; improving management of UK wildfire through knowledge exchange

Presenter: Julia McMorrow, Senior Lectuer in Remote Sensing and NERC Knowledge Exchange Fellow, University of Manchester, UK

Bio: Julia is a physical geographer and Senior Lecturer in Remote Sensing at the University of Manchester (UK). She holds a nationally-funded Knowledge Exchange Fellowship, leading the Knowledge for Wildfire project. Previously, she led the FIRES seminar series – fire interdisciplinary research on ecosystem services. As a member of the England and Wales Wildfire Forum and other national fire-related groups, she works closely with the Fire Services, land managers and other stakeholder communities to help provide evidence-based recommendations on wildfire policy. Her action research includes using satellite and Fire Service data to analyse spatial and temporal patterns of UK vegetation fire risk.

P10. Students of Fire: Local actions to support global issues

Presenter(s): Kelsy Gibos MSc., Wildfire Management Specialist, Edson Wildfire Management Area, Forest & Emergency Response Division, Alberta Environment & Sustainable Resource Development

Additional Author(s):
Roger Strickland, Senior Instructor, Country Fire Authority
Rod Stebbing, Principle Consultant, Emtrain Fire & Community Safety Pty Ltd

Paul Gleason left a legacy of thinking firefighters whose safety was linked to their application of fire science principles at the fireline. His vision fostered experiential learning where knowledge was passed from those bearing battle wounds of near-misses to those just beginning their inherently risky wildland fire career.

Australian wildfire educators Roger Strickland and Rob Stebbing have co-founded a unique community of practice called Students of Fire (SoF) under the auspices of IAWF. Driven by their personal experiences with a near-miss tanker burnover, SoF was developed as a platform for sharing. SoF is about activity and continual improvement; it is about local action to learn about a global issue. It builds connections across the wildfire community and a dialogue between firefighters, researchers, local government authorities, educators, and all those with responsibilities in wildfire.

SoF recognizes the value in informal sharing of personal experiences; it is born from those in-camp-after-dinner reflections between strangers on what was supposed to happen, what really did happen and attempts to explain discrepancies. It arises from a need to fuzz out jurisdictional borders and a desire to challenge the science of fire behaviour prediction. SoF is for thinkers; it is about inquiry and a search for understanding. It is a safe place to ask questions, to step outside of the boundary of the 'norm' and to challenge the use of terms like 'unprecendented', 'unexpected', 'extreme' and 'unforseen'.

This presentation outlines the mission of the Student of Fire project and provides details on how to participate at the workplace level. It is delivered by a practicing SoF who will provide tips to help ignite mindfulness about the relationship between science and safety and encourage calibration based on personal experience.

SoF highlights that the language of fire amongst those who observe it is universal. Comradery is widespread amongst personnel whether it is national or international boundaries that are breached by a spreading fire. Emergency management environments change over time and space, but the mathematics of fire spread and the feeling of heat on skin will remain the same.

Keywords: Students of Fire, Paul Gleason, experience-based learning, global fire community, lessons learned

Bio: Kelsy Gibos is a fire behaviour specialist who has observed and studied fire behaviour in Canada, New Zealand and Australia. Her experiences abroad have ignited an interest in sharing lessons learned especially with regards to the application of science at the fireground. Her focus is in finding a way to translate complex, peer-reviewed scientific information into practical, on-the-ground feet-in-the-ash applications. She currently resides in Edson, Alberta, Canada with her partner Travis and their two Australian cattle dogs.

P11. The Incident Risk Console (RisC) – A Risk Assessment Synopsis for Wildland Fires

Presenter(s): Lisa Elenz, Deputy Program Manager, Wildland Fire Management Research Development & Application program, Rocky Mountain Research Station, US Forest Service

Additional Author(s):
Thomas Zimmerman, Senior Wildland Fire Consultant, Tom Zimmerman Consulting
Sean Triplett, Geospatial Manager, US Forest Service Fire and Aviation Management
Morgan Pence, Fire Application Specialist, US Forest Service Wildland Fire Management RD&A
Mitch Burgard, Fire Technology Transfer Specialist, US Forest Service Wildland Fire Management RD&A
Jill Kuenzi, Geospatial Coordinator, US Forest Service Fire and Aviation Management

Wildland fire complexity is increasing dramatically and presenting difficult problems and concerns for wildland fire management agencies. To improve decision-making and management capability, managers need more and better information about changing fire dynamics. Numerous information management systems exist and others are under development to provide improved wildland fire information, but systems providing risk assessment information are currently lacking. As a result, the US Forest Service National Director of Fire and Aviation asked if a new system to access and display such information from a variety of sources could be designed. The Incident Risk Console (RisC), a data analytics dashboard and business intelligence tool for wildland fire decision makers, was developed to provide national fire program managers with relevant fire information for emerging and complex ongoing wildfires. RisC information goes beyond available fire statistics and includes specific calculated information and indices that afford a visual risk assessment synopsis for wildland fires, an early alert/risk assessment for potential problem areas, and an overview summary of national and regional incidents. RisC includes eight specific risk attributes that summarize a range of conditions and activities on a fire-by-fire basis. These are: values Inventory, jurisdictions, significant fire potential, relative risk, suppression capability, aviation exposure, modeled values at risk, and modeled suppression effectiveness. The initial Incident Risk Console represents the transformation of an idea into an actual system. The 2014 fire season allowed for a test and an evaluation of its applicability. It was found to have specific value in providing new information useful in: clarifying the overall fire situation, understanding individual fire dynamics, and improving understanding of the effects of management decisions.

Keywords: risk assessment, information technology, decision-making

Bio: The WFM RD&A provides the latest research to the field through the development of tools, training, and by providing decision and analysis support. Until fall 2009 she was the FMO at Grand Teton National Park, previously working as the AFMO. She worked seasonally on crews and engines at Grand Canyon and Yosemite National Parks until she was hired permanently 1994 working in suppression, prescribed fire, fuels management, structural fire and emergency operations. She graduated from college in with a General Chemistry Degree, minoring in Mathematics and Nutrition from Northern Arizona University.

P12. Fire in Southern Ecosystems

Presenter: Adam Kent, Ecologist, Normandeau Associates, Inc.

Additional Author(s):
Christine Denny, Principal Scientist, Normandeau Associates, Inc.
Jim Brenner, Fire Management Administrator, Florida Forest Service

An important obstacle to prescribed burning has been the lack of effective, coordinated, targeted fire education programs. Because financial support often results from public support, it is important to have a constituency that supports prescribed fire. In general, residents of the southeastern United States do not have a good understanding of prescribed fire or of the natural role of fire. Understanding these two concepts is important for the public, especially in Wildland Urban Interface areas where wildfire risk is high.

Many Florida fire managers believe Florida's severe wildfires of the late 1990s resulted from fuel buildup due to public resistance to prescribed fire. At that time in Florida, very few public school teachers and a smaller number (than might be expected) of park and nature center staff were regularly teaching about fire. The Fire in Southern Ecosystems (FISE) curriculum was started in Florida as a Florida-specific program to provide educators with the background, knowledge, and skills they need to teach about fire. FISE is a free workshop and curriculum package for educators of all types. The goal of the FISE program is to engender a citizenry that supports prescribed fires. The program is expanding from Florida to other states in the Southeast and can be used as a model for fire education programs in other regions as well.

Evaluation is key to improving the FISE program over time. A needs assessment was conducted and received input from more than 1,200 educators. Participants show statistically significant changes in knowledge and attitudes about fire immediately after, and even years after, attending a workshop. During more than 150 workshops in the past 15 years, this program has reached 95% of the school districts in Florida and more than 3,000 educators, with a potential impact of more than 1 million people. Workshops are coordinated and taught by Normandeau Associates, Inc., for the Florida Forest Service. The FISE curriculum and teaching resources are available to download for free from www.fireinsouthernecosystems.com.

Keywords: Fire, Southeast, Southern, Ecosystem, Education, Program, Community, Resiliency, Teach, Educator
Bio: Adam Kent is an Ecologist with Normandeau Associates with more than 20 years of professional experience as a wildlife biologist. His background includes securing funding for fire teams across the Southeast and instructing on fire ecology. Adam has written management guidelines, management plans, and educational materials that incorporate fire.

P13. What We Talk About When We Talk About Fire: Words, Media, and Wildfire

Presenter: Alexandra Weill, Graduate Student Researcher, UC Davis

Additional Author(s):
Jeff Kessler, Graduate Student Researcher, UC Davis

News articles, blogs, and other media can shape the way that people understand and perceive wildfire, and public perception can play a large role in wildfire policy. Using online databases of news articles and blogs and natural language processing techniques, we examine the most common words and phrases in wildfire-focused writing to uncover patterns in tone, word-choice, and coverage of topics including destruction of human structures, firefighting, climate change, ecology, and policy. We test the hypothesis that disaster-focused reporting is common and ecological content rare, which could limit understanding of broader issues in fire science and shape opinions on the use of fire suppression, prescribed fire, or other management strategies. We break down the data by region and time period in order to reveal trends over time and understand whether local fire history is reflected in wildfire media. These data will help those in the wildfire community understand what messages the public may be receiving and lay the groundwork for broader study in fire communication and education.

Keywords: wildfire, communication, news articles, language processing, public perception

Bio: Alexandra Weill is a PhD candidate in the Graduate Group in Ecology at UC Davis. Her research focuses on the effects of changing fire regimes on plants, ecological communities, and people and seeks to understand the resilience of both ecosystems and human society in the face of climate change and development of the wildland-urban interface.

P14. Big questions, local answers: Awareness and preparedness of unprepared people in Idaho

Presenter: Elise Thiel, Boise State University

Additional Author(s):
Dr. Thomas Wuerzer, Assistant Professor, Boise State University

This poster presents two aspects of wild fire related research. First, it shows briefly the educational outreach within the NSF Idaho EPSCoR program with a focus on wildfires. The Experimental Program to Stimulate Competitive Research (EPSCoR) in Idaho inspires undergraduates to explore research experiences in new emerging fields at graduate level.

Second, as the fire and social sciences aspect, this poster presents localized answers, with emphasis on the Treasure Valley and Boise, Idaho, to the increased presence of wildfires and the likelihood to influence the level of awareness and preparedness of residents in a specific area. These impacts depend on duration, re-occurrences and magnitude of the hazards, yet also on the institutionalized memory of the community and the places where the hazards occurred.

Using a complex dataset on wildfire risk and awareness at the wildland urban interface focusing on university population, this poster shows the relationships between homes and residences and areas of perceived high wildfire risks. Utilizing GIS and statistical methods, we spatially explore disconnects between being aware, prepared, and unaware/unprepared in a select population that has or has not property ownership.

Anticipated results of this study will support a) future regional planning and wildfire mitigation efforts, and b) the understanding of socially vulnerable population without property that is equally at risk compared to homeowners.

Keywords: Socially vulnerable population, perceived risk, disconnects

Bio: Elise Thiel is an undergraduate of Environmental Studies at Boise State University and native to Idaho. She worked as a park ranger in Idaho and scheduled to graduate in May 2015. Her interests are wildfires and water issues. She was awarded to the 2014-2015 NSF Idaho EPSCoR MURI program. Over the course of 4 months, she explores graduate studies as a research assistant to Dr. Thomas Wuerzer on topics of wildfires, regional planning, and social vulnerability.

P15. Collaborative Landscape and Community-Level Wildland Fire Management Planning and Implementation within the Resort Municipality of Whistler, British Columbia, Canada

Presenter: Nicholas O. Soverel, B.Sc. (University of Vermont), M.Sc. (University of British Columbia), Forester-in-Training

This poster presents an example of successful fire and fuel management planning within the Resort Municipality of Whistler (RMOW) through the collaboration of local and provincial government, forest consultants, First Nation representatives, timber licensees, and private land owners.
B.A. Blackwell and Associates, Ltd. began the process of developing and implementing various wildfire management plans and prescriptions for the RMOW in 2005. Since 2005, our firm completed a Community Wildfire Protection Plan (CWPP) with an update to this plan in 2011. Successful implementation of the CWPP has included individual fuel treatments projects in high-value neighbourhoods and immediately adjacent to the Whistler Blackcomb ski development and adjacent hotels and infrastructure. In 2013 our firm was engaged in developing a landscape-scale fire behaviour modeling report to the municipality which has been implemented through the treatment of one of the eleven primary fuel breaks identified in this analysis. In the summer of 2014, B.A. Blackwell participated in direct consultation with private landowners through the use of the Provincial B.C.'s FireSmart program. These highlighted projects in conjunction are an example of successful local government planning and provides a potential model to protect communities in other municipalities

Bio: Nick joined B.A. Blackwell & Associates Ltd. in 2013 and leads Blackwell's Specific Claims research and report writing effort. He works in the areas of fire and fuel assessment and management within the Resort Municipality of Whistler. He also works in timber harvest planning and cruising within the Interior of British Columbia.

Prior to joining the Blackwell team, Nick worked as a Rangeland Data Specialist where he analyzed and processed large amounts of ecological information for research and land management purposes. Nick was a member of the Integrated Remote Sensing Studio within UBC's Faculty of Forestry where he researched the topic of characterizing burn severity using remote sensing techniques within western Canadian National Parks.

P16. BRINGING THE FIRE ADAPTED MESSAGE TO ADA COUNTY

Presenter: Jerry McAdams

The Fire Adapted Communities Learning Network (FACLN) encourages the development and sharing of best practices to accelerate the adoption of fire adapted community concepts nationwide. The FACLN supports eighteen hub organizations and pilot communities that have committed to implementing and sharing the FAC-centric work that they are conducting, in order to increase their communities' resilience to a real and historic threat of wildfire. Funding for the FACLN is provided by the USDA Forest Service's Fire Adapted Communities Program and participants' matching funds. The FACLN is cooperatively managed by the Watershed Research and Training Center and The Nature Conservancy.

Meeting one of the focal points of the National Cohesive Wildland Fire Management Strategy of creating Fire Adapted Communities, the Boise Fire Department, in partnership with the FACLN, acts as the hub organization for the Ada County FAC. One of the underpinning values of the FACLN is that "Collaboration and partnerships are keys to successful adaptation." In this spirit, the City of Boise Wildfire Mitigation Team (WMT) has taken great strides to identify stakeholders and build collaborative partnerships, both internally and externally.

The City of Boise has created an interdepartmental Wildfire Mitigation Team (WMT), comprised of individuals from Fire, Parks, Planning and Public Works. Boise City staff have successfully partnered with federal agencies, not-for-profits, local university research teams, local environmental study groups, volunteer organizations, civic groups, small businesses, developers, as well as homeowners' and neighborhood associations, to reduce wildfire risk and increase community awareness. Through the relationship with the FACLN, the City of Boise WMT has had the privilege and opportunity to network and exchange ideas with other FACLN hub organizations throughout the United States. In additional, the association with the IAWF has also provided international networking opportunities for the City of Boise WMT.

This poster presentation will highlight many of these collaborative partnerships, as well as several years of FAC-centric work in Ada County.

Keywords: Fire Adapted Communities Learning Network Ada County FAC FACLN Partnerships Best Practices Collaboration National Cohesive Strategy

Bio: Jerry McAdams is the Wildfire Mitigation Coordinator for the Boise Fire Department, where he has worked for 15 years. He serves on City of Boise and Multiagency Wildfire Mitigation Committees. He is a Board Member for the International Association of Wildland Fire and holds an NWCG certification as a Wildland Fire Investigator. Jerry has previously presented at Backyards & Beyond, a Ready, Set, Go! webinar, an Idaho Power luncheon and at the Southwest Idaho Wildfire Mitigation Forum. Jerry has a Bachelor of Science in Psychology from Boise State University. He enjoys working with communities and seeking new, cooperative partnerships.

P17. Ranching with Fire: Livelihoods, Resiliency and Adaptive Capacity of Rural Idaho

Presenter: Kyle McCormick

Additional Author(s):
Thomas Wuerzer, Ph.D, Assistant Professor, Boise State University

Wildfires have different faces – the spectacular forest fires and the equally devastating rangeland fires. This poster presents the challenges of rural areas that are in close proximity to fire prone areas presenting high risk not only by the fire event but also by its long-term effects. The threat that wildfire poses for rural communities goes beyond personal and household safety, but also threatens to diminish their economic livelihoods-- being a multidimensional threat.
An increase of fire activities suggests the threat of post-event impacts such as the greatly reduced availability of summer ranges on federal land for livestock grazing. The time-consuming restoration efforts of federal rangelands results in additional extreme hardship on such communities. This situation creates tension between federal agencies, ranchers, and other involved stakeholders due to the amount of efforts spent in preparing, responding, and recovering. The high personal/economic value of property in these areas creates a higher risk associated with wildfire, therefore creating a necessity to consider creative solutions for adapting. The adaptive capacity and resilient nature of rural ranching communities depend on regional planning efforts to coordinate and collaborate on mitigation efforts for pre-fire activities, timely response during the event and post-fire restoration actions.
Within Idaho, one such effort is to create better regional partnerships and cohesion with the Rangeland Fire Protection Associations (RFPA) program. The RFPA program, headed by the Idaho Department of Lands, gives rural communities a platform on which to build regional adaptive capacity. This program aids ranchers with training to be first responders to wildfires and the opportunity to create a collaborative relationship between themselves and government agencies.
This poster will present findings on how the RFPA's regional planning efforts can create rural town resiliency. This includes lessons learned and reflections of existing Idaho RFPA's. This case study on rural wildfire mitigation is supported by semi-structured interviews, and spatial analysis using GIS.
Anticipated findings will help planners (federal, state and local), firefighters, RFPA's, and range management specialists to gain a better understanding of the livelihoods at stake and the adaptive capacity of ranching communities and therefore create resiliency.

Keywords: resiliency, vulnerability, ranching, rangelands, wildfire

Bio: Kyle McCormick will receive his Masters of Community and Regional Planning from Boise State University in the Spring of 2015. Kyle spent two summers working in Stanley, Idaho where he experienced two large wildfires that had critical implications for the small rural town. From then on he has been interested in how communities can become better prepared for large wildfires. At Boise State University he works and researches with Dr. Thomas Wuerzer on issues in the wildland urban interface. Kyle has engulfed himself as a student of wildfire, and hopes to one day help communities prepare for wildfire.

P18. Enhancing Community Response-Utilising existing information networks during bushfires

Presenter: Kathy Overton

Inquiries undertaken after major bushfires in Victoria Australia invariably mention difficulties with information flow to and throughout communities during bushfires, as well as highlighting that a significant number of people continue to be unprepared for bushfires when they occur.
Considerable improvements in the timing and dissemination of warnings and information during bushfires have occurred since the Black Saturday Bushfires of 2009. Emergency Service Organisations (ESOs) have given increased priority to the provision of information to communities under threat of bushfire. Great emphasis is placed on planning for bushfires, both at personal and community level by fire agencies.

However, people without bushfire plans and people getting helpful, reliable, timely, and tailored information, when and how they need it during bushfires, continue to be major challenges. Understanding how communities communicate and disseminate information outside of times of disasters will help develop strategies that will assist during times of disaster. Connecting existing emergency structures and processes with existing community networks and processes during bushfires and other emergencies must be considered if we are to increase the effectiveness of community response.

Building on a project undertaken in 2011, this presentation discusses ways that local governments and communities (including ESOs), may work together to better utilise existing information networks within communities during disasters. It will also encourage discussion on how new approaches may enhance community response and resilience when bushfires threaten, as well as barriers to changing perspectives.

Keywords: existing, networks, connecting, barriers, trust, complexity, support

Bio: As a result of training as a firefighter during her time as an environmental educator, Kathy Overton went on to work as a fire educator and community engagement specialist for Victorian fire agencies for 12 years.
During that time Kathy was responsible for the coordination of the early development of the AIIMS Information Officer role and training for the Victorian Government's forest firefighting organisation. More recently she has supported fire agencies in the improvement of warnings and community information dissemination during emergencies.
For the past three years her foremost interest has been community response during bushfires, primarily the importance of community networks in dissemination of information.

P19. Fires of Change: An Art and Science Collaborative

Presenter: Andrea Thode, PhD, Associate Professor, Northern Arizona University

Additional Author(s):
Barbara Satink Wolfson, Program Coordinator, Southwest Fire Science Consortium
Andrea Thode, Associate Professor, Northern Arizona University
Cari Kimball, Program Coordinator, Landscape Conservation Initiative, NAU
Collin Haffey, Ecologist, USGS Jemez Mountains Field Station

The Southwest Fire Science Consortium (SWFSC) has expanded its target audience to include the public and based on the success of a similar project in Alaska, we developed an art and science collaborative called Fires of Change. This is a collaborative project with the SWFSC, the Landscape Conservation Initiative and Flagstaff Arts Council. The goal was to create a stronger link among fire, landscape conservation and climate change; making the newest scientific ideas more accessible to non-science oriented audiences through novel media. Bringing science and art together is not a new concept, but perhaps more important in our current world view, considering the changes we face on a global scale. Artists bring unique perspectives which may lead the public to see science differently. As part of the project, we held multi-day field trips to areas around northern Arizona. We visited the North Rim of the Grand Canyon to learn about their successful fire program and we visited the Slide Fire to learn about the successes in promoting ecologically beneficial fire even during a suppression incident. During the field trips, artists, managers and scientists were all present and contributing to conversation about fire ecology, historical fire regimes, changes in the last century due to human intervention and changes occurring due to a shifting climate. Artists will have a year to produce artwork based on what they learned during the field trips.

Keywords: art, collaboration, fire science, public education

Bio: Andrea E Thode (Andi) is Associate Professor of Fire Ecology and Fire Science in the School of Forestry at Northern Arizona University. Andi completed her B.S. and later her Ph.D. in fire ecology through the Ecology Graduate Group at the University of California, Davis. Her research focuses on fire effects at the local and landscape scale. Andi has been heavily involved in the Association for Fire Ecology (AFE) since its inception as a founding board member, education committee chair and member and through development and planning of several regional and national level conferences. Andi has been the Principal investigator for the Southwest Fire Science Consortium since its inception in 2009.

P20. We all play a part- Bushfire Ready Neighbourhoods

Presenter: Peter Middleton, Community Development Coordinator, Tasmania Fire Service. Member of the International Association for Public Participation.

Additional Author(s):
Mai Frandsen, Dr- Reseacher, University of Tasmania

From pilot to program, the Tasmania Fire Service community development approach - the Bushfire Ready Neighbourhoods program.

In 2009 the Tasmania Fire Service embarked on a community development pilot program with the aim of trialling a community development approach to bushfire preparedness in a number of targeted communities that have a higher level of bushfire risk.

Critical to the approach was to build a strong evidence base by collaborating with the University of Tasmania, Australian Fire and Emergency Services Council (AFAC) and the Bushfire Cooperative Research Centre. This included the publication of a PhD thesis by Dr Mai Frandsen in 2012 titled: 'Promoting community bushfire preparedness: Bridging the theory – practice divide'. This collaborative research approach is leading the nation in informing best practice in community bushfire preparedness and has created a sound evidence base in Australia.

Since undertaking this pilot program Tasmania Fire Service has embarked on the implementation of a strategic community development program - Bushfire Ready Neighbourhoods including the employment of dedicated Community Development Officers across Tasmania. This has a long-term goal of embedding community development and engagement in the organisation's culture and the way we work with communities to share the responsibility for bushfire.

Peter will share the key learnings from this research. He will discuss key themes, what has worked, what has not and practical ideas that people working and volunteering at all levels in community bushfire preparedness can take from the research.

Key topics Peter will discuss include:
- 'One size does not fit all' community development approach;
- Case studies from Tasmania;
- Research and human behaviour analysis;
- Best practice community engagement;
- Evaluation techniques;
- Tools, techniques and approaches to building resilience.

National Winner of the 2014 Resilient Australia Award- the award recognises excellence and innovation in disaster resilience.

Keywords: shared responsibility; capacity building; community development; resilience; prevention; preparedness; organisational change; community led approach; engagement; research; evidence base.

Bio: Peter Middleton is the Community Development Coordinator at Tasmania Fire Service in Hobart, Tasmania, Australia. Peter's role develops community capacity to prevent, prepare for and respond to bushfires and fires in the home. Peter coordinates the Bushfire Ready Neighbourhoods program which aims to increase shared responsibility and has a vision that 'we all play a part- individuals, fire agencies and communities'. A member of the International Association of Public Participation. Peter has hands on firefighting experience as a Volunteer and Remote Area Firefighter in Australia for 15 years.

Peter has a passion for evidence based community development in emergency management which is demonstrated in the success of the program.

P21. Boulder County Wildfire Partners - Home Ignition Zone, Education, Certificates, Case Studies and iPads

Presenter: Ryan Ludlow, Forestry Education and Outreach Coordinator, Boulder County Colorado

Wildfire Partners is a new and innovative way to help homeowners prepare for wildfires. We provide a comprehensive, 2-4 hour assessment of the home ignition zone; a customized report detailing actions homeowners should take; a rebate for mitigation work; and a follow-up certification to ensure that the homeowner is as prepared as possible. In 2014, we easily enrolled our target of 500 homes and conducted 450 assessments.

Meetings between Boulder County staff and some of the nation's leading wildfire mitigation scientists—Jack Cohen and Steve Quarels—helped build our program design. We focus on the need to create effective d-space, retrofit homes and maintain the efforts over-time. The latest social science highlights the importance of education and the need to explain the real hazard homeowners' face. This is why we require each homeowner to actively participate in their home assessment.

Our program is using an innovative home assessment tool, an iPad app, which can be easily replicated in other communities. The app is powerful and allows us to capture photos and annotate them directly in app. Wildfire Partners is rich in data. All data we collect via the iPads is tracked in salesforce, a powerful database. Data can be analyzed by home, fire district, and mitigation measure. We also track the total hard dollars and hours of labor each homeowner contributes. At this presentation we will share our data, case studies and stories from homeowners who are benefiting from the program.
After homeowners complete all required mitigation measures we re-visit their property. If they pass their inspection we issue a Wildfire Partner Certificate. Allstate Insurance has announced their support for the initiative by being the first insurance company to accept our certificate.
The program has proven very popular with participants. In a recent survey, 91% of respondents said they are very likely or likely to refer a friend or neighbor to the program.

Our presentation will provide an overview of our program design, our innovative approach, the iPad assessment tool and why we believe Wildfire Partners is designed for success.
To learn more about Wildfire Partners visit: http://www.wildfirepartners.org/

Keywords: Wildfire Mitigation; Home Ignition Zone; Defensible Space; Home Retrofits; Education and Outreach; Case Studies; Certificates; Technology; iPad Assessment Tools; Mitigating Fire Risk; Understanding Risk; Wildland Urban Interface; Building Resilient Commun

Bio: Ryan Ludlow coordinates the Forest Health Outreach Program for Boulder County in Colorado. Ryan passionately promotes the need for proactive wildfire mitigation and understands the importance of designing effective educational programs. In 2010, the Fourmile Fire ignited in the foothills of Boulder County destroying 169 homes. This fire motivated Ryan and Boulder County to do more to help residents prepare for future wildfires. Over the past few years he has built a wide-reaching educational network that is working. Homeowners are taking personal responsibility and when you visit the foothills of Boulder County you can see the impact.

P22. First Nations Wildfire Evacuation Partnership

Presenters:
Tara K. McGee, PhD, Associate Professor, University of Alberta
Amy Christianson, Fire Social Scientist, Natural Resources Canada, Canadian Forest Service

Thousands of Canadians are evacuated from their homes every year to protect the health and safety of residents during wildfires. Despite comprising only 4% of the Canadian population, almost 1/3 of wildfire evacuations between 1980 and 2007 involved Aboriginal people. In 2011, thousands of residents in 35 Aboriginal communities in Alberta, Saskatchewan and Ontario were evacuated due to the close proximity of the fire, smoke or power outages due to wildfires. The First Nations Wildfire Evacuation partnership brings together researchers, First Nations communities in Ontario, Saskatchewan and Alberta that were evacuated due to recent wildfires, and agencies responsible for conducting or providing support during these evacuations. The aim of this partnership is to examine how First Nations residents and communities were affected by recent wildfire evacuations and identify ways to reduce negative impacts of evacuations on First Nations people. This research will provide participating communities with information about how residents in their own and other communities were affected by recent wildfire evacuations and factors that influenced residents' evacuation experiences. The results of this research may assist First Nations communities to prepare for and carry out future evacuations, and may also assist government agency partners in their evacuation decision making and support activities. This research partnership may also enhance relationships between partnership members and develop a shared understanding of the impacts of wildfire evacuations on First Nations people. The research carried out by this partnership aims to contribute to the evacuation literature by exploring wildfire evacuations in Aboriginal communities, a topic that has received little attention in Canada and internationally.

Bio: Tara McGee is an Associate Professor in the Department of Earth and Atmospheric Sciences at the University of Alberta. For the past 15 years, her research has focused on the human dimensions of hazards, mainly focusing on wildfires. Tara leads the First Nations wildfire evacuation partnership.

P23. INSIGHT + ACTION = RESILIENCE Proven Results from Wollombi Australia

Presenter: Glenn, O'Rourke, BSc(Hons) MBA, Deputy Captain Wollombi Brigade, New South Wales Rural Fire Service

A strategic and targeted approach to building resilience in the high bushfire (wildfire) risk community of Wollombi has generated remarkable results beyond that of research findings reported by the Australian Bushfire and Natural Hazards Cooperative Research Centre [BNHCRC] between 2009 and 2014.
Nestled in a rugged valley north west of Sydney, the small rural village of Wollombi is bordered on all sides by extensive eucalypt forest. The risk of bushfire is high, with major fires occurring in 1994, 2001, 2002 and 2004.

INSIGHT - community resilience insights arising from research.
A review of findings of BNHCRC research conducted to investigate community responses to bushfire threat over seven studies between 2009-2014 reveals generally low levels of risk perception, planning and preparation to survive bushfire. Findings provide a clear focus for 'engagement action', and recognition of shared responsibility required to improve bushfire survival.

ACTION - responding to what we have learned from the research.

In 2005, the volunteer Wollombi Rural Fire Brigade established the Wollombi Valley Bushfire Safety Program. Driven by constant measurement and community feedback the program has continued to innovate, developing a series of integrated risk based initiatives specifically targeted at closing the survival planning, preparation, decision-making gaps highlighted in the BNHCRC research.

RESILIENCE - building stronger community resilience and a better prepared community.

The Wollombi model of integrated risk based community engagement has not only achieved significant increases in community bushfire risk awareness [from 0% to 73%], preparation skills [from 34% to 94%], decision making [from 7% to 90%] and planning [from 9% to 95%], but has most significantly achieved measured tangible behavioural change in both the 'preparation for' [91% prepared/well prepared/very well prepared] and 'response to' bushfire [79% plan implementation] as evidenced by the findings of locally conducted research. Most significantly, 51% declare they have a written Bushfire Survival Plan compared 5.4% of people surveyed by the BNHCRC.

CONCLUSION

The Wollombi experience presents strong proof that a strategic and targeted approach to community bushfire safety works…. achieving tangible behavioural change and significantly improved community resilience. The Wollombi Rural Fire Brigade program is a leading example of a highly effective localised research based program driven by volunteers.

Keywords: Wildfire; Community Safety; Volunteer Program; Resilience; Survival Planning and Decision Making

Bio: Glenn is Deputy Captain and Community Safety Officer of the volunteer Wollombi Rural Fire Brigade, of the New South Wales Rural Fire Service, Australia. He holds the NSW RFS Commissioner's Commendation for Service.
Glenn commenced service as a volunteer over 30 years ago and is passionate about community bushfire safety. Over the past 10 years he has driven the development and implementation of what is regarded as cutting edge, best practice community engagement.
Professionally, Glenn is a strategist with an international construction company, and has a background in business strategy, change management and stakeholder communications.
Glenn holds a Bachelor of Science (Honours) and Master of Business Administration.

P24. Assessment of the Barriers to Wildland Firefighters' Fitness Training

Presenter: Aria Mangan, M.S. Candidate, Research Assistant, University of Montana

Additional Author(s):
Aria Mangan, Research Assistant, University of Montana
K. Ann Sondag, PhD. Project Director, University of Montana
Joseph Domitrovich, PhD. Exercise Physiologist, University of Montana and MTDC

Introduction: Working on a wildland fire can be physically and mentally taxing. Given the physical demands of the job, fitness is a key component in keeping wildland firefighters (WLFFs) healthy and safe from injury. Unfortunately little is known about physical training (PT) regimens of WLFFs.
Purpose: The purpose of this study was to examine motivators and barriers to PT in WLFFs. Personal, interpersonal, organizational and environmental factors that influence PT were identified. Strategies for overcoming barriers were recommended.
Methods: This study utilized a descriptive research design. Information about PT practices was collected through interviews with key informants (i.e. individuals in leadership positions who work directly with crew members). Interview data was analyzed qualitatively. Additionally, a questionnaire was developed, reviewed by experts, pilot tested and distributed electronically to WLFFs. Questionnaire data was entered in the SPSS statistical program. Barriers and motivators to engaging in PT among distinct categories such as agency type and crew type were examined for differences among the categories.
Results: Fourteen interviews were conducted with key informants from multiple state, federal and volunteer agencies. Two over-arching concepts emerged from interviews as major influences on PT. The first concept, firefighter culture, encompassed several themes. Themes included the powerful influence of leadership and the desire to be seen as a strong, capable and dependable crew member. The second concept, environment, included the influence of factors such as training facilities and equipment and the need for more holistic education about PT and health. Preliminary questionnaire results from nearly 1000 firefighters reveal the most frequently identified barrier to PT to be projects and work related trainings taking precedence over PT. Multiple motivating factors were identified including having a supervisor that participates in PT and wanting to be seen as a strong crew member.
Conclusions: This project was an attempt to gain an understanding of the current physical training practices of wildland firefighters. More importantly, results from this study identify, from the perspective of the firefighters themselves, the major motivators and barriers to engaging in quality, consistent physical training.

Keywords: Physical Training, Barriers, Motivators,Wildland Firefighters

Bio: Aria Mangan has a B.A. in Biology with a minor in Health and Human Performance. Aria is currently a Master of Science Candidate at the University of Montana studying Health and Human Performance with an emphasis in Community Health. Aria has six seasons of wildland fire experience working for the Forest Service in Region 4 and Region 1. Aria is currently working as a Research Assistant at the University of Montana.

P25. Polycyclic Aromatic Hydrocarbon Exposure from Prescribed Fire

Presenter: Kathleen Navarro

Additional Author(s):
John R. Balmes, Professor, University of California, San Francisco
S. Katharine Hammond, Professor, University of California, Berkeley

Background: Wildland firefighters work in high smoke exposure conditions with little to no respiratory protection. Wood smoke contains many hazardous air pollutants, including polycyclic aromatic hydrocarbons (PAHs). PAHs are known for their cancer-causing potential and have been associated with increased cancer risk of and immune system dysfunction. Past studies have demonstrated that open-air burning of wood generates more gas-phase PAHs such as naphthalene, phenanthrene, and fluorene than particulate-phase PAHs.

Objective: Gas-phase PAHs were measured during 5-day prescribed burn training. Air samples were collected during holding, firing, and mop-up at broadcast burns.

Methods: Personal PAH air samples were collected in duplicate using standard methods (actively-sampled XAD sorbent tubes) and analyzed for naphthalene, phenanthrene, acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, pyrene, and retene. Information on job task, smoke intensity and exposure duration was also recorded.

Results: Naphthalene (NAP) and phenanthrene (PHE) concentrations were highest while firing and holding (NAP= 2280 ug/m3; PHE = 160 ug/m3). Concentrations of naphthalene and phenanthrene were higher during firing (NAP=1480 ug/m3; PHE=110 ug/m3) compared to holding (NAP=760 ug/m3; PHE = 42 ug/m3). Concentrations of naphthalene and phenanthrene were lowest during mop-up (NAP=580 ug/m3; PHE=60 ug/m3).

Conclusion: The levels of naphthalene and phenanthrene measured in this study were significantly higher than those measured in previous studies. It is important to characterize exposures from wildland fires to better understand any potential long-term health effects.

Bio: Kathleen Navarro is currently a doctoral candidate in the Environmental Health Sciences division of the UC Berkeley School of Public Health, where she also completed her MPH degree in 2011. Her dissertation focuses on evaluating new tools and methodologies to measure and calculate exposures to hazardous air pollutants in occupational settings, such as wildland firefighting. She has a Bachelor of Science degree in Environmental Toxicology from UC Davis.

P26. Impact of a Flame Resistant Synthetic Material Base Layer on Heat Stress Factors

Presenter: Matthew Dorton, Masters Student, University of Montana

Additional Author(s):
Joseph Domitrovich PhD, Exercise Physiologist, Forest Service
Brent Ruby PhD, Professor, University of Montana
Charles Dumke PhD, Professor, University of Montana

Protective clothing worn by wildland firefighters (WLFF) may increase physiological strain and heat stress factors due to increased insulation and decreased ventilation. The effect of a flame resistant synthetic material base layer on heat stress factors

Bio: Matt Dorton is a graduating masters student at the University of Montana. His research interests include the physiological responses to exercise and the environment.

P27. Preliminary evaluation of factors affecting inhalation exposures among wildland firefighters

Presenter: Tim Reinhardt

Additional Author(s):
Tim Reinhardt, CIH Associate Scientist, Amec Foster Wheeler PLC
George Broyles, Fire & Fuels Project Leader, US Forest Service

Preliminary Evaluation of Factors Affecting Inhalation Exposures among Wildland Firefighters
In this paper, we present preliminary results of a statistical evaluation of various site, environmental and work activity factors on the shift- and fireline-average smoke exposures among wildland firefighters in the U.S. Inter and intra-crew variability to exposure and exposure metrics for fireline overhead personnel will be presented.

Wildland firefighters work in a dynamic environment and are exposed to a variety of hazards, including inhalation hazards from fire smoke, soil dust and powered equipment exhaust. Potential health effects include short-term conditions such as headaches, fatigue, nausea, and respiratory distress while long-term health effects may include an increased risk of cardiovascular disease.

The USFS under took a four year project to quantify exposure for wildland firefighters across the United States. Data was collected on wildland and prescribed fires in 17 states representing 11 of the 13 NFDRS fuel models. Exposure to carbon monoxide, respirable particulate matter (PM4) and crystalline silica (SiO2) were measured in the breathing zone of firefighters. Direct observation of firefighters was done in order to determine which variables are related to high exposure so that firefighters and fire managers can be better prepared to reduce these exposures. Measurements were also taken at incident base camps. During the four-year study, 7,517 hours of CO measurements on firefighters and 1,554 hours of CO measurements at ICPs and spike camps were taken.

Based on the findings there has been no appreciable reduction in firefighter smoke and dust exposure from levels that previous research had found. Exposure to wildland smoke has direct consequences on the ability of firefighters to remain safe by compromising their ability to think clearly and function at their highest mental and physical level. Exposure to the harmful constituents in wildland smoke must be addressed effectively in order to assure risk management decisions are sound.

Partial funding for this project is comes from JFSP Project Announcement No. FA-FON0013-0001, task statement 2; Health impairment from exposure to fire smoke: Relationships among the National Ambient Air Quality Standards (NAAQS) and industrial health guidelines.

Keywords: Inhalation irritants, carbon monoxide, silica, particulate matter, risk management, firefighter health and safety

Bio: Tim Reinhardt holds a BS in Environmental Science (Washington State University) and MS in Forest Resources (University of Washington) and has over 30 years' experience in air quality, human health risk assessment, and health, safety and environmental compliance. He worked as a wildland firefighter in 1978-79 with the USDA Forest Service, assisted emissions measurement research in the 1980s with the USDA-FS Pacific Northwest Research Station, lead research performing occupational exposure measurements among firefighters in the 1980s and 90s, and has been a Certified Industrial Hygienist since 1992.

P28. Rethinking the Fire Shelter

Presenter(s): Vincent H. Homer

Additional Author(s):
Carol Rice, Wildland resources, Consultant

A review of the statistics yields a questionable life safety record for shelter deployments in burn over and entrapment situations. USFS data indicates a wildland firefighter who deploys a fire shelter in true burnover conditions has a 4% chance of perishing, and a 50% chance of receiving 2nd degree or worse burns if s/he does survive. These statistics and concern over firefighter safety prompted an investigation into a new design from a perspective of thermodynamics and atmospheric survivability. We present data and concepts surrounding the thermodynamics of protecting humans from untenable temperatures, heat flux exposures and hot, toxic gases. Current Fire Shelters rely heavily on reflecting radiant energy from fires but do not provide sufficient protection against convective energy transfer. It is common in burn-over situations for shelters to experience direct contact with flames and high velocity, hot gases. We conducted high heat flux (~80 kw/m2) tests involving flame impingement on original and new generation fire shelter materials as well as heat resistant fabrics used in protective garments. These show that at 80 kw/m2 the inside surface of original fire shelter material reaches 75˚ C in less than 10 seconds. The New Generation, two-layer shelter performs marginally better. The only way to delay the temperature rise within the shelter is to provide insulation and/or heat sink capability. We present the design and test data on ways to delay heat rise, such that inside surface temperature can be held below 50˚C for up to 5 minutes.

The second major problem for the firefighter is maintaining a survivable atmosphere inside the shelter and exposure during repositioning during a deployment. We propose possible solutions for these problems.

It is obvious that adding insulation to the existing shelter configuration will increase the weight and bulk of the unit.

Lighter and less bulky alternative materials and methods of construction will be discussed to reduce this problem.

The talk is intended to inspire a fruitful discussion of the Fire Shelter program using test data and configuration suggestions to improve upon the current Fire Shelter design.

Keywords: Fire Shelter, Burnover survivability, breathable air, thermal burns

Bio: Vincent H. Homer, PE, CSP- My experience includes 40 years of fire related work in industry and government as a safety, fire protection and explosion mitigation engineer as well as a design engineer for an aerial fire fighting company. My most recent project was a fire fighting system to protect personnel in armored vehicle post IED fires. I have also been a wildland fire fighter as well as a volunteer fire fighter in both rural and industrial settings. My education includes a Associate degree in Mechanical Technology, BS in Aerospace Engineering and an MS in Engineering Management. I hold a PE (Mechanical) in three states and am a Certified Safety Professional.

P29. Fire and Debris Flows at the Boise Front

Presenter: Katherine T Gibble, MS Student, Boise State University Department of Geosciences

Additional Author(s):
Jennifer Pierce
Eric Lindquist

The foothills of the Boise Front are closely tied to the citizens that occupy them. Once dominated by sagebrush-steppe, human activity in and around Boise, Idaho has led to the invasion of non-native, flammable grasses. Paired with heightened flammability is continual growth of the Wildland Urban Interface (WUI) and, as a result, an increase in human-caused fire ignitions at the WUI. The cost and risk associated with extinguishing human ignitions and managing the resulting landscape raises the need to recognize patterns of ignition distribution, the unintended consequences they have on the landscape, and where this understanding fits into land management decision making. The risks arising from post-fire landscapes are often poorly understood. While it is known that fire increases erosion on burned watersheds, not all watersheds respond with hazardous post-fire debris flows. Currently, the areas at risk from post-fire erosion at the Boise Front are poorly defined. In fact, Boise has not undertaken a post-fire debris flow assessment, despite the risk inherit to its fire-prone, ignition-laden setting, which contains complex topography known to have produced post-fire erosion in the recent past. Presented here is the work being completed to assess fire-induced debris flows in the Boise Front. Recent work has attempted to quantify post-fire debris-flow probability and volume for the western US (Cannon et al., 2010). These models have been used to inform land managers of debris flow activity risks over several post-fire landscapes (USGS Landslide Hazards Program). Despite their utility, these models were produced using data from forest systems, excluding the influence that rangeland systems may have on the models. Here were present our work applying currently existing post-fire debris flow models over the Boise Front and, with the inclusion of ignitions, modifying these models to inform of hazards that may exist in the highly vulnerable rangeland WUI, and better characterize debris flow risks intrinsic to the geomorphically unique Boise Front for use by land managers and decision makers.

Keywords: post-fire debris flows, hazards, WUI, ignitions

Bio: Katie is pursuing a master's degree in geology at Boise State University. Her interests lie in fire-induced erosion and associated hazards, notably post-fire debris flows and flooding as well as the implications of these hazards on decision making.

P30. Modeling Potential Fire Behavior Changes Due to Fuel Breaks in the Monterey Ranger District, Los Padres National Forest, California

Presenter: Stacy Drury, PhD, Senior Fire Ecologist, Sonoma Technology Inc.

The Monterey Ranger District (MRD) of the Los Padres National Forest and its partner, FireScape Monterey, are proposing to re-establish and maintain a set of fuel breaks around the Ventana Wilderness. The proposed fuel breaks are intended to 1) increase fire suppression efficiency, 2) reduce wildfire risk to life and property near the MRD and surrounding communities, 3) reduce wildfire suppression costs, and 4) reduce adverse fire suppression impacts. I used the fire behavior modeling tools in the Interagency Fuels Treatment Decision Support System (IFTDSS) to analyze whether the fuel breaks would increase wildland fire suppression efficiency and reduce wildfire risk to life and property. The project objectives were to a) identify if large fires would occur within the Ventana Wilderness and move into the surrounding wildland-urban interface (WUI), b) identify whether the fuel breaks are strategically located where they will be encountered by wildfire, and c) identify the potential for the fuel breaks to mitigate fire movement into the communities of Big Sur, Palo Colorado, and Cachugua.

I used a multi step process to bring historical fire occurrence, historical fire weather patterns, and fuel model assessments into a fire behavior modeling framework. I modeled potential fire behavior and fire growth across spatial landscapes with and without the proposed fuel breaks simulated in the landscape. Baseline conclusions support preparing and maintaining the fuel breaks. The modeling shows that fuel breaks are strategically placed in locations that have historically burned during wildfires and/or have provided opportunities for fire suppression activities, such as back burning. Alone, and in conjunction with fire suppression actions, the fuel breaks can lower flame lengths and mitigate fire movement, meeting the objectives of the MRD. The lowered flame lengths and decreased rates of spread can provide opportunities for firefighters to use alternative strategies for suppressing fire. Pre positioned fuel breaks can serve as anchor points for creating additional fuel breaks as needed or provide safe areas for igniting back burning operations.

Keywords: Fuels Treatment planning, Fuels Treatment evaluations, Fire Behavior Modeling

Bio: At STI, Stacy provides scientific oversight and technical guidance on fire and fuels research and software development. He conducts research on fuel loading, fire occurrence, fire behavior, fuel consumption, and fire effects. Much of Stacy's research is centered on modeling wildfire hazard and risk – in particular, how fuels treatments mitigate fire hazard and risk to natural resources and communities. He has assessed fuels treatment effectiveness using satellite imagery, modeled fuel loading changes due to fuels treatments, and modeled potential fire behavior and fire effects in the Wildland Urban Interface.

P31. Fuel Treatment Research and Technology Transfer – How to Better Support Practitioners' Needs

Presenter(s): Thomas Zimmerman. Ph.D. Senior Wildland Fire Consultant, Tom Zimmerman Consulting.

Additional Author(s):
Richard Lasko. Natural Resource Consultant. US Forest Service retired
Merrill Kaufmann. Emeritus Scientist, Rocky Mountain Research Station

Significant changes occurring in the wildland fire environment of the United States are generating uncharacteristic shifts in the complexity, behavior, extent, and effects of wildfires. Treatment of wildland fuels to mitigate the risk of severe wildland fire impacts to human communities and valuable natural and cultural resources, and maintain and improve the health and resiliency of forest and rangeland ecosystems is emerging as a keystone land management process. With fuel treatment activities receiving greater attention and scrutiny, it is imperative to find ways to improve overall fuel treatment program effectiveness. The foundation for successfully meeting this challenge is research that addresses pertinent issues and provides actionable information to support management practices. Although much work has been done on this subject, there is a need to provide better guidance to research and development to address high priority knowledge and technology needs. Many questions remain at the center of both management and policy. We conducted a one-year study, supported by the Joint Fire Science Program (JFSP), that surveyed a large number of individuals across the United States from areas including, but not limited to fire and fuels management, research, education, technology transfer, program management, decision-making, and program leadership. From these individuals we gathered fuel treatment research needs; explored the progress of the scientific community in meeting these information needs; examined technology transfer venues that link practitioners to scientific information; and assessed program reference materials, management tools, and other supporting information. From this information, we identified potential areas of future fuel treatment research and possible venues for improving technology transfer.

Keywords: fuel treatment, science, fire management, wildfire, fire risk, technology transfer

Bio: Thomas Zimmerman is senior wildland fire management consultant. He served for 35 years in wildland fire management with the Bureau of Land Management, National Park Service, and US Forest Service in various capacities at all organizational levels. He has worked in areas of fire ecology, fire suppression, prescribed fire, wildland fire use, fire behavior, smoke management, incident management, emergency response, technology transfer, training, national fire policy development and implementation, fire reviews and accident assessments, decision making, risk assessment, and change management. He is a certified Senior Fire Ecologist and Senior Wildland Fire Manager by the Association of Fire Ecology.

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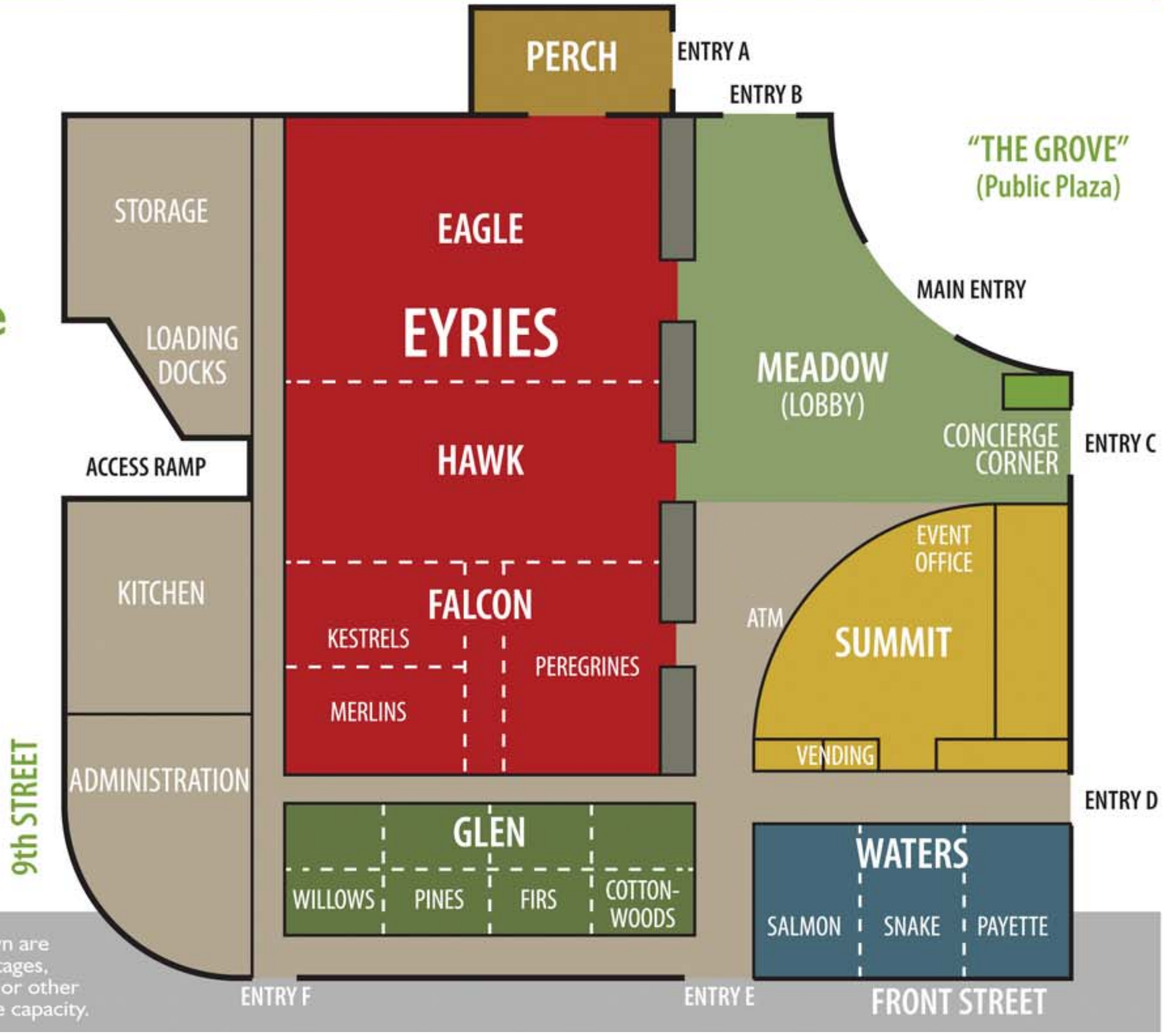

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